Evaluation of MoCA Scale Ratings with Cognitive Level Correlation in Mild Cognitive Disorders

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Abstract

Objective: In this study, Montreal Cognitive Assessment (MoCA) test was applied in patients with mild cognitive impairment (MCI). Hippocampal volumes were compared between healthy controls and patients with MCI. Scores of MORBID scales and cognitive level were compared among patients with MCI to investigate if there is a correlation. We aimed to investigate the availability of the test on the diagnosis.

Methods: This study included 25 healthy controls and 25 patients diagnosed with MCI according to the Petersen criteria. Detailed neurological examination was performed. MoCA and Standardized Mini Mental State Examination (MMSE) were used in the patient group, whereas MMSE was used in all participants. To all exhibitors cranial magnetic resonance imaging was performed. Right and left hippocampal volumes were calculated using special volumetric three-dimentional T1-weighted inversion recovery sequence. Neuropsychological test results and hippocampal volumes were compared between the patient and control groups.

Results: There were significant differences in hippocampal volumes and MMSE scores between the HBB patient and control groups (p<0.001, p=0.011, p=0.014). We found a significant relationship between MoCA average test score and left hippocampal volume with correlation analysis (p=0.013).

Conclusion: As a result, hippocampal volume markedly decreased in patients with MCI compared with that in the healthy control group; we found that hippocampal volume reduction is proportional to MoCA scores. These findings suggest that MoCA scores were correlated with cognitive level in MCI and suggests the usefulness of the test in the diagnosis of MCI.

Keywords: Mild cognitive impairment, Montreal cognitive assessment test, magnetic resonance imaging

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Introduction

Approximately 35.6 million people are followed up with the diagnosis of dementia across the world. The incidence of dementia has increased along with the prolongation of human life span, and it is a challenging process for the affected people and their relatives and a significant financial burden for the economies of countries (1). Alzheimer-type dementia, which is the most common cause of dementia, constitutes 50%-70% of all dementia cases (2).

There is still no treatment modality that could alter the pathological and clinical course of Alzheimer's disease (AD), and numerous studies are ongoing in this regard. In recent years, there has been a belief that the diagnosis of Alzheimer-type dementia can be made before the manifestation of clinical findings and that this approach may allow application of possible new treatments in the early period (3).

Mild cognitive impairment (MCI) implies a transition state between normal cognitive functions and Alzheimer-type dementia. MCI is characterized by cognitive loss, absence of impairment in daily activities, and absence of dementia according to age and education norms which are also confirmed by the relatives of the patients. Studies have shown that MCI can be used to identify individuals with high risk in terms of the progression to Alzheimer-type dementia (4). Alzheimer-type dementia has been reported to develop in 10%-40% of patients within 1 year following the diagnosis of MCI (5).

The diagnosis of MCI is made through clinical evaluation, imaging modalities, and neuropsychometric tests. The Montreal Cognitive Assessment (MoCA) scale is a test that has been used in recent years to assess cognitive features such as attention and concentration, executive functions, memory, language, visual-spatial functions, abstract thinking, calculation, and orientation. The scale has been developed by Nasreddine et al. (6) and is recommended for use in the mild stages of cognitive impairment. Several features in the design of the MoCA test allow it to detect MCI with greater sensitivity. In MCI, executive functions, high language functions, and complex visual-spatial functions are moderately affected. This moderate decrease can be demonstrated by the

MoCA test, which should fulfill more tasks when compared with the Standardized Mini Mental Test (SMMT) (6).

The adaptation of the scale to Turkish and validity-reliability studies were performed by Selekler et al. It is believed that the MoCA test can distinguish individuals with Alzheimer-type dementia and MCI and healthy groups from each other and can be used in clinical practice in our country (7).

In addition to clinical history and neuropsychometric evaluation, imaging modalities also provide important contributions in the diagnosis of MCI. Magnetic resonance imaging (MRI) is used in the diagnosis of AD because it can detect cortical atrophy, sulcal/ventricular dilatation, and reduced parenchymal and hippocampal volume (8). Neuroimaging studies are also conducted in individuals having an increased risk of AD. The cases diagnosed with MCI belong to this group, and the hippocampal volumes calculated by MRI is smaller than healthy controls (9).

In this study, we aimed to compare the hippocampal volumes of patients with MCI diagnosis and healthy controls, and more importantly, we aimed to investigate whether a correlation exists between MoCA scale scores and hippocampal volumes in MCI patients and whether the MoCA test has a diagnostic value.

Methods

Patient Population
Twenty-five patients (13 females and 12 males) who attended the neurology polyclinic of our hospital and were diagnosed with MCI and 25 subjects (14 females and 11 males) who were cognitively healthy and had no specific somatic complaints were included in our study. All the participants were informed about the study, and their volunteer consents were received. Complete blood counts, routine biochemical examinations, thyroid function tests, serum B12 and folate levels, and The Venereal Disease Research Laboratory (VDRL) test were performed in all the participants to exclude other diseases that could lead to cognitive impairment. Subjects with pathological examination or laboratory findings, neurodegenerative disease findings on MRI, intracranial space-occupying lesions, head trauma or other neurological diseases (including Parkinson's disease), a history of alcohol or other psychoactive substance addiction were excluded from the study. The dominant hand of all subjects was the right hand. All the 25 patients with appropriate characteristics and the 25 healthy volunteers who agreed to participate in the study were evaluated prospectively. Approval was received from the ethics committee of our hospital prior to the conduct of the study.

Neuropsychological Assessment
The participants were neurologically examined in detail by two neurologists. Information was obtained regarding the cognitive status of the patient and at least one of his/her relatives. The SMMT was applied to all participants (10). Those who did not have any complaint of forgetfulness reported by themselves or their relatives, who had normal neurological examination, and who had SMMT score of ≥28 were evaluated as the control group.

On the same day, the MoCA test was applied to the patients who were considered to have MCI and whose SMMT score was between 23 and 26 as assessed by an experienced psychologist. MoCA is evaluated as follows: recall from short-term memory, five-word learning exercises (two times), and delayed recall (5 points) after 5 min; clock-drawing test (3 points) that measures visual-spatial functions and cube copying (1 point); trail-making test that measures the executive functions -combining consecutive figures and letters adapted from the form B (1 point); verbal fluency (1 point) and two-object similarities (2 points) that evaluate abstract thinking; subtraction test (3 points) that comprises tasks of attention functions and working memory and forward and backward digit span test (1 point each) and naming three animal pictures that measures language functions (3 points); and syntactic repetition of two complex sentences (2 points), orientation (6 points), and tapping the desk when he/she hears the letter A (1 point), which requires inhibition. The highest score that can be obtained from the scale is 30 and the lowest score is 0. The cut-off score of MoCA was determined as 21 in those who were normal.

In our study, the patients whose cognitive functions were found to be impaired but who did not fulfill the DSM-V criteria for dementia based on the result of clinical assessment and neuropsychometric examinations and the patients who had a MoCA scale score of 17-21 were diagnosed with MCI according to Petersen criteria (6). All the patients were evaluated as having amnestic MCI.

Magnetic Resonance Imaging
MRI examinations were performed in the MR unit with 1.5 T (Signa Hdxt; GE Medical Systems, Milwaukee, WI, USA). Gradient-weighted Fast Spoiled Gradient-Recalled-Echo (FSPGR) 3D T1 inversion recovery (IR) sequence, which allowed multiplanar reformation and volume measurement, was added to the routine brain MRI of the patients and the control group. No contrast material was used in the examinations. A total of 450 consecutive coronal T1-weighted gradient echo images were obtained (Figure 1a). Cross-sectional thickness was determined as 0.8 mm, TR as 13.7, TE as 5.8, TI as 400 ms, flip angle as 11°, field of view (FOV) as 22 cm, number of excitations (NEX) as 1, and pixel matrix was determined as 288×288.

The obtained T1-weighted three-dimensional coronal sections were processed volumetrically. The volumes of bilateral hippocampus areas were calculated in mm^3 using the method of marking-extracting with the automatic image analysis software AW Volumeviewer 3, accompanied by axial and sagittal reformat images, on the GE Advantage (AW4.4) workstation (Figure 1b). The researcher who made the volume calculation was blind to the clinical information of the subjects.

Statistical Analysis
SPSS 15.0 for Windows (SPSS Inc.; Chicago, Illinois, USA) was used for the statistical analysis. The chi-square test was used to assess the relationships between categorical variables, and the Student's t-test was used to evaluate the difference between the averages of the continuous variables of the two groups. The relationship of numerical variables was examined through Spearman's correlation analysis.

Results

The mean ages of the patients and the control subjects were 69.1±6.2 and 67.4±5.9 years, respectively. No statistically significant difference was observed between the groups in terms of age and gender (p=0.320 and p=0.777, respectively).
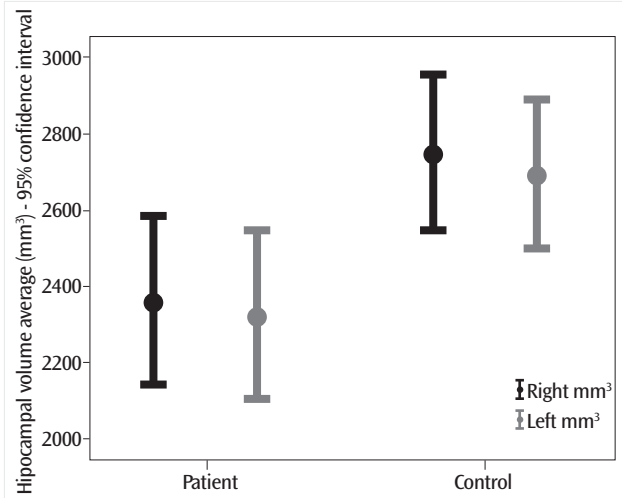
Figure 2. Hipocampal volume averages

The SMMT and MoCA scores and the hippocampal volume averages are shown in Table 1.

The SMMT scores and the right and left hippocampal volume averages were statistically significantly lower ($p<0.001$, $p=0.011$, and $p=0.014$, respectively) in the patient group than in the control group.

The hippocampal volume averages of the patient and control groups are shown graphically in Figure 2.

A statistically significant positive correlation was found between the MoCA scores and the left hippocampal volume ($p=0.013$). There was no statistically significant relationship among the right hippocampal volume, age, and SMMT scores (Table 2).

Discussion

Elderliness is a natural stage of human life. Human lifespan has prolonged along with improved living conditions and treatment or control of diseases. This causes an increase in the prevalence of diseases related to elderliness.

Alzheimer's disease has a separate place and importance in geriatric diseases because the deterioration in cognitive ability directly affects the quality of life of individuals.

Mild cognitive disorder is an interim period that should be recognized and should not be overlooked, because it has a high risk of progression to Alzheimer-type dementia (11). Although this risk is reported at different rates in various series, it is 6%-40% per annum (12). In amnestic MCI, which is the most common subtype, the risk of conversion to Alzheimer-type dementia is especially apparent. This ratio is about 1%-2% in healthy people over 65 years of age (13).

Today, different examination methods are used for the diagnosis of MCI and Alzheimer-type dementia. In the study of Ge et al. (14) in which 129 healthy controls were monitored for 42 months, the participants who had increased tau/A β 1-42 ratios in the cerebrospinal fluid (CSF) and who had an increased frequency of the apolipoprotein E ε4 allele were reported to have been diagnosed

Figure 1. a, b. 3D coronal image taken with T1 weighted IR sequence (a) and the right hippocampus marked and ejected using the AW image-analyzer AW volume-viewer 3 on the workstation GE Advantage (AW4.4) (b)

Table 1. The comparison of SMMT and MoCA scale scores with the hippocampal volume averages of the patient and control groups

		Patient		Control		
		Avg±SD	Min-Max	Avg±SD	Min-Max	p
MoCA		18,3±1,1	17-21			
SMMT		23,1±1,2	23-26	28,5±0,6	28-30	<0,001
Hippocampal volume (mm³)	Right	2357,8±543,8	1581-3526	2748,8±499,0	2025-3820	0,011
	Left	2323,5±541,7	1506-3428	2692,4±479,8	2010-3756	0,014

SMMT: Standardized Mini Mental Test; MoCA: The Montreal Cognitive Assessment Scale

Table 2. The comparison of MoCA test scores with the right and left hippocampal volumes, age, and SMMT score averages in the patient group

		MoCA	
		Rho	p
Patient	Age	0,128	0,542
	SMMT	0,027	0,900
	Right hippocampal volume (mm³)	0,357	0,080
	Left hippocampal volume (mm³)	0,488	0,013

SMMT: Standardized Mini Mental Test; MoCA: The Montreal Cognitive Assessment Scale

with MCI at the end of the study. In voxel-based positron emission tomography (PET) that was performed using the BF 227 ligand, patients with AD and MCI were reported to have an abnormal distribution pattern in the field of posterior association (15). It has been reported that changes in latency and amplitudes of movement-related cortical potentials (MRCP) can indicate the presence of frontal dysfunction electrophysiologically in cases with MCI (16). These are difficult and expensive examinations to access and implement.

In the neuropathological examinations performed in AD, the formation of neurofibrillary tangles and senile plaques was demonstrated in the entorhinal cortex and the hippocampus in the early stages of the disease. The changes start from the hippocampus and spread to the entorhinal cortex. Atrophy develops in these structures in AD and MCI over time (17).

It has been reported that atrophy is correlated with the neurofibrillary tangles accumulating in the hippocampus and with the disease burden (18).

Neuropsychometric evaluations are helpful in determining the cognitive level. The easy implementation and the low cost make these tests more attractive.

In the Canadian reconciliation meeting, the application of detailed neuropsychological tests was recommended for patients with a suspicion of MCI or a concern about the cognitive status and for patients with the SMMT score within the normal range (19). Developed in recent years, DemTect is a test that evaluates immediate and delayed word list recall, verbal fluency, and backward counting range. The sensitivity of the test is 80%, and the specificity is 92% (20). It was found that the sensitivity of the clock-drawing test was 75% and the specificity was 76% in MCI (21). The sensitivity of the MoCA test was found to be 90% and the sensitivity was 87% for the diagnosis of MCI (6). Smith et al. (22) reported the sensitivity of SMMT and MoCA tests in MCI as 17% and 83%, respectively.

In our study, the MoCA test was performed in the patients who were clinically and radiologically diagnosed with MCI. In our opinion, the fact that amnestic type is the most common type and the patients who have complaints of forgetfulness were included in the study can explain the amnestic MCI diagnosis in all patients. Several features in the design of the MoCA test allow it to detect MCI with greater sensitivity. When compared with SMMT, the memory test contains more words, fewer learning trials are administered, and it has a longer delayed recall duration. Executive functions, high language functions, and complex visual-spatial functions are moderately affected in MCI. This moderate decrease can be demonstrated by the MoCA test, which should fulfill more tasks in comparison to the SMMT (7).

In our study, there was a significant difference between the right and left hippocampal volumes (p=0.011 and p=0.014, respectively) when subjects with MCI and healthy controls were compared. The severity of hippocampal atrophy in MCI determines the progression to dementia. The severity of atrophy in the hippocampus and the entorhinal cortex was found to correlate especially with the subunits of memory tests involving recall and new learning (23).

In our study, we found a significant association in the correlation analysis between the MoCA scale scores and the left hippocampal volume averages (p=0.013). We believe that this indicates a close relationship between cognitive function capacity and hippocampal volume, which can be demonstrated by the MoCA scale.

The inability to perform clinical follow-ups of patients, the inability to determine whether Alzheimer-type dementia developed, and the inability to perform subunit analyses such as memory, visual-spatial functions, attention, and volumetric index on MRI can be considered among the limitations of our study.

To summarize, we observed in our study that the hippocampal volume in subjects with MCI was significantly reduced compared to that in the healthy control group. We found that the hippocampal volume reduction was directly proportional to the MoCA scale scores. These findings suggest that the cognitive level correlates with the MoCA scale scores in MCI, and these tests that are inexpensive and easy to access can be used for the diagnosis.

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