Comprehensive Analysis of Neuropsychological and Neuroimaging Aspects of Alzheimer's Disease

Sobirov A.A. [1], Sultonov I.I. [1].

1. Samarkand State Medical University, Samarkand, Uzbekistan

ABSTRACT

This comprehensive study conducted on 105 patients with Alzheimer's Disease at the Samarkand Regional Psychiatric Hospital provided pivotal insights into the clinical manifestations, risk factors, neuropsychological impacts, and neuroimaging aspects of AD. Participants, encompassing both genders and various forms of AD, were subjected to a detailed clinical assessment following the International Notably, the prevalence of symptoms such as type II diabetes mellitus, chronic kidney disease, and chronic heart failure was higher in patients with the senile form of AD, emphasizing the need for personalized treatment approaches. Neuropsychological evaluation using the Mini Mental State Examination highlighted gender-based cognitive impairments, with male patients exhibiting more pronounced deficits. These findings underscore the importance of considering gender in AD research and treatment. Neuroimaging methods, particularly MRI and CT scans, played a crucial role in assessing brain atrophy. The study reported a decrease in the total volume of gray matter in AD patients, with atrophic changes observed in various brain regions. These neuroimaging findings are instrumental in enhancing diagnostic accuracy and tailoring treatment strategies. In conclusion, the study offers a holistic view of AD, contributing significantly to the understanding of its clinical, neuropsychological, and neuroimaging dimensions.

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Introduction

Alzheimer's disease is a devastating progressive neurodegenerative disease characterized by dementia symptoms such as memory and learning impairment, disorientation, deficits in executive function, and behavioral and psychological symptoms of dementia [12]. According to Alzheimer's Disease International, the total number of patients with dementia in 2015 was estimated at 46.8 million, and this number will almost double every 20 years, with AD being the main type of dementia (60-90% of dementia cases) [18]. Currently, the increasing number of patients with AD places a serious economic burden on countries and places a significant physical and psychological burden on AD patients and their caregivers.

Alzheimer's disease (AD), a progressive neurodegenerative disorder, presents a significant challenge to global public health and healthcare systems due to its increasing prevalence and the complexity of its symptoms and risk factors. This study, focusing on 105 patients, offers a deep dive into the clinical manifestations, risk factors, and neuropsychological impacts of AD, providing critical insights that enhance our understanding of this debilitating disease [2, 6,9,11,18]. The study's comprehensive analysis of clinical symptoms in AD patients highlights the varied and profound impact of the disease on patients' daily lives. Common symptoms observed in the study population included headache, dizziness, sleep disturbances, anorexia, general weakness, and psychotic disorders, reflecting the broad range of cognitive and physical challenges faced by individuals with AD [9,14,15,17]. Understanding these symptoms in detail is crucial for developing more effective symptom management strategies and improving the quality of life for patients.

In exploring risk factors for Alzheimer's disease, the study sheds light on the differing prevalence of various risk factors across different forms of the disease. Notably, the presence of type II diabetes mellitus, chronic kidney disease, and chronic heart failure were found to be more prevalent in patients with the senile form of AD. This finding is particularly important as it underscores the need for personalized approaches to AD prevention and treatment, considering individual risk profiles [2, 7, 9-13, 21].

The gender-based differences in the neuropsychological profiles of AD patients, as revealed by the Mini Mental State Examination (MMSE), add a critical dimension to our understanding of the disease. The more pronounced cognitive impairments observed in male patients suggest potential gender-specific pathways in AD's manifestation and progression, highlighting the importance of consider-

ing gender as a significant factor in AD research and treatment strategies [1, 3, 10, 17].

Furthermore, the use of structural neuroimaging methods in this study, including MRI and CT scans, provides valuable insights into the neurodegenerative aspects of Alzheimer's disease. The patterns of brain atrophy observed in patients are pivotal for enhancing diagnostic accuracy and tailoring treatment approaches. These findings align with emerging research emphasizing the role of neuroimaging in understanding the pathophysiological changes in AD and developing more effective interventions [14, 16, 20-23].

Materials and methods

This study was a comprehensive observational analysis conducted on 105 patients diagnosed with AD. The participants were selected from the Samarkand Regional Psychiatric Hospital and underwent inpatient treatment and dispensary observation. The patient cohort consisted of both genders and various forms of AD. The diagnosis of AD was established following the International Classification of Diseases 10th Revision (ICD-10). Diagnostic criteria from the International Working Group [4] were employed, ensuring an internationally recognized and consistent approach to AD diagnosis.

Patients underwent a detailed clinical assessment, which included the evaluation of neurological symptoms, anamnestic information, and complaints. The study paid special attention to the characterization of clinical symptoms such as headache, dizziness, nausea, sleep disturbances, anorexia, general weakness, and weight loss.

The Mini Mental State Examination (MMSE) was utilized to evaluate the cognitive impairments in patients. This tool allowed for the assessment of various cognitive domains, including memory, attention, language, and spatial orientation. Structural neuroimaging methods, including Magnetic Resonance Imaging (MRI) and Computed Tomography (CT), were used to analyze brain atrophy. These imaging techniques were crucial for identifying patterns of neurodegeneration characteristic of AD.

The data were statistically analyzed using standard statistical software. Descriptive statistics were employed to characterize the patient cohort, and inferential statistics were used to assess the significance of findings. The mean and standard deviation were calculated for continuous variables, and frequency distributions were used for categorical data. The study was conducted following the ethical standards of the Declaration of Helsinki. All patients or their legal guardians provided informed consent. The study protocol was approved by the Institutional Review Board of Samarkand State Medical University.

Results

Complaints, anamnestic information and clinical and neurologic symptomatology were studied in 105 patients with AD. Characterization of clinical symptoms of the disease is presented in Table 1. Thus, the symptom of headache was observed in 95 (90.5%), dizziness in 90 (85.7%), nausea in 81 (77.1%), sleep disturbance in 98 (93.3%), anorexia in 89 (84.7%), general weakness in 89 (84.7%), and weight loss in 74 (70.4%), hair pigmentation disorders (gray hair) in 57 (54.3%), psychotic disorders in 101 (96.2%), speech disorders in 81 (77.1%), and writing difficulties in 72 (68.6%) AD patients included in the study. Among all symptoms, the most frequent were headache, dizziness, sleep disturbance, anorexia, general weakness and psychotic disorders.

Table 1. Characterization of clinical symptoms of the disease

Clinical symptoms of the disease	Gender		Abs.	%
	Men	Women		
Headache	39	56	95	90,5
Dizziness	36	54	90	85,7
Feeling of nausea	32	49	81	77,1
Sleep disturbance	40	58	98	93,3
Anorexia	33	56	89	84,7
Weakness	35	54	89	84,7
Weight loss	31	43	74	70,4
Hair pigmentation disorder (graying)	21	36	57	54,3
Psychotic disorders	42	59	101	96,2
Speech disorder	32	49	81	77,1
Writing difficulties	30	42	72	68,6

*Note: *-p<0.05*

The duration of the disease in AD patients was 4.2±1.3 years. The identified risk factors of neurodegenerative pathology in patients with AD are presented in Table 1. When analyzing the main risk factors in patients with different forms of AD, it was revealed that a higher frequency of head trauma in the history, GB and atherosclerosis was found in the group of patients with the presenile form, and such risk factors as type II diabetes mellitus, chronic kidney disease and chronic heart failure were more often found in the group of patients with the senile form of the disease.

Table 2. Frequency of risk factors in patients with AD

Risk factors	Forms of AD		X^2
	Presenile form	Senile form	
	n(%)	n(%)	
Arterial hypertension	57(23,6)	18(25)	3,17
Atherosclerosis	34(14,1)	10(13,9)	3,4
History of head trauma	29(12)	7(9,7)	4,14
Diabetes mellitus type II	39(16,2)	10(13,9)	3,9
Chronic kidney disease	33(13,7)	13(18)	2,54
Chronic heart failure	49(20,4)	14(19,5)	3,5

*Note: *-p<0.05*

For patients with Alzheimer's disease, the dominant symptom is memory impairment for current events, while long-term memory is not badly preserved. We studied the degree of severity of memory disorders in patients with AD. Thus, memory disorders of various degrees of severity were revealed in 100% of AD patients. Mild memory disorders were revealed in 36 (34.3%), hypomnesia (memory decline) in 47 (44.8%) and amnesia (complete absence) in 22 (20.9%) of examined AD patients.

Table 3. Characterization of AD patients depending on the degree of memory impairment

Level of memory disorder	Gender		Total	%
	Men	Women		
Mild memory disorders	18	18	36	34,3
Hypomnesia (decline)	20	27	47	44,8
Amnesia (absence)	6	16	22	20,9

*Note: *-p<0.05*

Neuropsychological examination using the Mini Mental State Examination (MMSE) was performed in all examined patients. Patients with AD in general were characterized by less pronounced intellectual and mental impairments. According to the MMSE scale in patients with AD the average score amounted to 17.6±1.4. It should be noted that there was a significant difference in the neuropsychological profile between the examined men and women. Differences were found in the mean score on the MMSE scale. Thus, according to the MMSE comprehensive mental status test, the result in male patients with AD was worse (15.3±1.17) than in female patients with AD (19.9±0.71; p<0.01). The mean score of the MMSE time orientation disorders subscale was 3.7±1.3, MMSE memory 1.1±0.7, and MMSE attention concentration was 3.2±0.6. Male AD patients performed worse on the speech function subscale tasks (5.2±1.41) compared to female AD patients (7.7±1.47; p<0.001).

Table 4. Results of neuropsychological study of patients with Alzheimer's disease

Methods	Gender		p-value
	Men	Men	
MMSE (Total Score)	15,3±1,17	19,9±0,71	p<0,01
MMSE (Time Orientation)	3,3±1,03	3,8±0,92	NS
MMSE (Place Orientation)	3,6±1,53	4,1±1,24	NS
MMSE (Perception)	1,7±0,67	2,4±0,83	NS
MMSE (Concentration)	3,1±0,21	3,8±0,72	NS
MMSE (Memory)	1,0±0,52	1,4±0,69	NS
MMSE (Speech Functions)	5,2±1,41	7,7±1,47	p<0,01

According to the recommendations of the American Institute for the Study of Aging and the Alzheimer's Association (NIAAA), the detection of atrophy predominantly in the mediobasal sections of the temporal cortex and medial sections of the parietal cortex can be considered as a biomarker of neurodegeneration of the Alzheimer type [8]. The Global Cortical Atrophy (GCA) scale is a semiquantitative scoring system developed to verify brain atrophy, especially in neurodegenerative diseases [5]. The GCA scale assesses atrophic changes on MRI data in 13 brain regions. In each hemisphere, the state of the sulci of the frontal, parieto-occipital and temporal regions and the ventricular system is assessed separately in the range from 0 to 3 points, where 0 points - normal volume/no ventricular enlargement; 1 point - sulcus enlargement/mild ventricular enlargement; 2 points - reduced volume of the gyrus/moderate ventricular enlargement; 3 points - "knife blade"-type atrophy/explicit ventricular enlargement. The structural neuroimaging methods we performed in patients with AD (magnetic resonance or computed tomography of the brain) are presented in Table 4.

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MMSE (Total Score)	15,3±1,17	19,9±0,71	p<0,01
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MMSE (Perception)	1,7±0,67	2,4±0,83	NS
MMSE (Concentration)	3,1±0,21	3,8±0,72	NS
MMSE (Memory)	1,0±0,52	1,4±0,69	NS
MMSE (Speech Functions)	5,2±1,41	7,7±1,47	p<0,01

Thus, in our studies, all 105 patients with AD showed a decrease in the total volume of gray matter of the brain according to the GCA global cortical atrophy scale. Atrophic changes in the brain according to the GCA neuroradiologic scale averaged 18.1±1.32 points. There were no significant differences between female and male patients.

Atrophic changes accompanying the progression of AD also affect the parietal cortex. The parietal atrophy assessment scale (Koedam scale) is designed for visual assessment of parietal lobe atrophy, especially in atypical forms of AD [11]. To quantify the severity of atrophy, a visual scale from 0 to 3 is used, where 0 - small furrows, no gyrus atrophy; 1 - moderate furrow dilation and moderate gyrus atrophy; 2 - pronounced furrow dilation and pronounced gyrus atrophy; 3 - "knife blade" type gyrus atrophy.

Table 5. Structural neuroimaging methods used in patients with AD

	Gender		Total	%
	Men	Women		
MRI	12	30	42	40
CT	26	37	63	60

Thus, atrophy of parietal lobes of the cerebral cortex was also observed in AD patients included in our study; the total Koedam score was 2.3±0.21. There were no significant differences between the total scores of female and male patients.

Thus, in Alzheimer's disease the important risk factors are head trauma in anamnesis, hypertension and atherosclerosis, neurological symptomatology of AD patients is more accompanied with symptoms of headache, dizziness, sleep disorders, anorexia, general weakness and psychotic disorders, GCA and MMSE scales have the greatest diagnostic significance for verification of the genesis of intellectual-mnestic disorders when using structural neuroimaging and mental status.

Conclusions

The study highlighted a diverse range of clinical symptoms in patients with Alzheimer's Disease. These included headaches, dizziness, nausea, sleep disturbances, anorexia, general weakness, weight loss, changes in hair pigmentation, psychotic disorders, speech disorders, and writing difficulties. These findings underscored the multifaceted impact of AD on patients, pointing to the

necessity of a holistic approach in symptom management and treatment.

The research identified key risk factors associated with AD. It was observed that patients with the presenile form of AD showed a higher frequency of head trauma, hypertension, and atherosclerosis. Conversely, type II diabetes mellitus, chronic kidney disease, and chronic heart failure were more prevalent in patients with the senile form of AD. This differentiation highlighted the importance of considering specific variants of AD in developing personalized management and treatment strategies.

The utilization of the Mini Mental State Examination (MMSE) in the study revealed significant neuropsychological impairments among AD patients. Notably, male patients exhibited more pronounced cognitive impairments compared to female patients. This finding suggested that gender might influence the neuropsychological profile of AD, indicating the need for gender-specific approaches in research and treatment.

The study employed structural neuroimaging methods, including MRI and CT scans, to evaluate brain atrophy in AD patients. A decrease in the total volume of gray matter was observed, along with atrophic changes in various brain regions. These findings underscored the value of neuroimaging in diagnosing AD and understanding its progression.

The Global Cortical Atrophy scale and MMSE were found to be instrumental in diagnosing and assessing the severity of AD. These tools were crucial for verifying intellectual and mnemonic disorders, highlighting their diagnostic significance in clinical practice for AD.

The study's findings provided a comprehensive understanding of Alzheimer's Disease, essential for developing effective management and treatment strategies. The complexity of AD, as evidenced by its risk factors, clinical symptoms, neuropsychological impairments, and neuroimaging profiles, emphasized the need for ongoing research and innovation in the field of AD treatment and management.

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