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The Relationship between Age and Cerebral Atrophy on Head CT-Scan Examination at Haji Adam Malik General Hospital Medan

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ABSTRACT

Introduction: Cerebral atrophy is a condition associated with brain volume reduction and is a common manifestation of aging. Age is an important factor in the incidence of cerebral atrophy. This research aims to know the relationship between age and the incidence of cerebral atrophy in patients at H. Adam Malik General Hospital Medan.

Methods: This study is an observational analytic study with a cross-sectional design conducted at the Haji Adam Malik General Hospital Medan by collecting head CT scan data from the electronic medical records of 91 patients with the period January 1st 2021 to December 31st 2022. The research time will be carried out from October 2022 to December 2023.

Results: Cerebral atrophy began to be found in the age group of 20-39 years, the largest gender was male (56%), the highest level of education in patients with cerebral atrophy was elementary school / equivalent (66.7%) and D1 to D3 (66.7%), and from the area of residence, patients who experienced cerebral atrophy mostly lived in urban areas (58.7%). The age of onset of cerebral atrophy was found to be 20 years old. The types of cerebral atrophy found in the study subjects were cortical atrophy as many as 49 people (53.8%) and global atrophy as many as 10 people (11%). There was no significant relationship between age and the incidence of cerebral atrophy in patients at H. Adam Malik General Hospital ($p > 0.05$), but there was a significant relationship between age group and the incidence of cerebral atrophy in patients at H. Adam Malik General Hospital ($p < 0.05$).

Conclusion: There is no significant association between age and the incidence of cerebral atrophy in patients at Adam Malik General Hospital. Additional research is needed to gain a comprehensive understanding of cerebral atrophy and its relationship with other risk factors.

Keywords

Cerebral atrophy, Head CT-Scan, Age

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INTRODUCTION

Cerebral atrophy is a condition associated with a reduction in brain volume and is a common manifestation of aging, although it sometimes occurs in some childhood to middle age conditions.[1] According to the National Institute of Neurological Disorders and Stroke, atrophy refers to the loss of cells, and when this atrophy occurs within the brain, it means the loss of neurons and their connectors. This leads to shrinkage of all or part of the brain.[2] There are several causes of brain atrophy resulting in different patterns of brain volume loss ranging from focal, global, central, cortical and hemiatrophy. Imaging of the head is essential for diagnosis, evaluation of lesions and quantification of atrophy. Modalities such as MRI and CT scan can be evaluation tools for cases of cerebral atrophy.[3] Age is an important factor in the incidence of cerebral atrophy.[3] Progressive changes

in brain structure and function, particularly involving cognitive impairment, are a hallmark of aging.1 Cerebral atrophy develops progressively. The decline in brain volume with aging may begin between the ages of 30 and 40 years, although there are other studies that suggest that signs of brain aging begin to appear at the age of 20 - 40 years.[4,5] The moderate atrophy rate at 40 years is estimated to be about 0.2% per year, it accelerates progressively with aging reaching after 70 years about 0.5%/year. At 75 years of age, the brain volume is estimated to be about 10% lower than that measured at 30 years of age.[4]

Many studies have shown that the severity of cerebral atrophy is associated with increasing age. The Resnick et al. study showed no detectable cerebral atrophy over one year, but reported a 15 cm3 increase in ventricular volume over the same period in a cross-sectional data analysis. Subsequent analysis of follow-up data two and four years later revealed a significant association between cerebral atrophy and age.[4] Another study by Paltsyn et al. states that morphological signs of brain aging begin to appear at the age of 20 - 40 years, visible in white matter, and then at the age of 40 - 50 years, visible in gray matter.[5] In summary, the hypothesis that cerebral atrophy is associated with age itself is strong enough for many clinicians and radiologists, using CT scan imaging in assessing cerebral atrophy, researchers will focus on assessing the 2 types of atrophy that generally often occur related to age, namely crotical atrophy and global atrophy. Because of the above background, researchers want to know the relationship between age and the incidence of cerebral atrophy in patients at H. Adam Malik Hospital Medan.

METHODS

This study is an observational analytic study with a cross-sectional design. The study was conducted at the Haji Adam Malik Medan Central General Hospital by collecting head CT scan data from electronic medical records for the period January 1st 2021 to December 31st 2022 with a total of 91 patients. The research time will be carried out from October 2022 to December 2023. Inclusion criteria include age 20 years or over and head CT scan images in patients without comorbidities proven to affect cerebral atrophy. Exclusion criteria are patients with incomplete, missing, or inaccessible medical record data, and motion artifacts on CT scans.

Data collection was carried out by retrieving secondary data from medical records. The data retrieved first were CT scan data of cerebral atrophy that met the researcher's criteria in the form of medical record number, measurement of cortical sulcus width in millimeters, and measurement of ventricular width in millimeters. Then, data on sample characteristics, which are independent variables of this study (age in years, gender, education level, residential area classification), will be extracted, then recorded and collected in a table in an excel file.

Univariate analysis was aimed at obtaining descriptive data regarding the prevalence of cerebral atrophy case findings as well as the characteristic profile of patients with cerebral atrophy, such as age, gender, education level, and area of residence. Descriptions of categorical variables are presented as number (n) and percentage (%) of one digit behind the comma. Descriptions of normally distributed numerical variables are presented as mean ± standard deviation or mean. Descriptions of non-normally distributed numerical variables are presented as median and percentile. Bivariate analysis was used to see the relationship between the independent variable (age) and the dependent variable (cerebral atrophy). Variables were said to be statistically significantly associated when a p value of <0.05 was found. The independent variable age is numerical, so the test used in this analysis is the Eta test. Univariate and bivariate data analysis will be processed with SPSS v.27 statistical software.

RESULTS

The distribution of the study sample can be seen in Table 1. The majority of the samples were male (56%) and had an age range between 20 - 90 years (43.59 ± 16.35). The largest age group in this study sample was in the age group of 40 - 59 years (42.9%). The majority of the samples had a high school education (67%) and mostly lived in urban areas (69.2%).

Table 4.1. Distribution of Research Samples

Variabel	n	%
Age Group		%
20-39 years	38	41.8%
40-59 years	39	42.9%
60-79 years	11	12.1%
> 80 years	3	3.3%
Gender	N	%
Male	51	56.0%
Female	40	44.0%
Education Level	N	%
Not in School	4	4.4%
Elementary school/equivalent	6	6.6%
Junior high school/equivalent	3	3.3%
High school/equivalent	61	67.0%
D1 to D3	3	3.3%
D4 to S1	14	15.4%
Region of Residence	N	%
Urban	63	69.2%
Rural	28	30.8%

In the data normality test, it was found that age was normally distributed ($p>0.05$), while the measurement of cerebral atrophy was not normally distributed $p<0.05$) (Table 2).

Table 4.2. Data Normality Test

Variables	P-value
Age	0.200
Minimum Cortical Sulcus Width	0.020
Maximum Cortical Sulcus Width	0.001
Transverse Ventricular Width	0.000

Table 3. Measurement of Cerebral Atrophy

	Minimum Cortical Sulcus Width (mm)	Maximum Cortical Sulcus Width (mm)	Transverse Ventricular Width (in mm)
Mean ± SD	2.33 ± 0.93	2.88 ± 1.21	22.06 ± 6.55
Median	2.10	2.60	21.0
Minimum	0.90	1.00	11.0
Maximum	4.70	6.00	45.0

From the analysis, the mean minimum cortical sulcus width was 2.33 (0.93) mm, maximum cortical sulcus width was 2.88 (1.21) mm, and transverse ventricular width was 22.06 (6.55) mm. These measurements were then interpreted into a diagnosis of cerebral atrophy. In this study, it was said to be cerebral atrophy if the distribution of cerebral atrophy was cortical sulcus dilation ≥ 2.5 mm and/or transverse ventricular dilation ≥ 30 mm, said to be cortical atrophy if the distribution of cortical sulcus dilation ≥ 2.5 mm, said to be global atrophy if the distribution of cortical sulcus dilation ≥ 2.5 mm and transverse ventricular dilation ≥ 30 mm. The distribution of cerebral atrophy in the study sample can be seen in Table 4.

Cerebral atrophy began to be found in the age group of 20-39 years, but was most commonly detected in the age group of 40-59 years (27 patients). Based on gender, out of 51 male patients, 29 patients (56.8%) had cerebral atrophy. Of the 40 female patients, 20 patients (50%) had cerebral atrophy. The percentage of education level in patients with cerebral atrophy was mostly elementary school / equivalent and D1-D3 at 66.7%. From the area of residence, the majority of patients who experienced cerebral atrophy lived in urban areas (58.7%). All cerebral atrophy patients in this study had cortical atrophy. Some of the cerebral atrophy

patients in this study had global atrophy. These two separate measures of cerebral atrophy had a significant association with the diagnosis of cerebral atrophy used in this study ($p < 0.05$) (Table 5).

Table 4. Distribution of Characteristics of Research Samples on the Incidence of Cerebral Atrophy

Patient Characteristics		Cerebral Atrophy		Total	Atrophy
		Yes	No		Percentage (%)
Age Group	20-39 years	8	30	38	21.0
	40-59 years	27	12	39	69.2
	60-79 years	11	0	11	100
	> 80 years	3	0	3	100
Gender	Male	29	22	51	56.8
	Female	20	20	40	50.0
Education Level	Not in School	2	2	4	50.0
	Elementary school / equivalent	4	2	6	66.7
	Junior high school / equivalent	1	2	3	33.3
	High school/ equivalent	31	30	61	50.8
	D1 to D3	2	1	3	66.7
	D4 to S1	9	5	14	64.3
Regional Type	Urban	37	26	63	58.7
	Rural	12	16	28	42.8
Total		49	42	91	100

Table 5. Relationship between Cerebral Atrophy and Type of Atrophy

Types of Atrophy		Cerebral Atrophy		Total	p value*
		Yes	No		
Atrophy (Cortical)	Yes	49 (53.8%)	0 (0%)	49 (53.8%)	0.000
	No	0 (0%)	42 (46.2%)	42 (46.2%)	
	Total	49 (53.8%)	42 (46.2%)	91 (100%)	
Atrophy (Global)	Yes	10 (11%)	0 (0%)	10 (11%)	0.002
	No	39 (42.9%)	42 (46.1%)	81 (89%)	
	Total	49 (53.8%)	42 (46.2%)	91 (100%)	

* Chi-Square Test

Table 6. Age Group Distribution of Cerebral Atrophy

Age Group	Cerebral Atrophy		Atrophy (Cortical)		Atrophy (Global)	
	Yes	No	Yes	No	Yes	No
20-39 years	8	30	8	30	0	38
40-59 years old	27	12	27	12	5	34
60-79 years	11	0	11	0	3	8
> 80 years	3	0	3	0	2	1
Total	49	42	49	42	10	81
p value*	0,000		0,000		0,000	

The relationship between age group and the incidence of cerebral atrophy is shown in Table 6. From the analysis, significant results were obtained ($p < 0.05$). Comparison with atrophy categories from the measurement of sulcus width and ventricular width, namely cortical atrophy and global atrophy, was also significant ($p < 0.05$). The relationship between age in years and cerebral atrophy is shown in Table 7. From this analysis, the results were not significant ($p > 0.05$). Comparison with other categories of atrophy, namely cortical atrophy and global atrophy, also yielded non-significant results ($p > 0.05$).

DISCUSSION

In this study, the results of the analysis did not find a significant relationship between age and the incidence of cerebral atrophy ($p > 0.05$). However, there was a significant association between age group and the incidence

of cerebral atrophy in patients at HAM General Hospital ($p < 0.05$). We speculate that this finding is due to the wider range of the age variable (in years) compared to the age group variable (in years). That is, while age as a continuous variable did not show a significant association with cerebral atrophy, grouping patients by age did show a significant association. This may be because grouping patients by age allows for clearer comparisons between different age groups, whereas using age as a continuous variable may be less effective due to the wide age range in this study.

A longitudinal study conducted by Scahill et al. investigated the effect of age on global and regional brain volumes and the extent of atrophy in normal aging using MRI. They found significant age-related global and regional brain atrophy. The study found significant decreases in cross-sectional whole brain volume ($p<0.001$), temporal lobe ($P<0.001$), hippocampus ($p=0.003$) and a significant increase in ventricular volume ($p<0.001$) with age.6 Recent research by Markov et al. suggests that the brain aging process is not uniform and varies with each individual. Different brain tissues are affected differently by factors such as age and gender. This study found that brain volume changes that occur in old age are associated with cognitive decline that is different and occurs in various brain tissues.[7]

From this study, it can be concluded that there is an increased prevalence of cerebral atrophy based on increasing age, where at the age of 60 years and above, all patients who participated in this study had cerebral atrophy. There is ample evidence to support the assertion that age has a stronger influence on brain structure in older patients than in younger adults, but the onset and type of decline (linear or nonlinear) depends on the brain tissue and region.[8,9] A common understanding of tissue atrophy suggests that the onset of atrophy in gray matter can occur in young adulthood, around the age of 18 years. In contrast, white matter remains relatively stable until old age. Edman et al. stated that after the age of 35 years, there is a steady loss of brain volume of 0.2% per year, which gradually increases to an annual brain volume loss of 0.5% by the age of 60 years. After the age of 60, the same study showed a steady decline in brain volume of more than 0.5% per year.[10] This study has several possible weaknesses. Firstly, this study only involved 91 patients, which may not be enough to describe the actual situation. The second is regarding the range of age variables. Although the variable age in years did not show a significant association with cerebral atrophy, grouping patients by age group did show a significant association. This may be because grouping patients by age allows a clearer comparison between different age groups, whereas using age as a continuous variable (in years) may be less effective due to the wide age range in this study.

Cerebral atrophy or brain atrophy is a medical condition that affects the brain and is usually found in the elderly population. Based on this study, in the age group of 20-39 years, 21% (8 patients out of a total of 38 patients) had cerebral atrophy, in the age group of 40-59 years, 69.2% (27 patients out of a total of 39 patients) had cerebral atrophy. In the 60-79 years and over 80 years age groups, all study subjects (100%) had cerebral atrophy. This age range is important as it highlights the importance of monitoring brain health as we age. Cerebral atrophy is linked to cognitive decline, which can have a significant impact on a person's quality of life.

There are several studies on the relationship between age and cerebral atrophy. Research conducted by Hua et al. discussed the effect of age and the incidence of cerebral atrophy. They found that there was a small but significant decrease in regional and overall brain volume, as well as a small increase in ventricular volume with age. In addition, they also found significant differences in the extent of atrophy based on age.[11]

Several studies have investigated the relationship between age and cerebral atrophy, especially in global and cortical atrophy with CT scan as a diagnostic method. A study conducted by Ito et al. investigated brain atrophy during aging using CT scans. The study found that brain atrophy increased with age, and the rate of atrophy was higher in men than in women.[12] Another study by Chrzan et al. compared the rate of brain atrophy in people aged 100 years or older, and compared with elderly people aged 70-99 years. The study found that brain atrophy associated with aging is a constantly evolving process, and brain atrophy in centenarians is more severe compared to people aged 70-99.[13]

Based on gender, out of 51 male patients, 29 patients (56.8%) had cerebral atrophy. Of the 40 female patients, 20 patients (50%) had cerebral atrophy. This is in accordance with a study conducted by Yakushiji et al. showing that significant cerebral atrophy is strongly associated with male gender.[14] Research conducted by Hua et al. discussed the effect of gender on the incidence of cerebral atrophy. They found that there was a significant difference in the rate of atrophy based on gender. The rate of brain atrophy in women tended to be 1-1.5% faster compared to men.[11]

From the results of this study, it was found that patients who experienced cerebral atrophy mostly resided in urban areas (58.7%). Another possible reason is the high level of stress compared to living in rural areas. Some of the factors that affect stress levels in urban areas are overcrowding, traffic congestion, high crime rates, many slum neighborhoods, and high pollution. Research conducted by Hunt et al. that there is a strong correlation between living in a slum environment and a decrease in hippocampal volume, which suggests that living in a slum environment may contribute to the incidence of brain atrophy. The effect of living in a slum environment is equivalent to experiencing hippocampal atrophy associated with aging for 7 years. The study also revealed that men and older patients were more likely to have smaller volumes of hippocampus and brain tissue, while higher education levels provided protection with larger brain tissue volumes. The reported findings are in line with a growing body of evidence on the negative health effects of slum environments, and suggest that residential location may be a risk factor for brain volume loss during aging.[15]

In this study, the percentage of education level in patients with cerebral atrophy was as follows: No school 50%; elementary school/equivalent 66.7%; junior high school/equivalent 50%; high school/equivalent 50.8%; D1-D3 66.7%, and D4-S1 level 64.3%. There are several theories and opinions that higher educated individuals are less affected by brain degeneration that have not been fully tested. Research conducted by Nyberg et al. suggests that higher levels of education may slow the rate of brain and cognitive decline in adulthood and old age.[16] Despite theories and opinions that higher education levels may provide protection against brain degeneration, this study found no correlation between education level and cerebral atrophy. Therefore, further research is needed to understand the factors that influence this difference and to gain a more comprehensive understanding of the relationship between education level, cerebral atrophy and cognitive function decline. Other factors such as genetic factors, lifestyle, and environmental factors also need to be considered in future studies to gain a more comprehensive understanding of the factors affecting cerebral atrophy in the wider population.

CONCLUSION

There was no significant association between age and the incidence of cerebral atrophy, but there was a significant association between age group and the incidence of cerebral atrophy. Although this study provides valuable insight into the incidence of cerebral atrophy and its relationship with age, we feel there is still a need to conduct additional studies to gain a comprehensive understanding of cerebral atrophy and its relationship with other risk factors. Overall, monitoring brain health and taking steps to prevent the incidence of cerebral atrophy to preserve cognitive function is essential for improved quality of life in old age.

Declarations

The research has received approval from Faculty of Medicine, Universitas Sumatera Utara of Research and Ethics Committee. Participants were informed about this report.

Consent For Publication

The Authors agree to publication in Journal of Society Medicine.

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Competing Interests
The authors declare that there is no conflict of interest in this report.

Authors' Contributions
All authors are responsible for conceptualization, manuscript preparation, manuscript editing, and manuscript assurance.

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