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Comparing Clock Test for Cognitive Screening: Quantitative Analysis of Five Scoring Methods – What is Optimal?

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Keywords

CDT, MMSE, Cognitive Screening

Abstract

Objectives: The clock drawing test (CDT) is a widely used cognitive screening tool that has been well accepted. However, it is still questionable which scoring system is the best. We assessed the correlation of five common scoring methods of the CDT with Mini Mental State Examination (MMSE), and intercorrelations between each different scoring system.

Methods: CDT scores of different scoring systems from participants from the geriatric club in Pondok Kopi Jakarta Islamic Hospital, were compared. The CDT was scored according to the methods of Rouleau, Babins, Mendez, Lin, and Shulman. Correlation coefficients between the five scoring methods of the CDT with MMSE were calculated, as well as the intercorrelations between each different scoring system.

Results: The study sample consisted of 106 non-demented subjects, aged between 60 and 77 years. The five scoring methods of the CDT correlated significantly with MMSE, but correlation coefficients were moderate (r = 0.43 to r = 0.46). The highest was Lin's method (r = 0.46). Especially, correlation coefficients between the five scoring methods of the CDT with MMSE attention domain were higher (r = 0.42 to r = 0.52). The intercorrelations between each different scoring system were high (r = 0.87 to r = 0.99). The correlation coefficients between Rouleau's method with Mendez's method was the highest (r = 0.99).

Conclusions: The correlation of five common scoring methods of the CDT with MMSE were moderate positive. The CDT scored according to the method of Lin was the highest. The intercorrelations between each different scoring system were high.

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Introduction

The world population is aging rapidly. The older populations in more developed countries are projected to continue to grow in size. In Asia, about 8 percent of Asians are aged 65 and older. East Asia is one of the oldest sub-regions globally.[1,2]

Population aging also reflects a human success story of increased longevity. However, increasing longevity has led to new challenges. Rising life expectancy is associated with increased prevalence of chronic diseases like dementia and mild cognitive impairment.[1,2,3]

Currently, dementia cannot be cured, but several promising methods of treatment exist to improve the patient's well-being and to delay disease onset. Current research aims to predict developing dementia reliably in order to enable the effective use of treatment options.[3,4]

Research into the early screening of cognitive disorders, specifically mild cognitive impairment and dementia, has increased over the last two decades. The clock drawing test (CDT) and Mini Mental State Examination (MMSE) are widely used cognitive screening tools that has been well accepted among clinicians and patients for its ease of use and short administration time.[3,4,5]

The CDT is a valuable cognitive screening test for both quantitative and qualitative assessment of a variety of cognitive functions, including selective and sustained attention, auditory comprehension, verbal working memory, numerical knowledge, visual memory and reconstruction, visuospatial abilities, on-demand motor execution (praxis) and executive function.[3,5,6]

Although there is great interest in the CDT as a cognitive screening tool, there are many scoring methods have been proposed without clear agreement on which is best for most clinical settings. The aim of this paper is to assess the correlation of five common scoring methods of the CDT with MMSE, and intercorrelations between each different scoring systems.

Methods

Participants

From June 2013 to June 2014, a total of 106 subjects aged 60 years and older were recruited consecutively. The study sample was taken from the geriatric club in Pondok Kopi Jakarta Islamic Hospital. Other inclusion criteria were: non-demented, physically and mentally healthy, able to read and write, and willing to participate in this research.

Exclusion criteria in this study were: hearing and / or communication problems, depression, major psychiatric disorders, severe illness, history of use of drugs that interfere with brain function and structure, history of cerebrovascular disease, history of brain tumors, history of severe head injury, parkinsonism, epilepsy, and severe physical disorders.

Clock drawing test (CDT) administration

The subjects were given a blank sheet of paper and asked to follow directions: "Please draw a clock face, placing all the numbers on it. Now set the time to 10 past 11".[3]

Scoring systems

Within this study, we scored each clock according to different scoring systems blinded to the results of the rest of the assessment. We chose five scoring systems: Rouleau, Babins, Mendez, Lin, and Shulman. The characteristics of clock drawing test scoring systems are described in table 1.

Statistical analysis

The obtained CDT scores of different scoring systems from each participants were compared. Correlation coefficients between the five scoring methods of the CDT with MMSE was calculated, as well as the intercorrelations between each different scoring systems. The correlation coefficients and the intercorrelation was tested using the correlation coefficients Pearson ®. All statistical analyses were performed using SPSS 20 for Mac, with a two-tailed level of significance set at 0.05.

Results

The study sample consisted of 106 non-demented subjects, aged between 60 and 77 years. The mean age of the sample was 64.63 years (SD. 4.69). 76 women and 30 men took part in the study. 52 had gone to school for up to twelve years, and 54 for 13 or more years. The sample's mean MMSE score was at 27.46 points (SD. 2.34). The baseline demographic characteristics of the subjects are described in table 2.

The five scoring methods of the CDT correlated significantly with MMSE (statistically significant; $p < 0.05$), but correlation coefficients were moderate ($r = 0.43$ to $r = 0.46$). The highest was Lin's method ($r = 0.46$). Especially, correlation coefficients between the five scoring methods of the CDT with MMSE attention domain were higher ($r = 0.42$ to $r = 0.52$).

The intercorrelations between each different CDT scoring systems were high ($r = 0.87$ to $r = 0.99$). The correlation coefficients between Rouleau's method with Mendez's method was the highest ($r = 0.99$).

Discussion

The Clock Drawing Test (CDT) and Mini Mental State Examination (MMSE) are a reliable instrument that have good sensitivity and specificity for the differentiation between clearly demented vs cognitively healthy persons.[13]

MMSE is more established, but it takes longer time than CDT. It has been reported that the MMSE can take up to 20 minutes to complete, but even if it takes only 5 to 10 minutes to complete, this tests practicality in the time-limited primary care context where consultations are conducted in 10 to 15 minute blocks.[14]

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Table 1. Characteristics of clock drawing test scoring system

Scoring system	Scoring criteria	Score range
Rouleau et al.[7]	1. integrity of the clock face (maximum 2 points) 2. presence and sequence of the numbers (maximum 4 points) 3. presence and placement of hands (maximum 4 points)	0 – 10
Babins et al.[8]	1. contour integrity of the clock face (maximum 2 points) 2. center (maximum 2 points) 3. numbers (maximum 6 points) 4. hands (maximum 6 points) 5. gestalt (maximum 2 points)	0 – 18
Mendez et al.[9]	1. general clock face (maximum 3 points) 2. clock numbers (maximum 12 points) 3. hands (maximum 5 points)	0 – 20
Lin et al.[10]	1. is 12 placed correctly? 2. is the minute hand longer than the hour hand? 3. is the hour hand pointing to 11 o'clock?	0 – 3
Shulman et al.[11,12]	1. 5 points = "perfect" clock 2. 4 points = clock containing minor visuospatial errors 3. 3 points = for acceptable visuospatial organization but inaccurate representation of 10 past 11 4. 2 points = moderate visuospatial disorganization of numbers 5. 1 point = a severe level of visuospatial disorganization 6. 0 points = inability to make any reasonable attempt	0 – 5

The CDT more accepted among clinicians in the time-limited primary care setting because is easy to administer and short administration time. However, there are many scoring methods have been proposed without clear agreement on which is the best.[3,4,5,6]

The five common scoring methods of the CDT are Mendez's method, Babins, Rouleau, Shulman, and Lin's method. The Mendex's method is the most complex and time consuming, while the Lin's method is the simplest and less time consuming. The aim of this study is to assess the correlation of five common scoring methods of the CDT with MMSE.

The correlation of five scoring methods of the CDT with MMSE were moderate (r = 0.43 to r = 0.46). The correlation of the CDT with other screening tests, including the 'gold standard' MMSE, is good in most studies. Some authors argue that there may be a rationale for using both the MMSE and the CDT whilst screening for MCI or dementia, as the MMSE measures mostly verbal skills and so could miss patients with early dementia.[3] However, this would considerably increase the time of administration.

Interestingly, the highest correlation coefficients (r) was Lin's method (r = 0.46), followed by the Mendez, Babins, Shulman, and Rouleau's method. The Lin's method of CDT can take only 5 minutes to complete.

This result suggests that increasing the detail and complexity of CDT scoring systems does not significantly increase the performance of the test. One potential reason for this could be that normative data for the majority of the aforementioned scoring systems have not been adequately developed in healthy older adults.[5]

Some authors also reported that increased rigidity in scoring may limit the test's ability to capture subtle errors that may be indicative of decreased cognitive functioning. Furthermore, most authors support the use of simpler scoring systems, because of their high correlation with more complex systems and simple administration and scoring.[5]

Conclussions

The correlation of five common scoring systems of the CDT with MMSE were moderate positive. This result suggests that the psychometric properties of the most common scoring systems of the CDT and MMSE are similar.

The intercorrelations between each different scoring methods of the CDT were high. This result suggest that performance of the most complex scoring methods and the simplest scoring methods are remarkably similar.

Table 2. General characteristics and main test results of the subjects

	Characteristics
Age, years	64.63 years (SD. 4.69)
Sex, M/F	30/76
Tests, scores	
MMSE (0 - 30)	27.46 (2.34)
Rouleau et al. (0 - 10)	8.17 (2.13)
Babins et al. (0 - 18)	15.32 (3.40)
Mendez et al. (0 - 20)	17.24 (3.94)
Lin et al. (0 - 3)	2.27 (0.95)
Shulman et al. (0 - 5)	4 (1.14)

Table 3. Correlations between different CDT scoring methods with MMSE

CDT scoring methods	Correlation coefficients (r)
Rouleau et al.	0.43 ($p < 0.05$)
Babins et al.	0.44 ($p < 0.05$)
Mendez et al.	0.45 ($p < 0.05$)
Lin et al.	**0.46 ($p < 0.05$)**
Shulman et al.	0.43 ($p < 0.05$)

Table 4. Intercorrelations between each different CDT scoring systems

	Rouleau et al.	Babins et al.	**Mendez et al.**	Lin et al.	Shulman et al.
Rouleau et al.	1	0.98	**0.99**	0.89	0.94
Babins et al.	0.98	1	0.98	0.89	0.93
Mendez et al.	**0.99**	0.98	1	0.87	0.95
Lin et al.	0.89	0.89	0.87	1	0.92
Shulman et al.	0.94	0.93	0.95	0.92	1

This is important when considering the increased time required for scoring the more complex systems. The simpler scoring methods of the CDT, such as The Lin's method, may be optimal for use in the time-limited primary care settings.

More data will be necessary to give to this interpretation. However, this study may encourage the wider use of clock drawing test, which is easily applicable and well accepted by clinicians and patients.

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