

Radiological Characteristics and Cognitive Disorders of Dementia Patients at Prof. Dr. Hospital I.G.N.G Ngoerah Period September 2023 - September 2024

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ABSTRACT

Dementia is a progressive neurodegenerative disorder characterized by a decline in cognitive function. Identifying the relationship between radiological characteristics and the level of cognitive impairment can help early detection and intervention planning. This study aims to describe the radiological characteristics and level of cognitive impairment in dementia patients at Prof. Dr. I.G.N.G Ngoerah Hospital during the period September 2023–September 2024. The method used was a retrospective descriptive study of 31 patients who had been diagnosed with dementia at the Neurobehavior polyclinic. The level of cognitive impairment was categorized into mild, moderate, and severe based on the MoCA-Ina score. Radiological characteristics were assessed through Global Cortical Atrophy (GCA), Medial Temporal Atrophy (MTA), Fazekas, and Koedam scores. Results showed that MTA scores tended to increase with the severity of cognitive impairment, with the severe dementia group having an MTA score of 4 at 100%. This finding indicates that a high MTA score is associated with a more severe decline in cognitive function. The implication of this study is the importance of brain radiology examination in predicting the progression of dementia, so that early interventions can be made to slow cognitive decline.

KEYWORDS

Cognitive Impairment; Dementia; MTA Score; MoCA-Ina; Radiology;



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INTRODUCTION

Dementia is a progressive form of neurodegenerative disorder characterized by a significant decline in cognitive function. This decline has a major impact on an individual's ability to carry out daily activities independently. Not only limited to memory impairment, dementia also involves decreased function in various other cognitive aspects such as language, attention, ability to assess situations, as well as executive functions such as planning and decision-making (Gómez-Gómez & Zapico, 2019; Gupta et al., 2021). The disorder develops gradually and over time can lead to total dependence on others in living daily life.

The increase in dementia cases globally is strongly related to the increase in life expectancy and the growth of the elderly population in various countries. The more people who reach old age, the higher the population's risk of degenerative diseases such as dementia. This trend is reflected in global data showing a significant year-on-year increase in the prevalence of dementia. As reported by Kamatham et al. (2024), increasing old age is the main factor driving the surge in the number of dementia cases worldwide.

The World Health Organization (WHO) in 2016 noted that as many as 47.5 million people in the world live with dementia, and every year there are around 7.7 million new cases. This figure shows a huge global burden and indicates that dementia is one of the urgent public health issues that needs serious attention from various sectors, including medical, social, and public policy.

Nationally, Indonesia also faces great challenges related to the increasing number of people with dementia. As a country with a large elderly population, Indonesia ranks eighth in the world in terms of the number of elderly populations. This condition makes Indonesia one

of the high-risk countries in facing the burden of dementia disease in the future. Based on data from the World Alzheimer Report 2016, the estimated number of people with dementia in Indonesia reached around 556,000 in 2015. This number is even projected to increase dramatically to around 2.3 million people by 2030 (Prawiroharjo & Pukovisa, 2022). This projection emphasizes the importance of the national health system's readiness to handle the future surge in dementia cases, including increased capacity for diagnosis, treatment, and support for patients and their families.

The impact of dementia is not only felt by the sufferer, but also places a huge burden on families and caregivers. Furthermore, the social and economic burden of the disease makes it one of the biggest challenges for healthcare systems, particularly in developing countries and countries with high numbers of elderly people. Therefore, a comprehensive understanding of the diagnosis and management of dementia is crucial (Aranda et al., 2021). Clinically, the definition of dementia includes a decline in cognitive function that occurs compared to the patient's baseline condition, as well as a decline in performance in at least two cognitive domains that is severe enough to interfere with daily life (Abayon et al., 2024). To make a proper diagnosis, a neuropsychological examination or cognitive test is required, which generally includes assessment of executive function and attention, memory, language, and other universal domains. These tests help early identification and classification of the severity of dementia so that medical and non-medical interventions can be provided appropriately (Alzola et al., 2024; Hemmy et al., 2020).

The role of neuroimaging in the management of dementia has now significantly evolved compared to its traditional role of only focusing on ruling out possible neurosurgical lesions such as tumors or other structural abnormalities. In modern medical practice, radiological findings can be an important support in establishing the diagnosis of certain neurodegenerative disorders (Hafeez et al., 2025). In fact, in some cases, such findings become an absolute requirement to confirm a diagnosis. A major challenge facing the field of neuroimaging today is how this technology can contribute to the early detection of neurodegenerative diseases such as Alzheimer's disease. Early diagnosis involves recognizing pre-dementia conditions such as mild cognitive impairment (MCI), which are at high risk of progressing to dementia. Early diagnosis allows for timely treatment, both with currently available therapies and those still in development. In addition, neuroimaging is also used to monitor disease progression and has been widely applied in clinical trials examining MCI and Alzheimer's Disease (Asih et al., 2025).

International recommendations also emphasize the importance of brain imaging in the clinical evaluation of patients with suspected dementia. The National Institute for Health and Care Excellence (NICE) in the UK, as well as diagnostic guidelines from Europe and the US, recommend the use of structural brain imaging such as non-contrast CT scans or ideally MRI as part of standard evaluation procedures. MRI is considered to have several advantages over CT, especially in detecting subtle changes in brain structures that are relevant for the diagnosis of dementia. Therefore, MRI is now the main imaging modality widely used in clinical practice (Vernooij et al., 2019; Frisoni et al., 2023).

As explained by Ferreira et al. (2015), a good understanding of the typical findings on MRI results within the framework of a structured diagnostic algorithm may help clinicians to recognize the radiological features of different types of dementia more accurately. While expertise in neuroradiology remains critical in ensuring proper interpretation of brain images, a targeted systematic approach can also improve neurologists' ability to self-analyze imaging studies in patients with suspected dementia.

This MRI examination needs to be performed systematically to detect signal changes or brain atrophy. In this case, the use of T2-weighted sequences or fluid attenuated inversion recovery (FLAIR) is helpful in identifying damage to cerebral blood vessels. However, the

findings of signal changes on such imaging are not limited to vascular, but may also indicate inflammatory processes, metabolic disorders, exposure to toxic substances, or infection, all of which may contribute to the decline in cognitive function. On the other hand, the distribution pattern of brain atrophy, also known as the topographic pattern, has a high predictive value in establishing the diagnosis of dementia, as confirmed in previous pathological studies (Ferreira et al., 2015).

Dementia itself, especially that caused by Alzheimer's disease, generally begins with a phase of mild cognitive impairment (MCI). The most common causes of dementia include Alzheimer's disease (AD), vascular disorders in various forms, dementia with Lewy bodies (DLB), and frontotemporal lobar degeneration (FTLD), among others (Ferreira et al., 2015; Ghouri et al., 2023). To improve diagnostic accuracy, current diagnostic criteria for AD and MCI have begun to incorporate the use of neurodegenerative biomarkers. One important biomarker in this context is medial temporal lobe atrophy (MTA), which can be visually assessed through MRI imaging (Prawiroharjo & Pukovisa, 2022).

In clinical practice, several visual measurement tools such as the MTA score, Fazekas (to assess leukoaraiosis), GCA (global cortical atrophy), and Koedam score (which assesses parietal atrophy patterns) have been used as important indicators. These four scales allow for a relatively quick assessment based on head MRI results. However, widespread application in the clinic is still limited due to the unavailability of cut-off values that are easy and practical for clinicians to use (Prawiroharjo & Pukovisa, 2022).

Prof. Dr. I.G.N.G Ngoerah Central General Hospital (RSUP) in Bali, as one of the major referral hospitals in the region, has great potential as a source of relevant clinical and radiological data for study. In particular, the Neurobehaviour polyclinic at this hospital receives many patients with complaints of cognitive impairment, including patients with a diagnosis of dementia. This provides an opportunity for a retrospective study to assess the clinical and radiological characteristics of patients who have undergone MRI examination and cognitive testing.

Based on this description, this study was designed to describe the characteristics of radiological findings and the level of cognitive impairment in patients with dementia admitted to Prof. Dr. I.G.N.G Ngoerah Hospital during the period September 2023 to September 2024. It is hoped that the results of this study can make an important contribution to the medical community in understanding the correlation between MRI results and the cognitive condition of patients, and assist in making more accurate and personalized clinical decisions for the management of dementia patients.

METHOD

This study used a retrospective descriptive design, which aims to describe the radiological characteristics and level of cognitive impairment in dementia patients based on available medical record data. Retrospective descriptive design is a type of research design that aims to describe or describe certain phenomena based on past data that is already available, such as medical record data, radiology reports, or clinical records. This means that the data used is collected from events or records that have occurred in the past. Researchers do not make direct observations of current patients, but use previously recorded data (such as from documented medical records or radiology examination results).

The study was conducted at the Prof. Dr. I.G.N.G Ngoerah Central General Hospital (RSUP), with a data collection period from September 2023 to September 2024. The study subjects consisted of patients who had previously received a diagnosis of dementia and underwent follow-up evaluation at the Neurobehaviour Polyclinic of the hospital. A sample of

31 patients was purposively selected with the inclusion criteria of patients who had complete data on cognitive function assessment and brain radiology imaging.

The level of cognitive impairment in patients was classified into mild, moderate, and severe cognitive impairment, based on the MoCA-Ina score. This score reflects the condition of the patient's cognitive function and was used as the basis for grouping the study subjects. To assess the radiological characteristics of patients with dementia, brain MRI results were interpreted by focusing on four main parameters. The first parameter is Global Cortical Atrophy (GCA) which is used to assess the overall level of cortical atrophy. Furthermore, Medial Temporal Atrophy (MTA) is an important indicator to evaluate the degree of atrophy in the medial temporal area, which is a brain region that is strongly associated with memory function. The Fazekas score is used to assess the severity of lesions in the white matter, which is often associated with cerebral vascular disorders. Finally, the Koedam score is used to identify the presence of atrophy in the posterior parietal area, which also has a role in cognitive function. All of these radiology interpretations were obtained through direct reading by radiology specialists at Prof. Dr. I.G.N.G Ngoerah Hospital and were professionally approved before being used in the analysis of this study.

The data collected were then analyzed descriptively to determine the distribution of radiological characteristics in each cognitive impairment group. The percentage score of each radiological parameter was compared between groups to see the pattern of relationship between the degree of brain atrophy and the level of cognitive decline.

RESULT AND DISCUSSION

This study included a total of 31 patients who were selected based on specific inclusion criteria to ensure compliance with the study objective, which was to evaluate the relationship between brain radiologic findings via MRI and the degree of cognitive impairment in patients with dementia. All patients underwent examination and data collection at I.G.N.G Ngoerah Hospital, which is one of the referral center hospitals in the region. The study protocol was formally approved by the hospital and deemed ethically and professionally feasible to conduct, thus ensuring that the data collection and analysis process was conducted in accordance with medical research standards.

The data collected included demographic information such as age and gender, as well as clinical characteristics such as history of comorbidities, cognitive score (MoCA-Ina), and radiological visual assessment results (MTA, GCA, Koedam, and Fazekas scores). The full characteristics of these subjects are presented in Table 1, which provides a basic overview of the patient population analyzed. This information is important not only for understanding the context of the study results, but also for assessing the external validity of the findings, including the extent to which the results of this study can be generalized to a wider population of dementia patients.

Table 1. Sample Characteristics

Variable	N=31
Age(years) mean $\pm$ SD	68,2 (SD $\pm$ 5.895)
Genital Type	
Man	20(62,5%)
Women	11(37,5%)
Shoes MoCA-Ina	
18-25 (Mild cognitive impairment)	17 (54,8%)
10-17 (Moderate cognitive impairment)	11 (38,7%)
< 10 (Severe cognitive impairment)	3 (9,6%)
ScoreGlobal Cortical Atrophy (GCA)	

Variable	N=31
0	0 (0%)
1	11(34,4%)
2	19(62,5%)
3	1(3,1%)
Score <i>Mild Temporal Atrophy</i> (MTA)	
0	3(9,4%)
1	4(12,5%)
2	9(28,1%)
3	12(37,5%)
4	3(12,5%)
Score <i>Potter</i>	
0	0(0%)
1	25(78,1%)
2	5(15,6%)
3	1(6,3%)
Score <i>Koedam</i>	
0	1 (3,1%),
1	28 (87,5%)
2	2 (9,4%)

This study involved a total of 31 subjects who had previously received a clinical diagnosis of dementia and met the criteria for further analysis. Based on demographic data, most of the patients involved in this study belonged to the elderly age group, with 29 patients (93.8%) being over 75 years old. Only 2 patients (6.3%) were recorded as being under 75 years old. Although the majority were elderly, the mean age of all patients in this study was 68.2 years with a standard deviation of ± 5.895 . This suggests that the age distribution in this cohort is relatively homogeneous, and most patients are already at an age prone to neurodegenerative disorders such as dementia.

In terms of gender, there were more male patients than female. The number of male patients was recorded at 20 people or around 62.5% of the total sample, while female patients amounted to 11 people or 37.5%. This ratio shows the dominance of male patients in the group studied, although dementia is generally reported to be more common in women, especially at a very advanced age. This difference could be due to hospital population factors, referral characteristics, or other local demographic variations.

Assessment of the patients' cognitive function was conducted using the MoCA-Ina instrument (Montreal Cognitive Assessment Indonesian version), which is a standard screening tool for evaluating cognitive impairment. Based on the MoCA-Ina results, patients were classified into three categories of dementia severity. The group with mild cognitive impairment, i.e. those with MoCA-Ina scores between 18 to 25, included 17 patients or approximately 54.8% of the total population. This indicates that more than half of the patients studied were in the early stages of dementia, where symptoms of impaired memory and other cognitive functions are still relatively mild and may not significantly interfere with daily activities.

Furthermore, the group with moderate cognitive impairment, who had MoCA-Ina scores between 10 and 17, numbered 11 patients or 38.7%. This indicates that almost 40% of patients have experienced more significant cognitive decline, which is generally characterized by disorientation, difficulty in attention and language, and starting to need assistance in carrying out daily activities.

As for patients with severe dementia, with a MoCA-Ina score below 10, there were 3 people or about 9.6%. Patients in this category generally experience severe memory impairment, accompanied by difficulty in recognizing time and place, decreased communication skills, and full dependence on the help of others. Although fewer in number, this group is very important to analyze as it reflects the final stage of dementia progression accompanied by extensive brain damage.

The results of this study also included an analysis of the radiological assessment scores from the patients' brain MRI results, which included the Global Cortical Atrophy (GCA), Medial Temporal Atrophy (MTA), Fazekas (also referred to as the Potter score in the text), and Koedam scores. These four parameters are used to evaluate the extent of atrophy or damage to brain structures in individual dementia patients, and are important indicators in understanding the progress of the disease.

On the Global Cortical Atrophy (GCA) score, which is used to assess the degree of overall atrophy of the brain cortex, the majority of patients were in the moderate atrophy category. A total of 20 patients (62.5%) were recorded as having a GCA score of 2, indicating a significant decrease in brain cortex volume. Meanwhile, 11 patients (34.3%) showed a GCA score of 1, meaning there was only mild atrophy, and only 1 patient (3.1%) was in the severe atrophy category with a GCA score of 3. No patient in this study was recorded as having a GCA score of 0 (no atrophy). These findings suggest that most patients in the study population already showed a moderate degree of cortical damage, which is consistent with a mild to moderate degree of dementia.

For Medial Temporal Atrophy (MTA), which specifically evaluates atrophy in the medial temporal lobe, including the hippocampus—a brain region strongly associated with memory function—the results showed a fairly varied distribution. There were 3 patients (9.4%) with an MTA score of 0, indicating no atrophy. Then 4 patients (12.5%) had a score of 1, indicating mild atrophy. An MTA score of 2 was found in 9 patients (28.1%), indicating moderate atrophy, while 12 patients (37.5%) had a score of 3, and 4 patients (12.5%) showed an MTA score of 4 which is the most severe level of atrophy. Most patients were at MTA scores of 2-3, indicating that atrophy in the medial temporal area had progressed significantly in the majority of subjects. This finding also supports the association between medial temporal lobe atrophy and memory impairment commonly found in patients with dementia, particularly Alzheimer's disease.

On assessment of the Fazekas score (referred to in the text as the Potter score), which is used to assess the degree of white matter hyperintensities (WMH) in the brain, the results showed that most patients (78.1% or 25 patients) were at grade 2. This means that there were moderate changes in the white matter that could be related to impaired blood circulation in the brain. Furthermore, 5 patients (15.6%) were at grade 3, which indicates more severe changes, and 2 patients (6.3%) were at grade 4, which is the most severe form of white matter damage. No patients were recorded at grade 0 or 1, meaning that all patients in this study had experienced at least moderate white matter changes. This is significant as white matter changes often contribute to decreased executive function and cognitive processing speed.

Finally, the results of the Koedam score assessment, which evaluates the presence of atrophy in the parietal areas of the brain—mainly used to help differentiate variants of dementia such as atypical Alzheimer's or posterior variant—showed that most patients were at a low score. A total of 28 patients (87.5%) had a Koedam score of 1, indicating mild or minimal atrophy in this area. Only 2 patients (9.4%) had a score of 2, while 1 patient (3.1%) was noted to have no parietal atrophy (score 0). There were no patients with a Koedam score of 3 or higher in this study. This finding suggests that atrophy of the parietal area has not become predominant in the majority of subjects, and is in line with the hypothesis that parietal atrophy is more common

in certain subtypes of dementia such as posterior variant Alzheimer's, or in more advanced stages of the disease.

Table 2. Characteristics of radiological images in mild dementia

DementiaLight (n=17)					
GCA	0	1	2	3	
Amount (%)	0 (0%)	7 (41%)	10 (59%)	0 (0%)	
MTA	0	1	2	3	4
Amount (%)	2(11%)	10 (58%)	3 (17%)	2 (11%)	0 (0%)
Kodeam	0	1	2	3	
Amount (%)	1 (6%)	15 (88%)	1 (6%)	0 (0%)	
Potter	0	1	2	3	
Amount (%)	0 (0%)	12 (71%)	4 (23%)	1 (6%)	

*GCA = *Global Cortical Atrophy* *MTA = *Medial Temporal Atrophy*

The mild dementia group consisted of 17 samples, with 0 samples having a GCA score of 0 (0%), 7 samples having a GCA score of 1 (41%), 10 samples having a GCA score of 2 (59%), and 0 samples having a GCA score of 3 (0%). (Table 2)

The group of patients with mild dementia consisted of 17 subjects, who showed degrees of brain atrophy that were generally still at the mild to moderate stage. Based on the Global Cortical Atrophy (GCA) score, none of the patients showed no atrophy (score 0) or severe atrophy (score 3). Most patients, 10 individuals (59%), showed moderate atrophy (GCA 2), while the remaining 7 patients (41%) showed mild atrophy (GCA 1). This indicates that despite cognitive impairment being at a mild stage, structural changes in the cerebral cortex have already been detected through radiological imaging.

Meanwhile, on the Medial Temporal Atrophy (MTA) score, most patients with mild dementia (58%) had an MTA score of 1, reflecting mild atrophy in the medial temporal lobe an area of the brain closely associated with memory and other cognitive functions. MTA scores of 2 and 3 were found in 3 (17%) and 2 patients (11%), respectively, indicating that a small proportion of patients in this group had experienced further atrophy. No patients had MTA 0 or MTA 4, indicating that although atrophy was present, none were in the very early (no atrophy) or very advanced stages.

In the Fazekas score, which is used to assess the severity of white matter lesions due to vascular changes, most patients (71%) were at the mild level (Fazekas 1). A total of 4 patients (23%) were at the moderate level (Fazekas 2), and only 1 patient (6%) reached the severe level (Fazekas 3). This indicates that in patients with mild dementia, although there are indications of vascular disorders, most are still in the early stages which may not yet have a significant impact on cognitive function to a large extent.

Finally, based on the Koedam score, which evaluates atrophy in the parietal area (related to spatial orientation and attention), most patients (88%) were at score 1, indicating mild atrophy. Only 1 patient (6%) showed no atrophy at all (Koedam 0), and another 1 patient (6%) had moderate atrophy (Koedam 2). No patient in this group reached the level of severe parietal atrophy (Koedam 3).

Table 3. Characteristics of radiological images in moderate dementia

Dementia Medium (n=11)					
GCA	0	1	2	3	
Amount (%)	0 (0%)	5 (45%)	5 (45%)	1 (9%)	
MTA	0	1	2	3	4
Amount (%)	0(0%)	1 (9%)	3 (27)	6 (54%)	0 (0%)
Kodeam	0	1	2	3	

Amount (%)	1 (9%)	9 (81%)	1 (9%)	0 (0%)
Potter	0	1	2	3
Amount (%)	0 (0%)	8 (72%)	2 (18%)	1 (9%)

*GCA = *Global Cortical Atrophy* *MTA = *Medial Temporal Atrophy*

The group of patients with moderate dementia in this study consisted of 11 subjects who showed a clearer pattern of structural brain changes compared to the mild dementia group. Based on the Global Cortical Atrophy (GCA) score, there were no patients without atrophy (score 0). A total of 5 patients (45%) showed mild atrophy with a GCA score of 1, and the same number also had moderate atrophy with a GCA score of 2. Only one patient (9%) had severe atrophy with a GCA score of 3. These data suggest that at the moderate stage of dementia, cortical atrophy has begun to develop more markedly, reflecting widespread brain tissue damage.

Assessment of Medial Temporal Atrophy (MTA) in this group showed that the majority of patients, 6 people (54%), had an MTA score of 3, indicating moderately severe atrophy in the medial temporal lobe, an area that plays an important role in memory function. The remaining patients had lower MTA scores, with 3 patients (27%) at 2 and 1 patient (9%) at 1. There were no patients with MTA scores of 0 or 4 in this group. These findings indicate that atrophy in the medial temporal area is a major characteristic in moderate dementia and correlates with a more severe decline in cognitive function compared to the mild dementia group.

On the Fazekas score, which assesses the degree of brain white matter damage due to vascular changes, most patients (72%) were mild (score 1). However, there was also a small proportion of patients who showed moderate (18%) and severe (9%) changes. This suggests that although vascular changes are not yet the dominant cause in this group, their contribution is beginning to be seen in a proportion of patients and may worsen cognitive conditions.

The Koedam score, which assesses atrophy in the posterior parietal area, showed that almost all patients (91%) had mild atrophy with a score of 1. Only one patient (9%) showed no atrophy in this area, and another patient had moderate atrophy. No one achieved a score of severe atrophy. This indicates that atrophy in the parietal region has begun to appear but has not yet dominated at the stage of moderate dementia.

Table 4. Characteristics of radiological images in severe dementia

Dementia Weight (n=3)					
GCA	0	1	2	3	
Amount (%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	
MTA	0	1	2	3	4
Amount (%)	0(0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)
Kodeam	0	1	2	3	
Amount (%)	0(0%)	3 (100%)	0(0%)	0(0%)	
Potter	0	1	2	3	
Amount (%)	0 (0%)	1 (33,3%)	1 (33,3%)	1 (33,3%)	

*GCA = *Global Cortical Atrophy* *MTA = *Medial Temporal Atrophy*

The severe dementia group in this study consisted of 3 subjects who showed significant and more severe structural brain changes compared to the mild and moderate dementia groups. On the Global Cortical Atrophy (GCA) score, all patients in this group (100%) had a GCA score of 2, indicating moderate cortical atrophy. No patient had a GCA score of 0, 1, or 3, so it can be concluded that the cortical atrophy in this group was quite widespread, but had not reached the level of severe atrophy (score 3).

The Medial Temporal Atrophy (MTA) assessment in the severe dementia group showed very distinctive findings, where all patients (100%) had an MTA score of 4, which is the highest score and indicates very severe atrophy in the medial temporal lobe, especially the hippocampus area. This indicates that at the stage of severe dementia, damage to areas that play an important role in memory and other cognitive functions is very severe, which is strongly related to the level of cognitive function decline experienced by patients.

For the Fazekas score, which assesses the degree of white matter damage due to vascular lesions, the distribution of scores was fairly even in this group. Fazekas scores 1, 2 and 3 were found in one patient each, at 33.3%. This suggests that white matter changes in patients with severe dementia vary from mild to severe, and vascular factors may contribute to the severity of dementia symptoms in these patients.

On the Koedam score, which assesses atrophy in the posterior parietal area, all patients (100%) had a score of 1, indicating mild atrophy in this area. There were no patients with a Koedam score of 0, 2, or 3 in this group. This finding suggests that although parietal atrophy is present in all patients with severe dementia, the extent is relatively mild and may not be the dominant change in this group.

This study showed a consistent pattern between MRI brain radiologic findings and the severity of cognitive impairment in patients with dementia. In the group with mild dementia, most patients had a GCA score of 2, MTA score of 1, Koedam score of 1, and Fazekas score of 1. These scores indicate that although there has been atrophy or damage to the brain structure, the severity is still relatively mild.

Meanwhile, in the moderate dementia group, it was found that most patients also had a GCA score of 2, but there was an increase in the MTA score to 3. The Koedam and Fazekas scores remained at 1. This increase in MTA score suggests that atrophy in the medial temporal lobe area is becoming more prominent, which is closely related to worsening cognitive function, especially in terms of memory.

In the severe dementia group, there was a further increase in the MTA score, where the entire sample (100 percent) had an MTA score of 4. The GCA score remained at 2 and the Koedam score was still at 1. Meanwhile, Fazekas scores in this group varied, with an even distribution from 1 to 3. The fact that all patients in the severe dementia group had the highest MTA scores reinforces the notion that atrophy in the medial temporal lobe, particularly in the hippocampus region, is an important marker of severe memory impairment.

Overall, the results of this study support a strong association between elevated radiological scores such as MTA, GCA, Koedam, and Fazekas and the severity of dementia. The higher the score indicating structural brain damage, the more severe the decline in cognitive function. The increase in MTA scores consistent with the decrease in MoCA-Ina scores also emphasizes that degeneration in the medial temporal area of the brain has a major contribution to dementia symptoms, especially those related to memory and other cognitive functions.

The findings in this study are in line with the results of a previous study conducted by Asih et al. in 2025. In the study, 222 subjects consisting of a control group and patients with various forms of dementia were evaluated. This study used a visual rating scale to assess atrophy in the temporal lobe. The results showed that this scale had a high sensitivity and specificity of 85 percent in detecting patients with Alzheimer's disease (Asih et al., 2025). This strengthens the validity of using the MTA score as an important indicator in assessing structural brain damage in patients with dementia, especially Alzheimer's disease.

The consistency of these results is also supported by a study by Ferreira et al. which revealed that in late-stage Alzheimer's patients, there was severe atrophy in the hippocampus and medial temporal lobe areas, which was clearly illustrated by the MTA score of 4. In addition, this study also noted that patients in advanced stages showed severe global brain

atrophy, which was reflected by a GCA score of 3 (Ferreira et al., 2015). Both findings confirm the importance of the MTA and GCA scores in describing the severity of dementia, particularly of the Alzheimer's type.

In addition, a retrospective study by Susianti and colleagues in 2024 also provided important insights into the long-term impact of white matter changes in the brain. In the study, 600 elderly people with normal cognitive function were initially evaluated for the role of the Fazekas score as a predictor of disability. The results showed that in the group with a Fazekas score of 3, about 25 percent experienced disability within one year. Furthermore, a three-year follow-up indicated that severe white matter changes independently and significantly predicted a more rapid decline in global function (Susianti et al., 2024).

Another relevant study was conducted by Hall in 2011, who found that MTA scores greater than 3 had a strong correlation with reduced cognitive outcomes in patients. This finding reaffirms the role of the MTA score as an important indicator in evaluating the progressivity of dementia and the potential for more severe cognitive function decline (Hall, 2011).

Patients in the mild stage of dementia generally show low MTA scores, in the range of 1 to 2, and are accompanied by mild GCA scores. These findings indicate that in the early stages of dementia, structural changes in the brain are still limited and not widespread. This is in line with the mild clinical picture, where patients may only complain of mild forgetfulness, without experiencing disorientation or impairment in carrying out daily activities independently (Orgeta et al., 2022).

As the disease progresses towards moderate dementia, MTA scores increase, reaching an average of 3. In addition, there is also an increase in GCA and Fazekas scores. These changes reflect a more widespread neurodegenerative process, with more significant neuronal tissue damage, particularly in the white matter and cortex areas of the brain. These changes also reflect worsening cognitive conditions and partial disruption of daily living functions (Abu-Rumeileh et al., 2019; Festa et al., 2024).

In patients who had entered the severe dementia stage, almost all of them showed the highest MTA score of 4, indicating severe atrophy in the medial temporal lobe, especially in the hippocampus area. In addition, Fazekas scores were also elevated, with many patients showing scores of 2 to 3. These findings emphasize that extensive brain damage, both in the hippocampus and white matter, is strongly associated with severe cognitive decline (Rizvi et al., 2018). Patients in this category generally experience difficulty in remembering, are no longer able to recognize time and place, and require full assistance to carry out basic daily activities, such as eating, bathing, or dressing (Cipriani et al., 2020).

In clinical practice, these findings reinforce the importance of using brain imaging such as MRI as a tool to assess brain structure, thus facilitating early detection and monitoring of dementia progression. Assessment of MTA, GCA, and Fazekas scores can provide valuable information in determining the severity of dementia and in designing appropriate treatment plans for patients.

Meanwhile, the Koedam score used in this study to evaluate the presence of atrophy in the parietal area of the brain also makes an important diagnostic contribution. However, the relatively uniform results with the majority of patients having a score of 1 across groups suggests that changes in the parietal area are not yet very prominent, especially in the early and moderate stages of dementia. It is possible that this method of visual assessment of the parietal area is still insensitive in capturing more subtle changes. Therefore, in the radiological evaluation of dementia patients, the Koedam score should be used as a complement to other scores, rather than as a single indicator in assessing disease progression.

One important finding in this study is the consistency of the MTA score, which shows a progressive pattern as the severity of dementia increases. That is, the higher the MTA score

seen on the patient's brain MRI results, the more severe the degree of cognitive impairment. This fact is of great clinical value, as visual assessment of MTA scores can be a simple, affordable and reliable enough diagnostic tool to be used in daily practice, especially in healthcare facilities that do not yet have access to more complex and expensive neurodegenerative biomarker or imaging technologies (Mårtensson et al., 2020).

A high Medial Temporal Atrophy (MTA) score, especially one that reaches the maximum value as in patients with severe dementia, reflects the presence of very serious brain damage in the medial temporal lobe area, especially in the hippocampus structure. This area plays a crucial role in short-term memory processes, new memory formation, and other cognitive functions related to orientation and recognition. Severe damage in this region leads to severe impairment of cognitive function, which is evident in the clinical symptoms of severe dementia patients such as almost total short-term memory loss, disorientation of time and place, and inability to carry out daily activities independently.

In the context of clinical management, a high MTA score indicates that the patient requires a highly intensive and multidisciplinary approach to care. Medical treatment is not enough to halt disease progression, but psychosocial interventions that focus on maintaining the patient's quality of life, including occupational therapy, cognitive stimulation, and management of behaviors that may arise due to brain damage, are also required. Family and caregiver support is crucial as patients at this stage usually lose the ability to care for themselves and require full assistance in daily activities.

In addition, a high MTA score also reminds medical personnel of the need for long-term planning in care, such as the provision of specialized care facilities, close monitoring of medical complications that may arise, and attention to the psychological well-being of patients and their families. Education for families and caregivers on how to deal with and care for patients with this condition is also an important part of comprehensive management, in order to reduce their stress burden and improve their ability to provide optimal care.

However, it should be noted that not all radiological indicators provide consistent results on cognitive function. Some previous studies have found that the Koedam score, which is used to assess atrophy in the parietal lobe, does not always correlate directly with the patient's level of cognitive impairment (Susianti et al., 2024). Instead, the Koedam score is more often considered as an additional or complementary measure in the evaluation of dementia patients. Research shows that this score is more related to non-cognitive symptoms such as agitation, aggressive behavior, or other affective disorders. In addition, different patterns of brain atrophy may result in varying symptoms. For example, patients with typical Alzheimer's (AD) who show atrophy in the medial temporal lobe will have prominent memory impairment, while patients with posterior atrophy, such as in the posterior cortical atrophy (PCA) variant, will show visual or spatial impairment. In this context, the Koedam score remains useful, especially in distinguishing Alzheimer's type from other forms of dementia such as frontotemporal dementia (FTD).

Although the results of this study provide a fairly strong picture of the relationship between radiological scores and the degree of dementia, the authors also recognize some limitations. This study was conducted retrospectively, so it is highly dependent on the completeness and accuracy of the data contained in the patient's medical record as well as the quality of the MRI imaging used. In addition, the sample size used in this study is still relatively limited and the majority of patients came from one referral hospital, so the results of this study cannot be fully generalized to a wider and more diverse population.

Considering these limitations, further studies are needed that have a prospective design, include a larger sample size, and use a multimodal approach. This could include a combination of structural imaging, liquid biomarkers (such as beta-amyloid and tau proteins), and functional brain imaging such as PET scans. Such follow-up studies are essential to deepen our

understanding of the relationship between changes in brain structure and decline in cognitive function in patients with dementia, and to improve diagnostic accuracy and quality of clinical management going forward.

Thus, the discussion section of this study emphasizes the importance of an integrated approach between radiological examination and neuropsychological examination in establishing a more accurate diagnosis of dementia. The MoCA-Ina examination proved to be effective in quantitatively evaluating the cognitive function of patients, as it is able to identify impaired memory, attention, language, and executive abilities that are commonly impaired in patients with dementia. The use of MoCA-Ina as a measurement tool provides an objective picture of the level of cognitive decline experienced by patients. When these MoCA-Ina results are combined with findings from radiological examinations such as MTA, GCA, Koedam, and Fazekas scores, clinicians can gain a more thorough understanding of the extent of brain damage and its impact on cognitive function.

This combined approach is very useful, not only in determining the stage or severity of dementia, but also in designing appropriate and personalized management strategies. With complete information from both structural (radiological) and functional (neuropsychological) perspectives, medical personnel can devise a more effective treatment plan that suits the patient's needs. In addition, this combination is also useful for monitoring disease progress over time and evaluating the success of interventions or treatments that have been given.

CONCLUSION

Based on the results of this study, it is known that there is a tendency to increase brain atrophy scores along with the worsening level of cognitive impairment in dementia patients. In the mild dementia group, the most dominant radiological scores were GCA 2, MTA 1, Koedam 1, and Fazekas 1. Meanwhile, the moderate dementia group generally had GCA 2, MTA 3, Koedam 1, and Fazekas 1. In the severe dementia group, all patients showed MTA 4 (100%), GCA 2, and Koedam 1, with Fazekas scores evenly distributed between 1 to 3. These findings reinforce the notion that higher MTA scores correlate with more severe decline in cognitive function, thus serving as an important radiological indicator in assessing the severity of dementia. The clinical implication of these results is the importance of using brain MRI with simple scoring assessments such as MTA, GCA, Koedam, and Fazekas to aid early prediction and decision-making in the management of patients with dementia. However, this study has several limitations, including a relatively small sample size, especially in the severe dementia group, as well as the limitations of retrospective data that only relies on available medical record documentation. This may affect the representativeness and generalizability of the findings. Therefore, it is recommended that future studies involve a larger sample size with a prospective design, as well as consider the addition of other clinical parameters and biomarkers that can enrich the interpretation of radiological results and their relationship with cognitive function of dementia patients.

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