Research Square

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The items in the Chinese version of the Montreal Cognitive Assessment Basic discriminate among different severities of Alzheimer's disease

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Abstract

Background To determine whether items of the Chinese version of the Montreal Cognitive Assessment Basic (MoCA-BC) could discriminate among cognitively normal controls (NC), and those with mild cognitive impairment (MCI), mild Alzheimer's disease (AD), and moderate-severe (AD). Methods MCI (n=456), mild AD (n=502) and moderate-severe AD (n=102) patients were recruited from the memory clinic, Huashan Hospital, Shanghai, China. NC (n=329) were recruited from health checkup outpatients. Five MoCA-BC item scores were collected in interviews. Results The MoCA-BC orientation test had high sensitivity and specificity for discrimination among MCI, mild AD and moderate-severe AD. The delay recall memory test had high sensitivity and specificity for MCI screening. The verbal fluency test was efficient for detecting MCI and differentiating AD severity. Conclusions Various items of the MoCA-BC can identify MCI patients early and identify the severity of dementia.

Background

Mild cognitive impairment (MCI) is a transitional cognitive state between normal ageing and the early stages of dementia. Alzheimer's disease (AD) is the most common neurodegenerative disease, and the incidence of AD increases with age. Approximately 10-20% of adults over the age of 65 have MCI, and approximately 10% of these patients may progress to AD [1] . Neuropathology has found that MCI patients also had extracellular amyloid deposition and neurofibrillary tangles in the susceptible brain regions of AD patients (such as the olfactory cortex in the medial temporal lobe)[2] . There is a close relationship between MCI and AD.

The Montreal Cognitive Assessment (MoCA) had been used as a quick evaluation scale to detect MCI in the group of highly educated elderly adults with an average education level of 13 years [3 , 4]. Several items in the MoCA incorporated tasks that showed wide differences due to formal education or literacy levels, such as the Trail-Making Test, cube copy, and naming low-familiarity animals[5]. The cutoff points to detect MCI or AD have been demonstrated to be different all over the world [6-9]. The Chinese version of the MoCA-B (MoCA-BC), translated with cultural modifications from the original English version, has shown excellent validity and accuracy in distinguishing between NC, MCI, mild and moderate AD among the Chinese elderly with various levels of education[10 , 11].

Compared with the MoCA, the MoCA-BC takes less time (the total number of tests is reduced by 3), and the change in some non-memory cognitive function tests improves the sensitivity for screening and the acceptance of the participants. There are nine items assessing different cognitive domains in MoCA-BC, including language, attention, calculation, orientation, memory, concentration, executive function, conceptual thinking, and visual perception.

There is currently no comparison of the items in the MoCA-BC scale among cognitively normal people, and individuals with MCI, mild AD, and moderate-severe AD. We selects five items in MoCA-BC that scored more than five points in a single item; these tests are the verbal fluency test, visual perception test,

immediate memory test, delay recall memory test and orientation test. Our study may help clinicians to fully understand and distinguish the severity of cognitive impairment.

Methods

Participants

A total of 1,389 participants aged between 50 and 90 years old comprised four groups: 329 cognitively normal controls (NC), 456 individuals with MCI, 502 individuals with mild AD, and 102 individuals with moderate-severe AD. The participants with MCI or AD were recruited from the memory clinic at Huashan Hospital, Shanghai, China, from May 2015 to March 2018. NC were recruited from their spouses and friends.

Materials and procedure

The inclusion criteria for all subjects were normal or nearly normal eyesight and hearing, no history of alcoholism, drug abuse, head trauma or other serious neuropsychiatric diseases and other disease that would affect their performance to complete all neuropsychological assessments. Participants or their legally authorized caregivers provided informed consent before the commencement of the study. This study had been approved by the ethics committee of Huashan Hospital. All subjects underwent complete neurological and neuropsychological assessments, brain imaging and other necessary laboratory tests. The diagnosis decision was made independent of MoCA-BC scores.

The diagnosis of MCI was on the basis of the following criteria[12]: complaints of cognitive impairments; normal activities of daily living or slight impairment in instrumental activities of daily living; objective cognitive impairment (Mini-Mental State Examination; MMSE) score cutoff[13], Clinical Dementia Rating (CDR) score of 0.5[14], and performance on a set of neuropsychological tests that was 1.5 standard deviations (SDs) or more below the normative mean; and no dementia.

The diagnosis of AD was made according to the National Institute of Aging and Alzheimer's Association criteria [15]insidious onset of symptoms, clear-cut history of cognitive decline by report or observation, and the initial and most- prominent cognitive deficits typically being amnestic or non-amnestic (including language, visuospatial or executive deficits). Diagnosis of mild AD and moderate-severe AD was based on CDR scores: a CDR score of 1 for mild AD and at or above 2 for moderate-severe AD [14].

Controls were required to have no cognitive impairment or no medical history of significance, an MMSE score at or above the cutoff, a CDR score of 0, a modified Hachinski Ischaemic Scale (MHIS) score of 4 or less, and a Hamilton Depression Rating Scale (HDRS) score of 12 or less over the previous 2 weeks.

The following clinical and neuropsychological tests were administered: MMSE, MoCA-BC, CDR, MHIS, and HDRS as mentioned above. Five items from the MoCA-BC were selected for assessment in the present

study and included measures of language, orientation, memory (instant recall and delay recall), and visual perception: 1. Measure of language: Ask the subject to name as many types of fruit as possible in one minute, and record that number to obtain the corresponding score; 2. Measure of orientation: Ask the subject to describe the time and place, with a total score of 6; 3. Measure of instant recall: The tester lists 5 words , then the subject recalls as many as possible. Repeats the list twice and that number is recorded with a total score of 10; 4. Measure of delay recall: following the other tests, the subject is asked to recall the 5 words and scores 3 points per word for free recall, 2 points following semantic classification clues, and 1 point for multiple choice recall; 5. Measure of visual perception: Identify the number of items in overlapping graphics in one minute, with a total score of 10.

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Statistical analysis

All analyses were carried out in SPSS version 20 for Windows. Pearson correlations were applied for better understanding of the effect of age and education level on performance on the five items. Demographic characteristics for each diagnostic group are described using means and SDs or frequencies where appropriate. Differences in demographic characteristics and cognitive test performance between diagnostic groups were determined by chi-square tests as well as ANOVA with subsequent Bonferroni corrections, with $P<0.05$ considered significant. Receiver operating characteristic (ROC) curve analysis for MCI or AD dementia was performed to obtain cutoff values with sensitivity and specificity measures for the scores of the five items. The area under the ROC curve (AUC) was used to compare the diagnostic performance of the five items. The level of significance was set at $\alpha = 0.05$.

Results

Demographic information

Correlation analysis between the five item scores and demographic characteristics were carried out in the control group and are summarized in Table 1. It is suggested that the orientation test had no correlation

with age and education level. Verbal fluency, visual perception, immediate recall and delayed recall were all negatively, but weakly, correlated with age (r<0.2). Verbal fluency, visual perception, and immediate recall were associated with education. Therefore, to reduce the impact of education level on the item scores of MoCA-BC, we divided the population into three levels according to the years of education: low level (≤6 years), middle level (7–12 years), and high level (>12 years). The study analysed the difference in the five sub-test scores in the MoCA-BC between the NC group, MCI group, mild AD group and moderate-severe AD group based on level of education.

Table 1. Correlation analysis between item scores and demographic characteristics

The demographic information according to education in the NC group, MCI group, mild AD group and moderate-severe AD group is shown in Table 2, and there was no difference in education between the subgroups (P>0.05). In the low and middle-level education groups, there was no difference in sex ratio among the NC group, MCI group, mild AD group and moderate-severe AD group. In the middle and high-education level groups, there was no difference in age among the NC group, MCI group, mild AD group and moderate-severe AD group.

Table 2. Comparison of demographic information according to level of education

Comparison of five items among NC, MCI, mild and moderate AD

We show the five item scores (verbal fluency, orientation, visual perception, immediate recall and delayed recall) for each subgroup in Table 3. There were significant differences between subgroup means for the five item scores, and the significance was less than 0.05. After post hoc pairwise between-group comparisons, we found that the verbal fluency test scores were significantly different between each diagnostic subgroup. There was no difference between the NC and MCI groups in the orientation test, but there were differences among the MCI, mild AD , and moderate-severe AD groups. Visual perception and immediate recall tests differed among each diagnostic subgroup at the high-education level, while at the low-education level, there was no difference between the NC and MCI groups. The delayed recall test did not differ between mild AD and moderate-severe AD groups, but there was a difference between the NC, MCI, and mild AD groups.

Table3.Comparison of the five items among 4 groups ($\bar{X}$±s)

ROC analysis of the five items between controls and individuals with MCI and AD

An ROC analysis of each item was performed for discriminating those with MCI from NC, and the delay recall item with an AUC of 0.808 (see Table 4, Figure1) showed excellent sensitivity and specificity. The

optimal cutoff score of each item was ranked in Table 4. Each item for the detection of AD had a higher AUC (0.945) than for the detection of MCI, and the most effective item was the delayed recall test (Table 5, Figure2).

Table 4. Sensitivity and specificity of the five items for distinguishing MCI from NC

Figure1. Receiver operating characteristic curve analysis of the five items for distinguishing MCI from NC.

Table 5. Sensitivity and specificity of 5 items for distinguishing AD from NC

Figure2. Receiver operating characteristic curve analysis of the five items for distinguishing AD from NC.

Discussion

The purpose of this study was to analyse the validity of the five MoCA-BC items (verbal fluency, orientation, visual perception, immediate recall, and delayed recall) for screening cognitive impairment and the severity of cognitive impairment. The optimal cutoff of the five items in screening for MCI and AD was analysed, which is helpful for clinicians to more intuitively judge these five domains of cognitive impairment. We found that there was a negative correlation between age and cognitive impairment, but the correlation was extremely weak, which is consistent with AD itself being an age-related disease. The level of education is considered to be the most important factor in cognitive testing (such as the MoCA and MMSE). The optimal cutoff scores for MCI or AD screening for cognitive impairment in China are different according to the level of education. Therefore, to reduce the influence of cultural bias on scores, this paper analyses the difference of the five item scores between NC, MCI, mild AD and severe-moderate AD according the educational level.

In our study, we found that among the NC, MCI, mild AD, and moderate -severe AD groups, there were differences in delayed recall, verbal fluency, visual perception, immediate recall, and orientation. These relations are similar to F. Clement's research [16 , 17]. Education had no effect on orientation and delayed recall. Our results showed that the orientation test was effective in identifying MCI, mild AD, and moderate to severe AD, but poor discrimination between MCI and NC. Memory impairment was the first impaired domain in MCI individuals who had less disruption in the orientation test [12 , 18]. The orientation test was easy to complete and showed a ceiling effect when screening for NC and MCI. The delayed recall test has good validity in identifying NC, MCI, and mild AD groups, but no validity in distinguishing the severity of AD; this is probably owing to a floor effect, because in confirmed AD individuals, delayed recall memory impairment is too serious to complete the delayed recall test. However, when screening for MCI or AD, the AUC for the delayed recall test was the largest, which is more conducive to the early recognition of cognitive dysfunction in MCI or AD patients. This is similar to the previous studies by Lin Huang et al. The memory index score of the MoCA-BC had high sensitivity and specificity for MCI screening, while the non-memory index score of the MoCA-BC had similar effectiveness for discrimination among MCI, mild AD and moderate AD groups.

Our results showed that the verbal fluency test had validity not only in the MCI group but also in the mild and moderate-severe AD groups in the three education subgroups. Visual perception and immediate recall tests had validity for discrimination among the NC, MCI, mild AD, and moderate-severe AD groups only in the high-level education population, while in low- and middle-level education populations the two items had poor validity for screening those with MCI from NC. This may be due to the need for a high level of education to complete the two items and the lower impairment in visual perception and immediate recall in MCI individuals.

Cognitive impairment can be manifested in many aspects, such as memory, orientation, language, executive function, visual perception, application, attention, and information processing. The MoCA-BC is a quick, simple, and feasible assessment tool not only for doctors but also for outpatients. Each item in the MoCA-BC is independent, which reflects the characteristics of cognitive impairment of dementia in different stages. Sometimes, elderly people may have vision or hearing impairments, and only part of the test can be completed; therefore, a total score cannot be obtained. The MoCA-BC item score is a good complement for these people. The analysis of the differences between the item scores across groups with different levels of cognitive function is very helpful in distinguishing the types of cognitive dysfunction and determining the field of cognitive impairment. Through each item, we can observe the main areas of cognitive impairment, and help identify the types of cognitive impairment, further distinguishing between the recognition of AD, Lewy body dementia, vascular dementia or depression.

Of course, the items of the MoCA-BC scale cannot fully satisfy the identification for the stage of AD, so the MoCA-BC needs to be complemented by a combination of more complicated neuropsychological tests.

In summary, the MoCA-BC is a comprehensive test that combines sub-items to identify early MCI patients and to identify the severity of dementia. This study observed differences in verbal fluency, visual perception, immediate memory, delayed memory, and orientation among the NC group, MCI group, mild AD group, and moderate-severe AD group. The results of the present study indicate that there is a need for further research on the difference in the item scores between those with AD, Lewy body dementia, vascular dementia and depression.

Abbreviations

MoCA-BC: the Chinese version of Montreal Cognitive Assessment Basic; NC: normal controls; MCI: mild cognitive impairment; AD: Alzheimer’s disease; MMSE: Mini-Mental State Examination; ROC: Receiver operating characteristic; AUC: area under the ROC curve (AUC)

Declarations

Conflict of Interest: None.

Ethics approval and consent to participate

Ethics approval was obtained according to regulation of the ethics committee of Huashan

Hospital. Written consent was obtained from participants or their legally authorized caregivers.

Consent for publication

Not applicable

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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None

Authors' contributions

Yan-rong Zhang, Yun-Long Ding were involved with conception and design of the study. Ting-ting Zhai, Wen-juan Wang, Wei Can, Yan Liu and Ke-liang Chen contributed to the data collection. Yan-rong Zhang and Yun-Long Ding analyzed statistical data. Yan-rong Zhang wrote the manuscript, Ke-liang Chen and Wan-li Dong were responsible for critical revision and supervised the interpretation of data. All authors read and approved the final manuscript.

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Tables

The tables could not be included here due to technical limitations. They can be found in the supplemental files section.

Figures

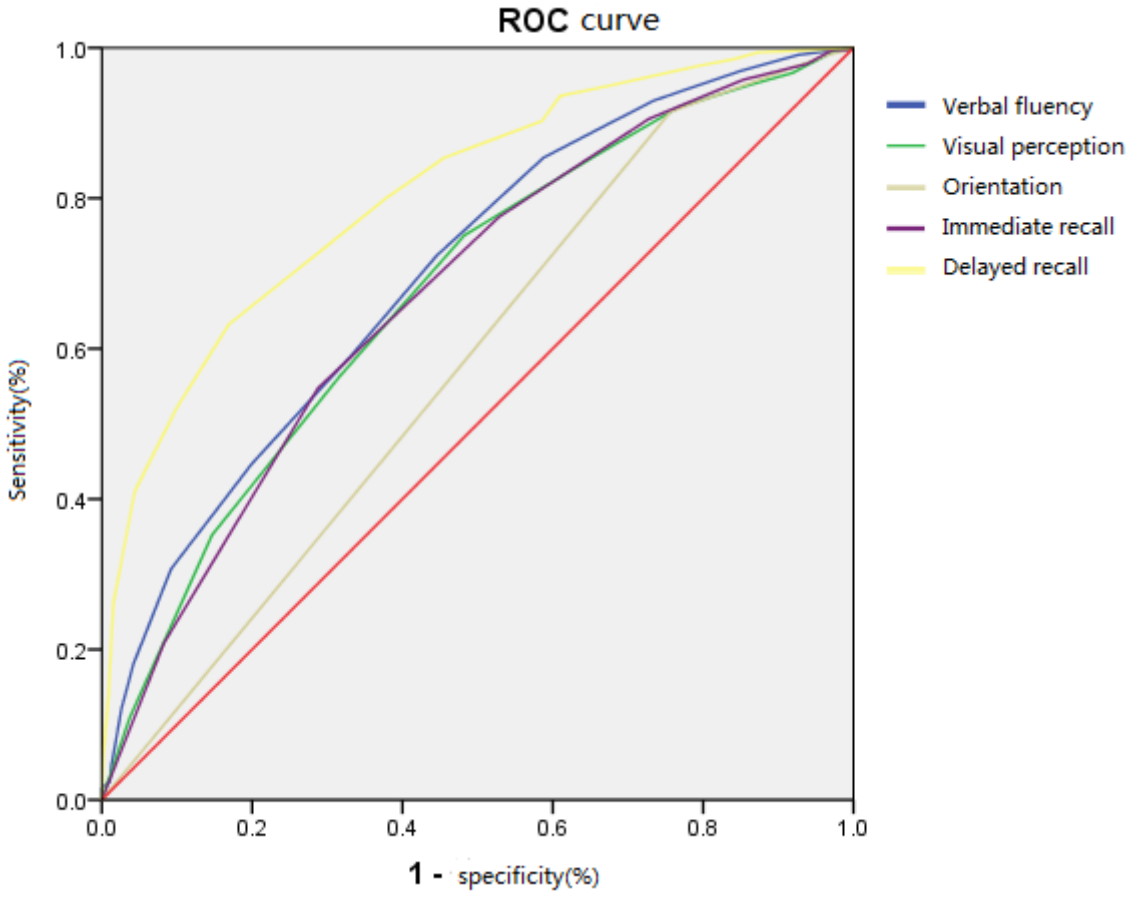

Figure 1

Receiver operating characteristic curve analysis of the five items for distinguishing MCI from NC.

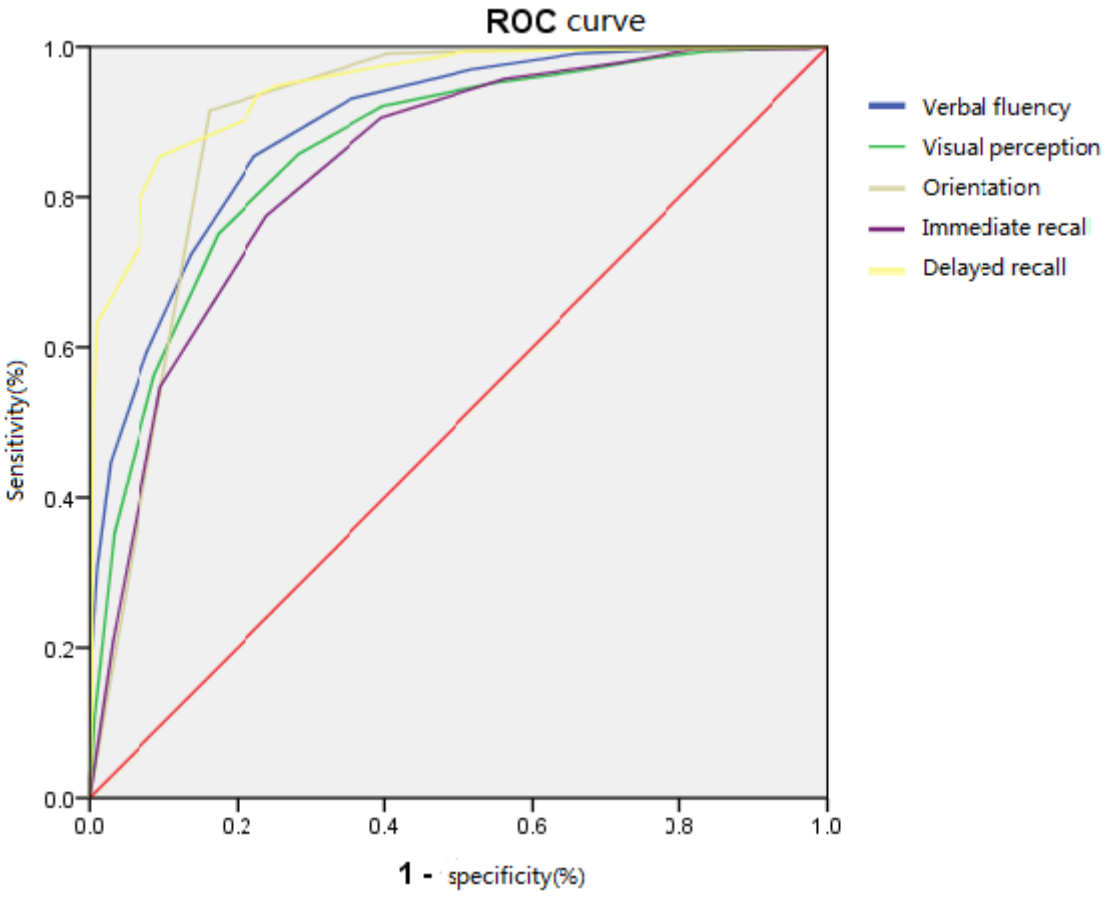

Figure 2

Receiver operating characteristic curve analysis of the five items for distinguishing AD from NC

Supplementary Files

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- supplement1.docx