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Brief Screening for Mild Cognitive Impairment in Elderly Outpatient Clinic: Validation of the Korean Version of the Montreal Cognitive Assessment

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The Montreal Cognitive Assessment (MoCA) is a brief cognitive screening tool with high sensitivity for screening patients with mild cognitive impairment (MCI). The authors examined the validity and reliability of the Korean version of the MoCA (MoCA-K) in elderly outpatients. The MoCA-K, a Korean version of the Mini-Mental State Examination (MMSE), Clinical Dementia Rating (CDR) scale, and neuropsychological batteries were administered to 196 elderly persons (mild Alzheimer's disease [AD] = 44, MCI = 37, normal controls [NC] = 115). MoCA-K scores were highly correlated with those of MMSE and CDR. Using a cutoff score of 22/23, the MoCA-K had an excellent sensitivity of 89% and a good specificity of 84% for screening MCI. Internal consistency and test–retest reliability were good. The results obtained show that the MoCA-K is brief, reliable, and suitable for use as a screening tool to screen MCI patients in elderly outpatient clinic settings.

Keywords: MoCA-K; mild cognitive impairment; Alzheimer's; cognitive assessment; dementia

Mild Cognitive Impairment (MCI) refers to a transitional state between the cognition of normal aging and mild dementia.[1] Many studies have been conducted on the definition, classification, and conceptualization of this cognitive continuum during the past decade.[2-5] Moreover, active discussions continue as to whether it is the earliest stage of dementia or whether it is a benign form of this cognitive continuum. Nevertheless, as a result of the many studies conducted, MCI is now recognized as a high-risk state or prodrome of Alzheimer's disease (AD).[6,7]

In the future, there will hopefully be effective drugs to modulate progression from MCI to AD.[8,9] Therefore, in primary care and elderly outpatient clinics, there is a need to develop valid screening tests that can differentiate MCI and demented patients from normal elderly subjects.

Several screening tools are used to detect dementia. The Mini-Mental State Examination (MMSE)[10] is most widely used for screening cognitive impairment, including dementia. However, since it was originally developed to detect moderate and severely demented patients rather than MCI and mildly demented patients, it has been criticized for its lack of sensitivity and specificity for the detection of MCI and mild dementia.[11,12] Moreover, although the Cognitive

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Capacity Screening Examination[13] and DemTect[14] were developed to screen MCI, they are too lengthy and insensitive, and therefore are not widely used.

To screen patients who present with mild cognitive complaints, who usually perform in the normal range on the MMSE, the Montreal Cognitive Assessment (MoCA)[15] was developed. The MoCA is a 30-point test that takes 10 minutes or so to administer and includes more complicated items than the MMSE to screen MCI. These items include short-term memory recall, visuospatial ability, executive function, attention–concentration-working memory, language, and orientation to time and place. The MoCA has high sensitivity and specificity to differentiate subjects with MCI or demented patients from normal subjects.

In Korea, many elderly persons have a low level of education, and thus it is questionable whether the MoCA could be applied to this population. The aims of this study were as follows: to evaluate the reliability and validity of the Korean version of the MoCA (MoCA-K), and to determine the optimal cutoff MoCA-K score that best corresponds to a clinical diagnosis of MCI or AD.

Methods

MoCA Translation

The original version of MoCA was initially translated into Korean by a Korean psychiatrist and a neurologist. Subsequently, this Korean version was back-translated by a bilingual psychologist who was unfamiliar with the original version, and the resulting revision was reviewed and amended by a translation committee, which consisted of 3 Korean psychiatrists and 2 psychologists. The resulting draft version was thus a linguistic equivalent to the original and was again revised by a translation committee after being administered to 20 elderly pilot persons.

The final version of the MoCA-K used in this study contained some cultural and linguistic changes as compared with the original. In the short-term memory recall task, velvet and daisy were changed to silk and azalea, because velvet and daisy are unfamiliar to Korean elderly. When we selected Korean words, we considered the equivalent frequencies in use of words to those of the original words.

The phonemic fluency task requiring the production of as many words beginning with the letter F as possible in 60 seconds was changed to a semantic fluency task requiring the production of as many objects which could be bought in a market as possible in 60 seconds. This was done because one Korean character is one syllable which consists of several phonemes (letters). A fluency test beginning with a letter is unfamiliar to Korean elderly, and there are too few words beginning with a character to test fluency. Therefore, we changed the phonemic fluency test to the semantic fluency test. For the same reason, we used Korean characters rather than Korean letters in the executive function test (the trail-making test).

Participants

All participants were aged 65 and over and were recruited from among elderly outpatients registered at Seoul National University Boramae Hospital and community residents. The review board of our institution approved the study protocol. Eligibility criteria were as follows: age 65 years or over; fluent in Korean; and no known history of neurological disease, head trauma, stroke or any other physical illness affecting cognitive function. All participants were allocated to 1 of 3 groups (ie, 115 to a normal control [NC] group, 37 to the MCI group, and 44 to the mild AD group).

NC group members had no or only mild memory complaints, were in the normal range for standardized neuropsychological tests, and had no neurological abnormality.

The MCI group was defined in accordance with the criteria of Petersen et al[1]: (1) a memory complaint, preferably corroborated by an informant; (2) memory impairment relative to age- and education-matched healthy individuals (below 1.0 SD); (3) intact general cognitive function; (4) largely intact activities of daily living; (5) without dementia; and (6) without other obvious medical, neurological, or psychiatric explanations for the memory loss (with the exception of mild depression).

AD group members had been diagnosed as having probable AD and met the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria.[16] These subjects were mildly demented (scores of 0.5 or 1 on the Clinical Dementia Rating (CDR) scale).[17] MoCA-K was not used to diagnose MCI or AD. All AD subjects received neurological examinations and brain magnetic resonance imaging to exclude other subtypes of dementia.

Procedures

The study subjects were administered MoCA-K, MMSE, CDR, and Consortium to Establish a Registry for Alzheimer's Disease (CERAD) neuropsychological tests[18] by 2 trained psychologists. MoCA-K was administered to all 3 groups independently from the psychologists and the clinicians who make the diagnosis of MCI and AD.

A trained psychiatrist and a neurologist performed the clinical diagnoses, with the support of a consensus diagnosis conference in which the clinical and neuropsychological data were reviewed. Test–retest reliability tests were performed using 29 of the study subjects at 4-week intervals.

Assessment Scales

MoCA-K. The original MoCA is a neurocognitive test designed to screen for MCI.[15] It scores from 0 to 30, where higher scores indicate better cognition and a score below 26 indicates cognitive impairment corresponding to MCI and AD. It can be administered in 10 minutes. To correct for education effects, 1 point was added for participants with 12 years of education or less. To screen MCI, the MoCA used neuropsychological complicated tasks. The MoCA is composed of 12 items. Memory is tested by a short-term memory recall task (5 points). Visuospatial ability is tested using a clock-drawing task (3 points) and a three-dimensional cube copy (1 point). Executive function is tested using a trail-making B task (1 point), a phonemic fluency task (1 point), and a 2-item verbal abstraction task (2 points). Attention, concentration, and working memory is tested using a sustained attention task (1 point), a serial subtraction task (3 points), and digits forward and backward tasks (1 point each). Language is tested using a 3-item confrontation naming task with low-familiarity animals (lion, camel, rhinoceros; 3 points) and repetition of 2 syntactically complex sentences (2 points). Orientation to time and place is also tested (6 points).

In the MoCA-K, the words used in the short-term memory recall task and the letters used in the trail-making B task were changed, and the phonemic fluency task was replaced with a semantic fluency task. One point was added for participants with 6 years of education or less instead of 12 years of education or less.

MMSE. The MMSE is a neurocognitive test designed to screen cognitive impairment.[10] It scores from 0 to 30 where higher scores indicate better cognition and scores of <25 cognitive impairment. It can be administered in 5 to 10 minutes. The Korean version of MMSE is composed of orientation (10 points), short-term memory registration and recall (6 points), attention (5 points), naming (2 points), following verbal commands (4 points), judgment (2 points), and copying a double pentagon (1 point). The MMSE was validated in Korean elderly by Lee et al.[19]

CDR. The CDR is an observer rating scale designed to rate severity in dementia patients.[17] It contains 6 performance areas: memory, orientation, judgment, problem-solving, community affairs, home and hobbies, and personal care. It rates each area in a 5 point scale where 0 represents the absence of dementia, 0.5 questionable, 1 mild, 2 moderate, and 3 severe dementia. The sum CDR scores in these 6 areas were used in this study. It was validated in Korean elderly by Choi et al.[20]

CERAD neuropsychological test. This is a neuropsychological test used to detect dementia by CERAD.[18] It contains the following elements: verbal fluency, the Boston naming test, word list memory, constructional praxis, word list recall, word list recognition, and recall of constructional praxis. The CERAD neuropsychological test is commonly used worldwide in studies of AD and other dementias of the elderly. It was validated in Korean elderly by Lee et al.[21]

Statistical Methods

SPSS for Windows (release 13.0; SPSS, Inc, Chicago, Ill) was used for the data analyses. Sex distributions in the 3 groups were compared using the chi-square test. Mean age, education years, and MoCA-K and MMSE scores for each of the 3 groups were compared by ANOVA (with Bonferroni adjustment for multiple testing). In order to measure the internal consistencies of the MoCA-K, Cronbach's alpha was computed. We assessed test–retest reliability using intraclass correlation coefficients (ICCs) for the baseline and follow-up MoCA-K scores. To see concurrent validity, we used Pearson correlation coefficients between the MoCA-K scores and those of the validation measures (MMSE, CDR). Receiver operating characteristic (ROC) analysis was used to assess the ability of the MoCA-K, as compared with the MMSE, to differentiate the MCI and NC groups using graphic methods. Larger area under curves

(AUCs) indicated improved diagnostic performance. Sensitivities, specificities, positive predictive values, and negative predictive values were measured at threshold scores. *P* values below 0.05 were considered statistically significant throughout the analysis.

Results

Demographic Findings and Group Differences

The study participants comprised 196 elderly persons: 44 with AD, 37 with MCI, and 115 normal control subjects (NC). Subject characteristics are displayed in Table 1. Mean ages, sex ratios, and number of education years were similar in the 3 groups. Of the participants, 104 (53.1%) had received 6 years of education or less, 73 (37.2%) had 6 to 12 years of education, and 19 (9.7%) had over 12 years.

Table 1 shows descriptive statistics for the MMSE and MoCA-K. MMSE scores were significantly different in the 3 groups ($F_{2,194} = 41.3$, $P < .001$), and by post hoc analysis with Bonferroni adjustment, MMSE scores differed for the AD and MCI groups ($P < .001$) and for the AD and NC groups ($P < .001$), but not for the NC and MCI groups ($P = .117$). MoCA-K scores were also significantly different in the 3 groups ($F_{2,194} = 204.5$, $P < .001$), and by post hoc analysis, MoCA-K differentiated effectively between AD and MCI ($P < .001$), AD and NC ($P < .001$), and NC and MCI ($P < .001$).

In the NC group, three-dimensional cube copy, semantic fluency, 2-item verbal abstraction, serial subtraction, and naming with low-familiarity animals were significantly correlated with education years ($P < .05$) among 12 items of the MoCA-K.

Internal Consistency and Test–Retest Reliability

Cronbach's alpha for the MoCA-K was 0.86. This result indicates a high level of internal consistency of the MoCA-K. A similar high consistency was found for all the 12 items of the MoCA-K with Cronbach's alpha values ranging from 0.81 to 0.84.

Test–retest reliability data were collected from 29 participants at 4 week intervals. Mean change in MoCA-K total scores from the first to second evaluation was –0.54 to 1.23 points ($P = .43$), and ICCs between the baseline MoCA-K scores and follow-up were high (ICCs = 0.75, $P < .001$).

Table 1. Demographic Data and Mean Scores (Standard Deviation) of Mini-Mental State Examination and the Korean Version of the Montreal Cognitive Assessment Among Subjects With Alzheimer's Disease, Mild Cognitive Impairment, and Normal Controls

	AD (n = 44)	MCI (n = 37)	NC (n = 115)
Age, years (SD)	70.4 (8.6)	71.3 (5.9)	69.1 (6.1)
Female, N (%)	23 (52.3)	23 (62.2)	81 (70.4)
Education years (SD)	7.9 (3.7)	8.3 (3.8)	8.0 (3.5)
MMSE scores (SD)	19.3 (4.7)	24.0 (2.9)	25.5 (3.8)
MoCA-K scores (SD)	12.9 (5.0)	18.5 (3.7)	25.0 (2.6)

NOTE: MMSE = Mini-Mental State Examination; MoCA-K = the Korean Version of the Montreal Cognitive Assessment; AD = Alzheimer's Disease; MCI = Mild Cognitive Impairment; NC = Normal Controls.

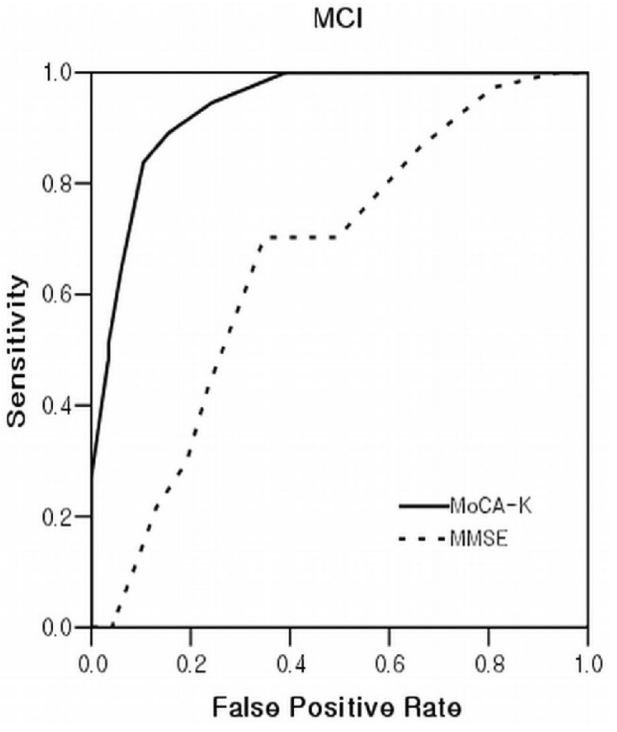

Figure 1. ROC curve analysis of the Mini-Mental State Examination (MMSE) and the Korean version of the Montreal Cognitive Assessment (MoCA-K) to detect mild cognitive impairment (MCI).

Concurrent Validity

Correlations with other validation measures (MMSE scores and the sum of CDR scores) were high.

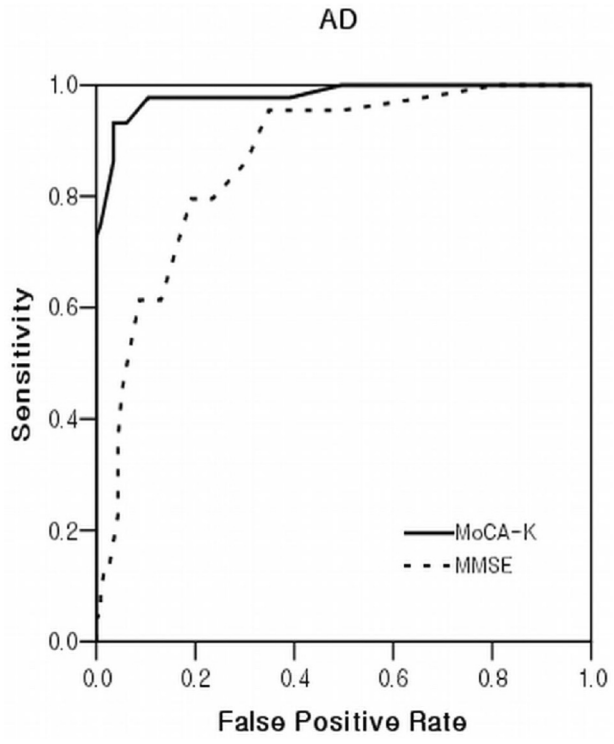

Figure 2. ROC curve analysis of the Mini-Mental State Examination (MMSE) and the Korean version of the Montreal Cognitive Assessment (MoCA-K) to detect Alzheimer's disease (AD).

MoCA-K scores were found to be highly and positively correlated with MMSE scores ($r = 0.65$, $P < .001$) and negatively correlated with the sum of CDR scores ($r = -0.62$, $P < .001$).

Sensitivity and Specificity

ROC curves were drawn for the MCI group versus the NC group, as well as the AD group versus the NC group, to determine the discriminatory validity of MoCA-K (Figures 1 and 2). Areas under the ROC curve for the MCI and AD groups by MoCA-K were 0.94 (0.90–0.98) and 0.98 (0.96–1.00), respectively. These results show that the MoCA-K differentiates these groups well, the corresponding values for the MMSE were 0.66 (0.57–0.76) and 0.87 (0.81–0.93).

Table 2 presents the sensitivities, specificities, positive predictive values, and negative predictive values of the MoCA-K at different cut-off values. The cut-off value determined by the developers of the original MoCA was 25/26, which suggested a probable case of MCI or AD, but the optimal cut-off value for the MoCA-K as determined by this study appears to be 22/23 (ie, 3 points lower than the original MoCA value). At this cut-off, the sensitivity of the MoCA-K in terms of screening MCI and AD were excellent (89% and 98%, respectively). The specificity of the MoCA-K was good (84%). At 25/26 cut-off points, the sensitivities of the MMSE for screening MCI and AD were 59% and 86%, respectively, and the specificity of the MMSE to screen MCI and AD was 70%.

Discussion

The demented population is rapidly increasing, but most patients do not receive appropriate early diagnosis and treatment in time because of poor recognition

Table 2. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of the Korean Version of the Montreal Cognitive Assessment for Detection of Mild Cognitive Impairment and Alzheimer's Disease

For MCI					For AD				
Cut-off	Se	Sp	PPV	NPV	Cut-off	Se	Sp	PPV	NPV
18/19	0.49	0.97	0.82	0.85	18/19	0.86	0.97	0.90	0.95
19/20	0.51	0.97	0.83	0.86	19/20	0.93	0.97	0.91	0.97
20/21	0.65	0.94	0.77	0.89	20/21	0.93	0.94	0.85	0.97
21/22	0.84	0.90	0.72	0.94	21/22	0.98	0.90	0.78	0.99
22/23	0.89	0.84	0.65	0.96	22/23	0.98	0.84	0.70	0.99
23/24	0.95	0.76	0.56	0.98	23/24	0.98	0.76	0.61	0.99
24/25	1.00	0.61	0.45	1.00	24/25	0.98	0.61	0.49	0.99
25/26	1.00	0.50	0.39	1.00	25/26	1.00	0.50	0.44	1.00
26/27	1.00	0.34	0.33	1.00	26/27	1.00	0.34	0.37	1.00

NOTE: SE = Sensitivity; SP = Specificity; PPV = Positive Predictive Value; NPV = Negative Predictive Value; MoCA-K = the Korean Version of the Montreal Cognitive Assessment; MCI = Mild Cognitive Impairment; AD = Alzheimer's Disease.

by primary care physicians and the poor sensitivity of the MMSE.[22,23] Thus, more accurate tests for screening MCI and AD in primary care and elderly outpatient clinics are required. Moreover, to the best of our knowledge, no screening tools are available to screen MCI in populations where the elderly are generally poorly educated. The MoCA-K, the first MCI screening tool in Korea, showed good validity and reliability, and excellent sensitivity for MCI and early AD with good specificity and a high level of test–retest reliability. The results obtained show that MoCA-K, which can be administered in 10 minutes, is valid, reliable, and reproducible in an elderly outpatient clinic.

To use screening tools in a new population, translation, back-translation, and modification according to cultural and linguistic differences are essential. The Korean version of MoCA, as described above, was well translated and revised, and all 12 items showed good internal consistency. Previous studies have reported that the semantic fluency task is more sensitive than the phonemic fluency task at detecting dementia,[24-26] and that phonemic fluency is more influenced by education than semantic fluency.[27] This study shows that phonemic fluency was an appropriate change.

The high correlations observed between MMSE and MoCA-K individual total scores proved good concurrent validity. Moreover, the MMSE could not differentiate the MCI and NC groups, whereas the MoCA-K could differentiate well both the MCI and AD groups from the NC group. In addition, the sensitivity and specificity of the MoCA-K were higher than those of the MMSE, indicating that the MoCA could be used to differentiate MCI and AD patients from normal elderly subjects, and that the MMSE could not.

In this study, the optimal cut-off point of the MoCA-K was found to be 3 points lower than the original MoCA, which may be due to a low number of years in full-time education. Mean education years in this study (8.3 ± 3.7 years in the NC group) was 5 years lower than that in the original MoCA study (13.3 ± 3.4 years). Moreover, the MoCA incorporates more complicated frontal function tests than previous dementia screening tests. For the MoCA-K in normal subjects, language function, calculation, and abstract ability were significantly correlated with education. These cognitive functions are related to frontal functions[28-30] and a low education level may be related to low frontal synaptic density and low frontal cognitive functions.[31] This cut-off difference may also be due to cultural differences; Korean elderly were not familiar with the westernized cognitive items used in the MoCA-K.

Some limitations of this study should be mentioned. First, we could not apply the MoCA-K to illiterate subjects because some of the MoCA tests (ie, the trail-making B task, the clock drawing task, and the sustained attention task) require literacy. In Asia, there are many illiterates among the elderly, and thus a literacy-neutral MCI screening test was required to screen MCI. Second, this was not a population-based study. More normative data in a population based sample will be needed before the MoCA-K can be used in the community to screen MCI. Third, Korean adults today are generally well-educated due to the institution of a westernized education system, and therefore, in the future, the cut-off score may have to be raised.

In conclusion, our results showed that the MoCA-K could be reliably used in primary care and geriatric outpatient clinics to detect cognitive impairment corresponding to MCI and AD in just 10 minutes.

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