Validity of Clinical Use of the Clock-Drawing Test in Thai Elderly Patients with Memory Problems

SUTTHICHAI JITAPUNKUL, M.D., M.Sc.*,
POUNGSOY WORAKUL, B.Sc.**,
JITTAWAN KIATPRAKOTH, B.Sc.**

Abstract

Forty eight elderly Thai patients, 12 demented, 36 non-demented who consecutively attended a geriatric clinic, at Chulalongkorn University Hospital, with a memory problem were recruited in the study which aimed to determine the validity of the clock-drawing test (CDT) and Chula mental test (CMT). Subjects took the Chula Mental Test (CMT) and were asked to draw a clock on a preprinted 12 centimeters circle showing the time of 11:10. Clocks were scored using the Chula Clock-drawing Scoring System (CCSS). Ten subjects voluntarily participated and completed the WAIS test. The best cutoff score of the CMT and the CDT using diagnosis of dementia as a gold standard were 15 and 7 respectively. Sensitivity and specificity for detecting dementia by the CDT were 100 per cent and 94.1 per cent respectively. Sensitivity and specificity for detecting dementia by the CMT were 83.3 per cent 91.7 per cent The likelihood ratio (95% confidence interval) of the CMT and the CDT were 10 (3.3-30.4) and 17 (4.4-65.2) respectively. There was a good correlation of the CDT score and the CMT score with the WAIS score. Although the CDT was better than the CMT in literate patients, the CDT had limitation of use among illiterate patients but not the CMT. The benefits of simultaneously application on dementia screening was shown. This study showed that the CDT was a valuable, brief method of dementia screening in elderly Thai patients with memory problems.

Key word : Clock-drawing Test, Chula Mental Test, Thai, Elderly, WAIS, Dementia

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During the last decade, there have been many reports of using clock-drawing for screening dementia patients especially for Alzheimer's disease (1-8). However, many scoring systems were proposed(1-8). These studies were all conducted in developed countries. The use of clock drawing with elderly people in developing countries has not been reported. We, therefore, conducted a study of the

* Department of Medicine,
** Department of Psychiatry, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

"clock-drawing" test in elderly Thai patients who attended the geriatric clinic with a memory complaint in order to determine its validity.

SUBJECTS AND METHOD

The subjects of this study consisted of 48 elderly Thai patients who were consecutively attending the geriatric clinic of Chulalongkorn University Hospital for memory problems. If the elderly patients were not able to draw, the reasons for this were recorded. After history-taking and a physical examination by a geriatrician, these 48 patients with cognitive defects were further evaluated with laboratory tests and CT scans of the brain. Every impaired cognitive patient was followed and reassessed for at least 6 months before the diagnosis of dementia syndrome and its cause were made. The DSM-3-R criteria was used for clinical diagnosis of dementia[9].

Within a month of their first visit to the geriatric clinic, each subject completed a Chula Mental Test (CMT)[10] and a clock-drawing test (CDT). For the CDT, subjects were provided with a piece of paper with a preprinted circle twelve centimeters in diameter and were asked to follow a two-step instruction: "First, draw a clock by putting in numbers. Second, put in long and short hands on the clock to make it read ten past eleven (11:10)." Instructions were repeated as necessary, but additional prompting was not provided. No time limit was placed on this task.

After a systematic review of the reported scoring system[1-8,11], we decided to develop a scoring system called "Chula Clock-drawing Scoring System (CCSS)" and used it in this study. (see appendix) Developing the CCSS adopted a rational mainly from the reports of G.P. Wolf-Klein and et al[1], I. Rouleau and et al[2], J. Shua-Haim and et al[3], Y.I. Watson and et al[4], T. Sunderland and et al[5] and K.I Shulman and et al[6]. Scores of the CCSS ranges from 0 - 10.

The Barthel ADL Index (BAI)[12] and the Chula ADL Index (CAI)[13] were assessed in all subjects. The subjects were also asked to participate in the test of Wechsler Adult Intelligence Scale (WAIS), Thai version[14]. Within 2 weeks after the CMT and the CDT had been completed, these volutary subjects performed the WAIS test.

The CDT score was evaluated for concurrent and criterion validity. Pearson correlation coefficient was used to examine the relationships between the CMT score and the CDT score. Sensitivity, specificity and the Receiver Operation Curve (ROC) were analyzed to identify a proper cutoff point for each test. Subgroup analysis (low and high education) was performed in order to compare the cutoff scores between subgroups. The likelihood ratios (LR) associated with an abnormal or positive result, given by sensitivity/(1-specificity), were computed [15]. The 95 per cent confidence intervals (95%CI) of the LR were estimated[16]. Accuracy rate of simultaneous use of the CMT and the CDT for dementia screening was evaluated. Mann Whitney-U test and chi square test were used to compare dementia patients and non-dementia patients. All test statistics were considered significant at $p < 0.05$. The SPSS-PC programme was used for statistical analysis.

RESULTS

Of 48 patients who attended the geriatric clinic with memory problems, 27 (56.2%) were male. The mean age and its standard deviation were 71.8 and 6.7 years respectively. Dementia syndrome was diagnosed in 12 patients. Three subjects (1 demented, 2 non-demented) were not able to draw a clock because of illiteracy. Characteristics, BAI scores, CAI scores, CMT scores and CDT scores of the demented and non-demented subjects are shown in Table 1. A good correlation between the CMT score and the CDT score was found (correlation coefficient = 0.66; $p < 0.001$).

Sensitivity and specificity of the CMT and the CDT at different cutoff scores are shown in Table 2. The best cutoff score of the CMT and CDT were 15 and 7 respectively (score of less than 15 and 7 were abnormal). The LR (95% CI) of the CMT and the CDT at their best cutoff level were 10 (3.3-30.4) and 17 (4.4-65.2) respectively. Evaluation of simultaneous application of these two screening tests were done and the result is shown in Table 3. If both tests were abnormal, the accuracy rate for dementia was 100 per cent. If both tests were normal, the subjects were non-demented patients.

Ten subjects voluntarily participated and completed the Thai-version WAIS test. The CMT score had a better correlation with Verbal WAIS score, Performance WAIS score and Full WAIS score than the CDT score. (Table 4)

Table 1. Characteristics of the demented and non-demented elderly patients recruited in this study.

	Demented patients (n = 12)	Non-demented patients (n = 36)
Mean age in years (SD)*	77.7 (8.9)	69.9 (4.5)
Male sex : number (%)	9 (75)	18 (50)
Education level : number (%)		
no	3 (25)	3 (8.3)
primary school	4 (33.3)	10 (27.8)
secondary school	4 (33.3)	12 (33.3)
higher	1 (8.3)	11 (30.5)
Mean BAI score (SD)*	16.7 (3.8)	19.4 (1.1)
Mean CAI score (SD)**	1.8 (1.9)	6.6 (1.9)
Mean CMT score (SD)**	12.9 (2.1)	17.2 (1.7)
Mean CDT score (SD)**	2.8 (2.1)	8.5 (1.7)

* There was statistical significance between the dement and non-dement patients of $p < 0.005$
** There was statistical significance between the dement and non-dement patients of $p < 0.0001$

Table 2. Sensitivity and specificity of different cut-off scores of the Chula Mental Test (CMT) and the clock-drawing test (CDT).

	Cut-off level	% Sensitivity	% Specificity
The CMT			
	13	33.3	97.2
	14	66.7	94.4
	15	83.3	91.7
	16	83.3	86.1
	17	100	72.2
The CDT			
	5	81.8	94.1
	6	90.9	94.1
	7	100	94.1
	8	100	73.5

Table 3. Result of simultaneous use of the CMT (score < 15 means test positive) and the CDT (score < 7 means test positive) for dementia screening in Thai elderly patients with memory problems.

CMT score	CDT score	Dementia	Non-dementia
+	+	9	0
+	-	0	3
-	+	2	2
-	-	0	29

DISCUSSION

Subjects in this study were elderly patients who were mainly self-refered with memory problems to the geriatric clinic of a university hospital which is located in the central area of Bangkok. Their education level was much higher than that of the elderly Thai population in general[17,18]. It was not surprising to find a low illiteracy rate (3 out of 48) among these subjects. Most of the demented patients in this study (9 patients) were mildly severe and were followed for at least 6 months before the diagnosis of dementia was made.

The criterion and concurrent validity of using the CDT as a screening tool were clearly demonstrated and suggested that the CDT was appropriate for dementia screening of elderly Thais with memory problems. It gave a higher LR compared with the CMT and suggested that it might be a better screening tool for dementia. However, 3 subjects (6.2%) were illiterate and were not be able to perform the CDT. This is a major pitfall of using this test in a population with a high rate of illiteracy such as the elderly Thai population (31%)[18,19]. Thus, the CMT may be the test of choice for screening dementia in general with the elderly population in Thailand.

The benefit of simultaneous application of these two tests was demonstrated in this study[20]. The accuracy for double positive and double negative results of these screening tests was 100 per

Table 4. Correlation coefficient of correlation between two screening test (the CMT and the CDT) and the WAIS in 10 voluntary patients.

	CMT	CDT
Full WAIS score	0.8990**	0.7600*
Full IQ	0.9201**	0.8232*
Verbal WAIS score	0.9511**	0.7717*
Subtests		
Information	0.7961*	0.6455
Comprehension	0.8419*	0.7872*
Arithmetic	0.8681**	0.5697
Similarities	0.8166*	0.5620
Digit Span	0.7575*	0.7800*
Vocabulary#	-	-
Verbal IQ	0.9516**	0.8067*
Performance WAIS score	0.7489*	0.6682
Subsets		
Digit symbol	0.7416*	0.5599
Picture completion	0.6593	0.8018*
Block Design	0.6436	0.5151
Picture Arrangement	0.6587	0.5641
Object Assembly	0.7266*	0.6827
Performance IQ	0.7715*	0.7293*

* Correlation coefficient; $p < 0.01$

** Correlation coefficient; $p < 0.001$

\# The vocabulary subtest is not included in the Thai-version WAIS test[14]

cent. If it is possible, therefore, we suggest using both the CMT and the CDT as screening tools in clinical practice in Thailand.

Excellent correlation with the WAIS scores and calculated IQ of the CMT and the CDT emphasized the validity of these two tests. They correlate better with the verbal subtest score and the verbal WAIS score than with the performance subtest score and the performance WAIS score as found in other studies[21]. This result suggested that impairment in clock drawing reflects lower intelligence or cognitive impairment rather than a spatial task[21,22].

The Chula Clock-Drawing Scoring System (CCSS) was developed for use in this study. It is a quantitative systematic scoring system which is simple and objective. Scoring on each item is independent from others. A predrawn clock condition is used because a high illiteracy rate among elderly Thais is a cause for concern and we want to eliminate variations in drawing a circle which always affects other tasks in this test especially the placing numbers. The use of a printed circle is valuable in that performance in drawing a clock at a fixed size can be observed. The clock setting (11: 10) is included because we want to maximise sensitivity for screening subjects with mildly severe dementia[2,5]. Our findings supported this assumption. Good correlation of the CDT score with the CMT score and the WAIS score confirms validity of this scoring system.

In conclusion, the criterion and concurrent validity of the CDT and the CMT for dementia screening were demonstrated. Although the CDT was better than the CMT in literate patients, the CDT had limitation of use among illiterate patients but not the CMT. This study showed that the CDT was a valuable, brief method of dementia screening in elderly Thai patients with memory problems.

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Chula Clock-Drawing Scoring System

		2 points	1 points	0 points
A	Number of digit from 1 to 12	complete	missing or adding of 1 or 2 digits	missing or adding of 3 digits or more
B	Error in the number of digits in the worst quadrant*	no error	1 or 2 errors	3 or more errors
C	Spatial arrangement and sequencing of the numbers	present in the inner side of the circle and present in the right order	present in the inner side of the circle but number places in counterclockwise direction or not present in the right order	gross spatial distortions
D	Presence of the hands	the size difference is respected and evidence of having centre-point of both hands (unnecessary to have a centre-point)	no representation of size difference between the hands or no evidence of having centre-point of both hands	only one hand or poor representation of 2 hands or no hand or perseveration on hands
E	Placement of the hands	hands are in correct position (11.10) or slight errors	incorrect position of one hand (wrong minute or hour)	incorrect position of both hands or write the time instead of draw the hands

* Divide the circle into 4 quadrants by drawing one line through the centre of the circle and the digit 12 (or mark that best corresponds to the 12) and a second line perpendicular to bisecting the first. Count the number of digits or marks in each quadrant in the clockwise direction. Each digit or mark is counted only once. If a digit or mark fall on one of the reference lines, it is included in the quadrant that is clockwise to the line. Any three digits or marks in a quadrant is considered to be correct.

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คุณค่าของการใช้ในทางคลินิกของการทดสอบวาดหน้าปัดนาฬิกาในผู้ป่วยสูงอายุไทยที่มีปัญหาความจำ

สุทธิชัย จิตะพันธ์กุล, พ.บ., วท.ม.,*
*พวงสร้อย วรกุล, วท.บ.**, จิตต์ตะวัน เกียรติปรากฏ, วท.บ.***

ผู้สูงอายุไทยจำนวน 48 คนที่มาปรึกษาด้วยปัญหาความจำ (12 คนได้รับการวินิจฉัยภายหลังว่ามีปัญหาจากกลุ่มอาการสมองเสื่อม) ณ คลินิกผู้สูงอายุ โรงพยาบาลจุฬาลงกรณ์ ได้เข้ารับการศึกษาที่มีจุดมุ่งหมายตรวจสอบคุณค่าของการใช้การทดสอบวาดหน้าปัดนาฬิกา (CDT) และแบบทดสอบสภาพจิตจุฬา (CMT) ในการทดสอบวาดหน้าปัดนาฬิกาได้ให้ผู้สูงอายุวาดรูปบนกระดาษที่มีวงกลมเส้นผ่าศูนย์กลาง 12 ซ.ม. และแสดงเวลา 11.10 น. การให้คะแนนใช้ระบบการให้คะแนนวาดหน้าปัดนาฬิกาของจุฬา ในผู้สูงอายุทั้งหมดมีผู้สูงอายุ 10 คนสมัครใจเข้าทำการทดสอบ WAIS test ผลการศึกษาพบว่าคะแนนที่ใช้ในจำแนกกลุ่มอาการสมองเสื่อมที่ดีที่สุดสำหรับ CDT และ CMT เท่ากับ 7 และ 15 คะแนนตามลำดับ ความไวและความจำเพาะของ CDT เท่ากับร้อยละ 100 และ 94.1 ตามลำดับ ความไวและความจำเพาะของ CMT เท่ากับร้อยละ 83.3 และ 91.7 ตามลำดับ อัตราส่วน Likelihood (95% confidence interval) ของ CDT และ CMT เท่ากับ 10 (3.3-30.4) และ 17 (4.4-65.2) ตามลำดับ พบความสัมพันธ์ที่ดีระหว่างคะแนนจาก CDT และ CMT กับ WAIS test ถึงแม้ผลการศึกษานี้จะแสดงว่า CDT ดีกว่า CMT สำหรับการจำแนกผู้สูงอายุที่มีกลุ่มอาการสมองเสื่อมแต่พบว่าการทดสอบวาดหน้าปัดนาฬิกามีความจำกัดในผู้สูงอายุที่อ่านไม่ออกเขียนไม่ได้ ประโยชน์ของการใช้และแปลผลการทอสอบทั้งสองชนิดในผู้สูงอายุที่มีปัญหาความจำได้รับการแสดงให้เห็นชัดเจน การศึกษานี้แสดงให้เห็นว่าการทดสอบวาดหน้าปัดนาฬิกาเป็นประโยชน์ในการใช้ในทางคลินิกสำหรับการตรวจคัดกรองกลุ่มอาการสมองเสื่อมในผู้สูงอายุไทยที่มีปัญหาความจำ

คำสำคัญ : การทดสอบวาดหน้าปัดนาฬิกา, คุณค่า, ผู้สูงอายุ, ไทย

สุทธิชัย จิตะพันธ์กุล และคณะ
จดหมายเหตุทางแพทย์ ฯ 2543; 83: 342-347

* ภาควิชาอายุรศาสตร์,
** ภาควิชาจิตเวชศาสตร์, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330