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Evaluation of the Relationship Between Musculoskeletal Problems and Cognitive Disorders in Alzheimer's Patients

Alzheimer Hastalarında Kas İskelet Problemleri ve Kognitif Bozukluklar Arasındaki İlişkinin Değerlendirilmesi

ABSTRACT

Objective

The objective of this study was to evaluate musculoskeletal problems and cognitive disorders that may be seen in individuals with Alzheimer's disease (AD) and to determine the interaction between these problems.

Material and Methods

Twenty-five individuals diagnosed with AD by a neurologist were included in the study. The participants' demographic data was recorded, a posture analysis was performed, and Mini-Mental State Examination (MMSE), Barthel Index (BI), and Global Deterioration Scale (GDS) were applied.

Results

Posture analyses revealed anterior head tilt in 76%, shoulder protraction in 76%, collapsed chest type in 8%, increased thoracic kyphosis in 84%, genu varum in 12%, and hallux valgus in 32%. There was a significant correlation between the MMSE results of the individuals and the results of BI and GDS (p=0.024 and p=0.002). In addition, it was determined that the dependency levels in BI increased significantly as the stages of the GDS increased (p=0.008). At the same time, there was no significant relationship between the education status and the stages of the GDS.

Conclusion

Musculoskeletal disorders are likely to develop in individuals with AD experiencing dementia and complete functional dependence. Therefore, promoting physiotherapy practices along with medical treatment is important to improve functional dependence and cognitive impairment.

Key Words

Alzheimer's, Functional Status, Mental Health, Posture

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ÖZ

Amaç

Bu çalışmanın amacı, Alzheimer hastalığı (AH) olan bireylerde görülebilecek kas-iskelet sistemi sorunları ile bilişsel bozuklukları değerlendirmek ve bu sorunlar arasındaki etkileşimi belirlemektir.

Gereç ve Yöntemler

Çalışmaya nöroloji doktoru tarafından AH tanısı konulan toplam 25 birey dahil edilmiştir. Katılımcıların demografik verileri kaydedilmiş, postür analizi yapılmış ve Standardize Mini Mental Test (SMMT), Barthel İndeksi (Bİ) ve Global Yıkım Ölçeği (GYÖ) uygulanmıştır.

Bulgular

Postür analizi sonuçlarında; %76'sında başın anterior tilti, %76'sında omuz protraksiyonu, %8'inde çökük göğüs tipi varlığı, %84'ünde torakal kifozda artış olduğu, %12'inde genu varum varlığı ve %32'sinde halluks valgus varlığı tespit edildi. Bireylerin SMMT sonuçları ile Bİ ve GYÖ sonuçları arasında anlamlı ilişki olduğu görüldü (p=0.024 ve p=0.002). Ayrıca GYÖ evreleri arttıkça Bİ'deki bağımlılık düzeylerinin anlamlı olarak arttığı tespit edilirken (p=0.008) eğitim düzeyleri ile GYÖ evreleri arasında anlamlı bir ilişki olmadığı tespit edildi.

Sonuç

Demans ve tam fonksiyonel bağımlılık yaşayan AH'li bireylerde kas-iskelet sistemi bozukluklarının gelişmesi muhtemeldir. Bu nedenle, tıbbi tedavi ile birlikte fizyoterapi uygulamalarının teşvik edilmesi, fonksiyonel bağımlılığı ve bilişsel bozukluğu iyileştirmek için önemlidir.

Anahtar Kelimeler

Alzheimer, Fonksiyonel Durum, Ruh Sağlığı, Postür

INTRODUCTION

Dementia is caused by various biological processes that damage or cause loss of neurons and processes in the brain. Impairments in many areas of neurocognitive function are common denominators for different types of dementia (1). Dementia affects over 50 million people worldwide, and this number is expected to rise to 152 million by 2050 (2, 3). The most prevalent form of dementia is Alzheimer's disease (AD) (4). AD is clinically characterized by global dementia, including memory loss, cognitive impairment, executive dysfunction, and personality and behavioral changes. AD results in synaptic loss and neuronal atrophy, mainly in the hippocampus and cerebral cortex, and the brain is characterized by the presence of amyloid plaques and neurofibrillary tangles (5).

It has been reported that approximately 24 million people worldwide have been diagnosed with AD. This figure is predicted to quadruple by 2050 (6). It is reported that there are many risk factors for AD including psychosocial factors, diabetes, hypertension, cardiovascular diseases, obesity, traumatic brain injury, physical activity level, sleep disorders, smoking and alcohol consumption, and environmental pollution (7).

The most common distinctive clinical phenotype of AD is a gradual and progressive decline leading to social or occupational disability in two or more cognitive domains, including episodic memory and executive functions (8). The amnestic type of mild cognitive impairment is generally recognized as the earliest clinical manifestation of possible AD (9).

At the onset of the disease, especially short-term memory and then language, mood, movement, and physiological functions are affected (6, 10). In more advanced stages of the disease, dysfunctions related to many cognitive areas such as attention and executive functions, thought and behavior, language, apraxia, and visuospatial functions may also be observed in the clinical picture (11).

Most individuals with the disease, including those in the early stages of AD, are adversely affected by physical performance due to musculoskeletal problems such as muscle weakness as well as body composition disorder, and therefore experience difficulties in activities of daily living (12).

Although there is no definite treatment for AD, the primary aim of medical treatment and physiotherapy is to alleviate or prevent the symptoms of the disease, to teach patients and their families how to manage symptoms, to maintain individual independence, and to improve the quality of life (13). To increase the effectiveness of the treatment applied to patients, it is important to evaluate the symptoms that may be observed with the disease and to determine the relationship between these symptoms.

In the literature, it is reported that although the basis of AD is related to brain damage, death and comorbidities in patients are caused by cardiac and respiratory problems,

malnutrition due to swallowing problems, and problems related to skeletal muscle and bone (14, 15).

Recent investigations have shown that skeletal muscle and bone are dynamic tissues that can communicate both biomechanically and molecularly. Furthermore, molecular factors released from skeletal muscle and bone can affect cognitive processes (16-18). Research has demonstrated that metabolically active tissues, such as skeletal muscle, release neurotrophic factors that regulate synapses in the brain (19). One of these factors is brain-derived neurotrophic factor (BDNF), which is released during skeletal muscle contraction. The absence of BDNF has been linked to neurodegenerative processes (20, 21). During muscle contraction, skeletal muscle releases molecular factors that may affect cognitive function. One such factor is BDNF, a neurotrophin that is required in adults for the maintenance of synaptic connections and adaptive neuronal plasticity, which regulates cognitive processes such as learning and memory (22). Skeletal muscle dysfunction and inadequate performance may affect the level of cognitive impairment by reducing the amount of neurotrophin released. This strengthens the link between low physical activity, posture disorders, and cognitive function.
The primary aim of this study was to evaluate musculoskeletal disorders and cognitive impairment in individuals diagnosed with AD. The secondary objective was to investigate the potential association between musculoskeletal issues and cognitive function.

MATERIAL and METHODS

For our study, which was planned and conducted as a cross-sectional study, permission was obtained from Mustafa Kemal University, Tayfur Ata Sökmen Medical Faculty Ethics Committee (approval number: 23/12/2014/248). All participants, family members, or caregivers were informed about the purpose of the study and the evaluation methods to be applied before the study. Written and verbal consent was obtained from the participants and their caregivers in accordance with the principles of the Declaration of Helsinki.

Inclusion criteria; 1) Being diagnosed with Alzheimer's disease by a neurologist, 2) Being between 55-80 years of age.

Exclusion criteria; 1) Presence of deep vein thrombosis, 2) Presence of serious cardiac problems, 3) Co-operation impairment.

The study sample comprised twenty-five volunteer participants who met the inclusion criteria. Demographic data of all participants were recorded and posture analyses were performed by a physiotherapist. In addition, the Mini-Mental State Examination (MMSE), Barthel Index (BI), and Global Deterioration Scale (GDS) were administered to all participants. Demographic information (sex, age, body mass index, smoking habit, alcohol habit, educational status, presence of neurological disease in the family, use of medication for the disease, presence of systemic disease, and history of previous cerebrovascular events) was recorded by means of a questionnaire created by the investigators in accordance with the information obtained from the participants and their family members or caregivers.

Posture Analysis

It is used to evaluate the current posture of individuals and to detect postural disorders. All participants were assessed by the same physiotherapist. The analyses were performed from the anterior, lateral, and posterior parts of the body with the help of a plumb line.
In the anterior part of the body; thorax, knees, feet, and toes, in the lateral part of the body; forward tilt of the head, the presence of a round back, protraction of the shoulder, presence of kyphosis-lordosis, the presence of anterior pelvic tilt, presence of genu recurvatum, in the posterior part of the body; lateral tilt of the head and scoliosis symptoms (shoulder inequality, hip inequality, lateral curvature of the spine and gibbosity) were recorded as presence or absence (23).

Mini-Mental State Examination (MMSE)

It was developed as a cognitive assessment for elderly individuals with dementia. It was designed to be applied quickly and efficiently. The Turkish version, which was found to be valid and reliable, was used in our study (24, 25). The test consists of five main topics; 1) orientation, 2) recording memory, 3) attention and calculation, 4) recall, and 5) language. A maximum of 30 points can be obtained from the test; 24-30 points are classified as normal, 18-23 points as mild, 10-17 points as moderate, and 10 points and below as severe dementia.

Barthel Index (BI)

The index is used to assess the physical competence and independence of individuals in basic activities of daily living. The Turkish version, which was found to be valid and reliable, was used in our study (26, 27). The scale questions mobility status such as feeding, washing, self-care, dressing, defecation control, urinary control, going to the toilet, ability to move from bed to wheelchair, walking or being dependent on a wheelchair, and stair climbing functions. There is a scoring according to whether the individual is assisted in performing these activities or not. The scoring is between 0 and 100; 0-20 points indicate complete dependence, 21-61 points indicate severe dependence, 62-90 points indicate moderate dependence, 91-99 points indicate mild dependence, and 100 points indicate no need for assistance.

Global Deterioration Scale (GDS)

It was developed by Reisberg et al., to determine the severity of the destruction in dementia. The scale consists of 7 stages. While stage 1 represents normal cognitive status,

stage 7 defines the most advanced dementia. The stages of the global impairment scale are as follows: Stage 1 defines normal cognitive functioning with no cognitive impairment, whereas stage 7 is the stage of very severe cognitive impairment and defines the stage in which all verbal and psychomotor abilities are lost in late dementia (28).

Statistical analysis

The data obtained from the research were evaluated in SPSS 25.00 statistical package programme. Numerical and percentage values in qualitative data and mean and standard deviation values in quantitative data were analyzed. Chi-Square and Kruskal-Wallis tests were used to analyze independent variables. The significance level was accepted as $p<0.05$.

RESULTS

In the study, 48% of the individuals were females and 52% were males. It was determined that 36% of the individuals were 65-69 years old, 28% were 70-74 years old and 24% were 75-79 years old. According to body mass index calculation, 60% of the individuals had normal body weight, 28% overweight, 8% were obese and 4% had low body weight. It was determined that 68% of the individuals included in the study had no smoking habit, 88% had no alcohol habit, 56% were illiterate, 56% had no family history of neurological disease, and 88% used medication for the disease. Among the systemic diseases, diabetes mellitus was present in 48%, hypertension in 52%, and cardiac problems in 32%, and only 12% had a history of cerebrovascular accident (Table I).

Table I. Demographic and Anamnesis Information of the Participants

		n	%
Sex (F/M)		12/13	48/52
Age	55-59	2	8
	60-64	1	4
	65-69	9	36
	70-74	7	28
	75-79	6	24
Body Mass Index (BMI)	Weak	1	4
	Normal	15	60
	Overweight	7	28
	Fat	2	8
Smoking Habit	Yes	8	32
	No	17	68
Alcohol Habit	Yes	3	12
	No	22	88
Education Status	Illiterate	14	56
	Literate	3	12
	Primary education	2	8
	Secondary education	4	16
	License	2	8
Family Diagnosed with Neurological Disease	Yes	11	44
	No	14	56
Use of disease-directed medication	There is	22	88
	None	3	12
Presence of Systemic Disease	Diabetes Mellitus	12	48
	Hypertension	13	52
	Cardiac Problem	8	32
Previous Cerebrovascular Event	There is	3	12
	None	22	88

When the GDS results of the individuals included in the study were evaluated, it was determined that 12% of individuals with stage 5, 24% of individuals with stage 6 and 32% of individuals with stage 7 were included in the study. As a result of MMSE, 48% of the individuals were classified as having mild dementia with a score of 10-17, and 56% were found to be fully dependent according to BI (Table II).

Table II. Results of the participants' GDS, MMSE, and BI

		n	%
Global Deterioration Scale	Stage 1	2	8
	Stage 2	3	12
	Stage 3	1	4
	Stage 4	2	8
	Stage 5	3	12
	Stage 6	6	24
	Stage 7	8	32
Mini-Mental State Examination	10-17	12	48
	18-23	12	48
	24 and above	1	4
Barthel Index	Fully dependent	14	56
	Highly dependent	4	16
	Moderately dependent	3	12
	Mildly dependent	3	12
	Independent	1	4

When the results of the posture analysis of the patients were evaluated; anterior tilt of the head in 76%, shoulder protraction in 76%, presence of normal chest type in 80%, increased thoracic kyphosis in 84%, normal pelvis position in 92%, presence of genu varum in 12%, presence of pes planus in 4% and presence of hallux valgus in 32% (Table III).

Table III. Posture Analysis Results of the Participants

		n	%
Head	Neutral	6	24
	Anterior tilt	19	76
Shoulder	Normal	6	24
	Protraction	19	76
Thorax	Normal	20	80
	Collapsed type chest	2	8
	Funnel type chest	1	4
	Barrel type chest	1	4
	Pigeon type chest	1	4
Spine	Normal	1	4
	Increase in cervical lordosis	2	8
	Increase in thoracic kyphosis	21	84
	S-Scoliosis	1	4
Pelvis	Normal	23	92
	Anterior tilt	2	8
Knee	Normal	22	88
	Genu varum	3	12
Foot	Normal	24	96
	Pes planus	1	4
Toes	Normal	16	64
	Hallux valgus	8	32
	Hammer finger	1	4

There was a significant correlation between the MMSE results of the individuals and the results of the BI and GDS (p=0.024 and p=0.002). The dependency levels of individuals in the moderate dementia group in BI (p=0.024) and the stages of the GDS were significantly higher than those with mild dementia (p=0.002) (Table IV).

Table IV. Comparison of Participants' Evaluation Parameters with the Mini-Mental State Examination

		MMSE			X^2	p
		10-17 (n)	18-23 (n)	24 and above (n)		
GDS	Stage 1	0	0	2	15,318	**0.002***
	Stage 2	0	2	1		
	Stage 3	0	1	0		
	Stage 4	2	0	0		
	Stage 5	1	2	0		
	Stage 6	3	3	0		
	Stage 7	8	0	0		
Posture	Head anterior tilt	6	12	1	6,500	**0.019***
	Head neutral	6	0	0		
CVE	There is	0	2	1	6,172	0.057
	None	12	10	0		
Education Status	Illiterate	8	6	0	1,725	0.198
	Literate	0	3	0		
	Primary education	1	1	0		
	Secondary education	1	2	1		
	License	2	0	0		
					KW	**p**
BI	Completely dependent	9	5	0	7,418	**0.024****
	Highly dependent	3	1	0		
	Moderately dependent	0	3	0		
	Lightweight	0	3	0		
	Independent	0	0	1		
BMI	18.5 and below	1	0	0	6,554	**0.038****
	18.5-24.9	9	6	0		
	25-29.9	2	5	0		
	30-40	0	1	1		

MMSE: Mini-Mental State Examination; BI: Barthel Index; GDS: Global Deterioration Scale; BMI: Body Mass Index; CVE: Cerebrovascular Event; X2: Chi-Square Test; KW: Kruskal-Wallis (**); (*): Fisher Exact Test; Significance p<0.05

While it was found that the dependency levels in BI increased significantly as the stages of GDS increased (p=0.008), there was no significant relationship between education status and stages of GDS (p=0.116) (Table V).

Table V. Comparison of Global Deterioration Scale with Barthel Index and Education Status

		GDS Stage							X^2	p
		1	2	3	4	5	6	7		
BI	Completely dependent	0	0	0	1	1	5	7	32,589	**0.008***
	Highly dependent	0	0	0	1	1	1	1		
	Moderately dependent	1	1	0	0	1	0	0		
	Lightweight	1	1	1	0	0	0	0		
	Independent	0	1	0	0	0	0	0		
Education Status	Illiterate	2	1	1	0	1	3	6	27,345	0.116
	Literate	0	0	0	2	0	1	0		
	Primary education	0	0	0	0	0	1	1		
	Secondary education	0	2	0	0	2	0	0		
	License	0	0	1	0	0	1	1		

BI: Barthel Index; GDS: Global Deterioration Scale; X2: Chi-Square Test; (*): Fisher Exact Test; Significance p<0.05*

DISCUSSION

Advanced age is the strongest risk factor for AD. Especially after the age of 80, women are more prone to AD than men (2). However, 52% of the study population was male, indicating that there was no significant difference between the sexes. Furthermore, the fact that 36% of the population was in the 65-69 age range is a worrying trend indicating that the age of onset of AD is decreasing. Furthermore, an unhealthy lifestyle and cardiovascular risk factors have been associated with an increased risk of dementia (29). In addition to high rates of diabetes, hypertension, and heart problems, family history of neurological diseases and smoking were also important factors in the research data. In the evidence that education plays a role in age-related cognitive decline, various studies on "normal ageing" report a slower cognitive and functional decline in individuals with a higher status of education (30). It has also been reported in the literature that a higher status of education may have a greater capacity to compensate for neuronal damage (31). In the study population, 56% of the individuals diagnosed with AD were illiterate, which suggests that individuals with a low status of education are at a serious risk of developing AD.

Although motor and sensory functions are preserved until the late stages of AD, cognitive function tends to decrease progressively. In the neurodegenerative process, the hippocampus and entorhinal cortex, which are responsible for memory functions, are affected first. Therefore, memory dysfunction is observed as the initial symptom of the disease (32, 33). Consistent with the literature, the data of the study population showed that 48% had mild dementia, 32% were in stage 7 of GDS and 56% were fully dependent. These findings support the destructive effect of the disease on memory.

It is known that the level of independence is negatively affected in AD with a decrease in muscle mass (34, 35). Coordination of muscles is important for their proper functioning during movement and includes the ability of all relevant muscles to work together (36). Agonists, antagonists, and synergists must work in coordination to ensure correct and efficient muscle performance. It is also known that shortening of the muscles disrupts muscle balance (37). In our study, various postural deformities including anterior head tilt, shoulder protraction, increased thoracic kyphosis, and hallux valgus were detected. Given the detrimental effect of AD on cognitive function and the significant level of functional dependence observed in our study, these postural changes in AD patients may be a consequence of reduced functional ability resulting from impaired cognitive function.

Previous studies have reported a significant correlation between cognitive function measured by MMSE and performance in activities of daily living measured by BI in individuals with AD (38-40). Consistent with previous studies, our findings show that as cognitive impairment

increases, the level of dependence on activities of daily living also increases.

In conclusion, considering that muscle parameters are associated with cognitive domains, it can be considered that good physical activity level, adequate muscle performance, and correct regulation of postural muscles will have a positive effect on cognitive functions.

Limitations

Our study has some limitations. Firstly, our study was conducted with individuals from a single center, which provided great convenience in conducting the study, but limited our ability to reach individuals with different living standards and habits. Secondly, the study population is relatively small and it is recommended to continue to study larger populations. Finally, since there was no control group in our study, it could not be compared with the normal population.

CONCLUSION

In individuals diagnosed with AD, musculoskeletal problems and posture disorders are observed as a result of the progression of cognitive function and progression toward complete dependence. The fact that the study population exhibited dementia and complete functional dependence made musculoskeletal disorders inevitable. To improve functional dependence and cognitive impairment, it is important to expand physiotherapy applications in addition to medical treatment for individuals with AD.

Ethics Committee Approval

This research complies with all the relevant national regulations, institutional policies and is in accordance the tenets of the Helsinki Declaration, and has been approved by the Tayfur Ata Sökmen Medical Faculty Ethical Committee, Mustafa Kemal University (approval number: 23/12/2014/248).

Informed Consent

All the participants' rights were protected and written informed consents were obtained before the procedures according to the Helsinki Declaration.

Author Contributions

Idea-O.G., M.A.D., E.D.H.; Design-O.G., M.A.D., E.D.H.; Supervision-O.G., N.K., F.O. I.M.; Data collection and/or processing-O.G., K.K., T.K.Y., O.Y.; Analysis and/or interpretation-O.G., M.B., F.T.; Literature review-O.G. M.A.D., E.D.H., M.B., F.T.; Manuscript writing-O.G., M.A.D., E.D.H., M.B., F.T., N.K., F.O., K.K., T.K.Y., O.Y., I.M.; Critical review-O.G., M.B.

Conflict of Interest

The authors have no conflict of interest to declare.

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