


Cognitive Impairment in Patients with Coronary Artery Disease; Comparison of Montreal Cognitive Assessment (MoCA) and Mini Mental State Examination (MMSE)

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ABSTRACT

Background & Objective: Mild cognitive impairment (MCI) is a transient state between normal condition and dementia. Available data indicates that coronary artery diseases (CAD) may increase the risk of MCI. Hence, the early detection of MCI can prevent the progression of cognitive decline.

Materials & Methods: A sample of 65 subjects with degrees of CAD was enrolled to the study. For cognitive assessment, Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) were used. Sensitivity, specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of MoCA were assessed in the cut-off points of 26 and 25. The SPSS 22 was used for data analysis. The statistical significance was set at P-value<0.05.

Results: The prevalence of cognitive impairment was calculated 41.5% and between 47.7% and 60% by MMSE and MoCA, respectively. At the cut-off point of 25 for MoCA test, the sensitivity and specificity were 92.6% and 84.2%, and PPV and NPV were 80.6% and 94.1%, respectively, and the efficacy of MoCA test for the detection of MCI was 87.69%. At the cut-off point of 26 for MoCA test, the sensitivity and specificity were 96.3% and 65.8%, and PPV and NPV were 66.7% and 96.2%, respectively, and the efficacy of MoCA test was 78.46%.

Conclusion: The prevalence of MCI in patients with CAD was higher than what was previously reported. The MoCA was more sensitive for recognizing the MCI in these patients. We suggested the cut-off point of 25 for the higher accuracy of the MoCA in detecting MCI in CAD patients.

Keywords: Mild cognitive impairment; Coronary artery diseases; Mini Mental State Examination; Montreal Cognitive Assessment



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Introduction

Mild cognitive impairment (MCI) is a transient state between normal condition and dementia (1). A patient with MCI is characterized by deterioration in cognitive functioning over the expected range relative to the age and education. However, the basic activities of a patient with MCI are not affected, and the patient does not meet the criteria for dementia (2). The prevalence of MCI was approximately estimated 3-17% of the general elderly population (2). The patients with MCI experience more difficulties in self-care management, including daily life, home finance, and medication above all (3-5). The risk factors of MCI include hypertension, diabetes, obesity, cardiovascular diseases, cerebrovascular disorders (6, 7), and cardiovascular diseases (6-9). Thus, the MCI has become a considerable matter for the health care providers. Available data indicates that coronary artery

diseases (CAD) may increase the risk of MCI (10-12). As mentioned, self-care and medication managing are impaired in the patients with MCI. However, the presence of concomitant CAD worsens this condition and vice versa (13). Hence, the early detection of MCI can prevent the progression of cognitive decline. To detect MCI in patients with CAD, a simple sensitive screening tool is required (2). A diversity of comprehensive screening tools was developed for the detection of dementia (14). The detection of MCI requires the assessment of at least four cognitive domains consisting of executive functioning/ attention, memory, language, and visuospatial. A paucity of screening tools had been suitable and validated for the detection of MCI (14). Although, the Mini Mental State Examination [MMSE] (15) is one of the most comprehensive screening tests which was used for

detection of dementia, it has low sensitivity and specificity for detection of MCI (14). However, the use of the Montreal Cognitive Assessment (MoCA) as a sensitive and specified comprehensive screening tool for detection of MCI has extensively increased (14, 16-19). Hence, the aim of the present study was to assess the sensitivity and specificity of the MoCA compared with MMSE for detecting cognitive impairment in patients with CAD.

Materials and Methods

Design and Sampling

This was a cross-sectional observational study in a population of patients with CAD admitted at post-catheter ward of Shahid Beheshti General Hospital in Qom, Iran, due to catheterization between April and December 2016. With presumption of 15% prevalence of MCI in developing countries and MoCA sensitivity of 90% compared to MMSE in elderly population, a sample of 65 subjects was calculated for the acceptable difference of 10%, type 1 error of 0.05, and power of 0.8, based on the normal distribution of the MMSE and MoCA score. Patients with degrees of CAD, diagnosed by two cardiologists, enrolled in our study due to angiography history. The patients with following criteria were excluded from the study: 1) neurocognitive problems documented in the medical history (cerebral vascular accident, transitional ischemic attack, short-term memory loss, confusion, delirium, or dementia); 2) history of psychotic disorders, bipolar disorder, learning disorder, developmental disability, renal failure requiring dialysis, or untreated sleep apnea; 3) use of neuroprotectives, anti-dementia, neuroleptic or anticholinergic drugs; 4) substance abuse within the past 5 years; 5) malignancies documented in the medical history; 6) history of myocardial infarction within last month; and 7) inability to fill out the questionnaires independently due to language barriers or visual impairment.

Demographic data (age, gender, weight, height, level of education) and Body Mass Index (BMI) were gathered through interviews with the patients. To detect the presence of coronary artery diseases, medical records were investigated for coronary angiography. Informed consent was obtained. The protocol was approved by the Ethics Committee of Qom University of Medical Sciences (IR.MUQ.REC.1395.64), where the study was performed.

Cognitive Assessment

As a considerable tool for the diagnosis of MCI, the MMSE was used for the cognitive assessment (20, 21). This is a 30-point cognitive test consisting of 11-task items that evaluate the cognitive domains including: visuospatial skills (1), language (7), concentration (4), working memory (14), memory recall (14), and orientation (9). A variety of cut-off points is suggested for the diagnosis of MCI. In the present study, for the diagnosis of MCI, the cut-off points 24 and 27 of the

MMSE were used and compared with the MoCA scores (14, 22). The standardized translated version of MoCA named the Persian-MoCA is available for download on the official website of MoCA (www.mocatest.org) for the Persian language patients. The 10 minutes MoCA is a brief paper-and-pencil comprehensive cognitive test which evaluates short-term memory recall, visuospatial abilities, executive function, verbal abstraction, attention, concentration, working memory, language, and orientation. One point was added to a total score of individuals whose education level was 12 years or less. The original study and others suggested that the best sensitivity and specificity of the MoCA for the detection of MCI was 26 (20, 23). We evaluated the sensitivity, specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of the MoCA in the cut-off points of 26 and 25 in the patients with CAD.

Statistical Analysis

To ensure the normal distribution of data, the Kolmogorov-Smirnov test was used, the results of which were presented as mean \pm standard deviation (SD). They were then summarized using absolute frequencies and percentages for categorical variables, which were also compared by Chi-square test or Fisher's exact test. Moreover, the Spearman correlation coefficient was measured for the MMSE and MoCA scores. Data were analyzed using SPSS 22.0 for windows (SPSS Inc., Chicago, IL., USA) with the statistical significance set at P -value <0.05 .

Results

From the total of 65 patients with CAD, 53.3% ($n=34$) were men and 47.7% ($n=31$) were women. Thirty-eight patients (58.5%) had an educational level of 12 years or less. The patients' age covered a range of 35-84 years (Mean \pm SD; 58.68 ± 10.09). The mean BMI was 28.92 ± 4.04 (ranging from 17.96 to 40.63). The Spearman correlation confidence between the MoCA and MMSE was 0.73. The mean score of the MMSE and MoCA was 25.98 ± 3.25 and 23.48 ± 3.91 , respectively with a P -value <0.001 in a paired t -test (Table 1). As shown in Table 1, there was no significant correlation between the demographic characteristics and the level of cognitive impairment.

At the cut-off point of 27 in the MMSE test, 41.5% of cases ($n=27$) had a cognitive impairment. On the other hand, at the cut-off point of 24 for the MMSE, 30.8 of cases ($n=20$) had a cognitive impairment (Table 2). Among them, at the cut-off points of 25 and 26, 2 and 1 cases, respectively had normal cognitive state with the MoCA test. Our findings indicated that 47.7% ($n=31$) and 60% of cases ($n=39$) had MCI at the cut-off points of 25 and 26 by the MoCA test, respectively.

At the cut-off point of 25 for the MoCA test, the sensitivity and specificity were 92.6% and 84.2%, and PPV and NPV were 80.6% and 94.1%, respectively. However, at the cut-off point of 25, the efficacy of the

MoCA test for detection of MCI in the patients with CAD was 87.69% (the level of agreement by Kappa coefficient of 0.752 and $P < 0.001$). Finally, at the cut-off point of 26 for the MoCA test, the sensitivity and specificity were 96.3% and 65.8%, and PPV and NPV

were 66.7% and 96.2%, respectively (Table 3). Therefore, at this cut-off point, the efficacy of MoCA test was 78.46% (with the level of agreement by Kappa coefficient of 0.583 and $P < 0.001$).

Table 1. Demographic characteristics of the patients

Variable	Male	Female	P-value
Age (mean±SD) ⁶	57.12±10.69	60.39±9.25	>0.05
Weight (mean±SD)	76.38±13.95	76.08±13.68	>0.05
Height (mean±SD)	17.41±10.19	16.21±7.73	>0.05
Education (mean±SD)	13.26±5.18	10.45±4.30	>0.05
BMI ⁶ (mean±SD)	27.75±5.83	30.38±5.05	>0.05
MMSE ⁷ (mean±SD)	26.34±3.18	25.58±3.33	<0.01*
MoCA ⁸ (mean±SD)	23.69±3.76	23.25±4.07	<0.01*

⁶SD: Standard Deviation; ⁶BMI: Body Mass Index; ⁷MMSE: Mini-Mental State Examination; ⁸MoCA: Montreal Cognitive Assessment; *: Significant

Table 2. MoCA and MMSE scores

		MoCA ⁸			
		≤25	>25	≤26	>26
MMSE ⁷	≤27	25	2	26	1
	>27	6	32	13	25
	≤24	18	2	19	1
	>24	13	32	20	25

⁸MoCA: Montreal Cognitive Assessment; ⁷MMSE: Mini-Mental State Examination

Table 3. Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Efficacy of the Persian version of MoCA test in the population of the patients with coronary artery diseases

MoCA ⁸ vs. MMSE ⁷	Sensitivity (%)	Specificity (%)	PPV ⁹ (%)	NPV ¹⁰ (%)	Efficacy (%)
25 vs.24	90	71.1	58.1	94.1	76.9
25 vs. 27	92.6	84.2	80.6	94.1	87.7
6 vs. 24	95	55.6	8.7	96.2	69.23
26 vs. 27	96.3	65.8	66.7	96.2	78.46

⁸MoCA: Montreal Cognitive Assessment; ⁷MMSE: Mini-Mental State Examination; ⁹PPV: Positive Predictive Value; ¹⁰NPV: Negative Predictive Value

Discussion

This is the first cross-sectional study comparing the MMSE and the MoCA in an Iranian population of patients suffering from CAD. The previous studies showed the prevalence of cognitive impairment before occurrence of dementia between 16.3% and 40% (24). However, in the present study, the prevalence of cognitive impairment was calculated 41.5% and between 47.7% and 60% by the MMSE and MoCA, respectively. This was consistent with the previous study performed in the same region (23). The special population who were selected for the present study may justify this difference. As reported, CAD and its risk factors may play an important role in the incidence of degenerative brain pathologies and consequent cognitive decline (10, 13). Furthermore, the early detection of MCI in the patients with CAD is very

important. According to the previous studies, the sensitivity and specificity of MMSE are low in detecting the majority of the cases with MCI (20, 23, 25, 26). The authors reported that the MMSE has less capacity for testing some domains including visuospatial, executive function and abstract reasoning. Moreover, there were no challenges in some task items of this test such as attention and delayed recall. Many investigators (2, 20, 23, 25, 27) suggested that the MoCA test can appear more successful in detecting the patients with MCI rather than the MMSE. Nasreddine *et al.* (20) argued that the sensitivity and specificity of the MoCA were 87% and 90%, respectively, and the MoCA was considerably more sensitive than the MMSE for recognizing the patients with MCI in elderly population. In the present study, we concluded

that the MoCA test was more sensitive in detecting the MCI in the population of the patients with CAD (92.6% and 96.3% at the cut-off points of 25 and 26, respectively). However, the MoCA test had high specificity (84.2%) for detecting the patients with the MCI in our study. The MoCA was approved as an acceptable screening tool for detecting the MCI in the Alzheimer's disease (28). However, a controversy is a proper cut-off point with a high accuracy for recognizing the MCI in patients with CAD. Although the standard cut-off point of 26 or less was applied for the MoCA (2, 27), some studies indicated that the cut-off point 26 for detecting the MCI in patients with concomitant diseases such as heart failure or cardiovascular risk factors had low accuracy (27). Thus, they recommended utilizing lower cut-off point which resulted in improved accuracy of the MoCA test around 50% (2). In our study, based on the previous reports (2, 27), the sensitivity and specificity of the MoCA were assessed at the cut-off points of 26 and 25. As stated, the MoCA specificity was higher at the cut-off point 25 (84.2% vs. 65.8), while, it was a little more sensitive at the cut-off point 26 (96.3 vs. 92.6). We found that PPV of the MoCA was improved at the cut-off point of 25 (80.6 vs. 66.7). Hence, we showed that the MoCA at the cut-off point of 25 had a higher accuracy for recognizing the MCI in the CAD patients. Based on the results of this study, we could not find any relation/association among demographic data and MCI (29-32), however, several studies reported their relation. This can be due to a small sample size of this study.

The sample size was small and the results cannot be generalized to the general population. In addition, there was not a control group.

Conclusion

This was the first study that compared the MoCA test with the MMSE to detect MCI in the patients with CAD. However, our findings indicated that MoCA was more sensitive for recognizing the MCI in the patients with CAD. We showed that the prevalence of MCI was higher than what was previously reported. Moreover, we suggested the cut-off point of 25 for the higher accuracy of the MoCA in detecting MCI in the population of CAD patients.

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Conflict of Interest

Authors declared no conflict of interests.

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