VISUO-SPATIAL AND CONSTRUCTIONAL ABILITY OF PATIENTS WITH SCHIZOPHRENIA ON THE CLOCK DRAWING TEST

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SUMMARY

Background: The Clock Drawing Test (CDT) is a simple neuro-psychometric instrument that can be easily applied to assess several cognitive functions. It assesses visuo-spatial task and constructional abilities and therefore can be useful for identifying deficits pertaining to right parietal lobe, constructional apraxia and executive function in patients with schizophrenia. The present study is designed to assess the performance of patients with schizophrenia on the CDT.

Material/Methods: Sixty patients diagnosed with schizophrenia according to ICD-10 criteria were selected and screened for active psychopathology using the Brief Psychiatric Rating Scale. The CDT was then administered and scored using the standard procedure. Sixty normal controls were selected from the nearby area and screened through the General Health Questionnaire-12, and were then also given the CDT.

Results: The results revealed poor visuo-spatial ability in patients with schizophrenia in comparison to normal controls. The frequent errors observed in the drawings of patients with schizophrenia were related to place assignment of numbers on the clock's face and inappropriate placement of the hands.

Conclusions: CDT is a good measure for assessment of multiple cognitive deficits in psychiatric patients, with results independent of age, education and cultural background, and can therefore be utilized as a screening tool for the psychiatric population. Extensive research is needed in this direction.

Key words: cognitive deficits, screening tool, right parietal lobe, apraxia, executive dysfunction

INTRODUCTION

The Clock Drawing Test (CDT) is considered to be a multicognitive test. It was originally used to probe visuo-spatial neglect and inattention. Doing the test requires verbal understanding, and so it assesses the patient's language function (verbal comprehension). Perfect completion of the test also requires the patient to utilize their memory capacity (recall of a visual engram, short-term storage, and recall of time setting instructions) as well as their visuo-spatial and constructional abilities. In addition, it also assesses the patient's ability to plan, initiate, sequence, monitor and stop complex behavior, i.e. the test is also a measure of executive functioning. The assessment of executive functioning may be particularly useful when evaluating the patient's functional status. In brief, the verbal command variation of the clock-drawing test is highly sensitive to dysfunction in the temporal lobe (due to its heavy involvement in both memory and language processes), right parietal lobe (due to involvement in visuo-spatial and constructional ability), and frontal lobe (due to its mediation of executive planning). This wide range of assessment applicability together with its brevity and ease of administration has helped the CDT to become a popular screening measure for dementia. The need for efficient and effective cognitive screening has become more pronounced because of the increasing impact of clinical, research and demographic developments (Malloy et al., 1997*).* From a clinical perspective, cognitive screening is necessary to help in early identification and monitoring change in such common conditions as dementia, delirium and a wide range of neuropsychiatric and neurological disorders. From a research perspective interest in cognitive dysfunction has come to be focused on the etiology, pathogenesis and treatment of schizophrenia (Meltzer et al., 1996*;* Tollefson, 1996) and mood disorders in old age (Emery & Oxman, 1997).

Due to the quick administration of the test, it can be used not only as a screening tool, but also to monitor whether the patient's cognitive level is deteriorating further or improving. The test has been successful in evaluating patients with dementia, but as far as psychiatric patients are concerned there have been only a few studies indicating the use of the CDT. In one study Heinik et al. (2000) found that patients with schizophrenia or Alzheimer's disease had similar total scores on the CDT, but differed on specific test items related to spatial planning deficits and perseveration. Due to these psychometric properties of the test, an attempt was made in the present study to evaluate the effectiveness of CDT as a screening tool for a psychiatric population, i.e. patients with schizophrenia, and also to assess the visuo-spatial and constructional ability of these patients.

MATERIAL AND METHODS

Sample

Using the purposive sampling technique we enrolled 60 patients who had been diagnosed with schizophrenia according to ICD-10 (DCR Criteria), who fell in the

age range of 25-45 years, who had a minimum education of 10th standard, and who were cooperative and gave consent for the study. They were selected from different wards of the Ranchi Institute of Neuropsychiatry and Allied Sciences (RINPAS), in Ranchi, India. Patients with any active psychopathology or any co-morbid condition were excluded from the study. Similarly, we chose 60 normal controls, who were literate, cooperative and falling in the age range of 25-45. Individuals with any significant physical problem, or a history of seizure/ severe head injury or any other neurological problems, or who had faced any traumatic event in the last 3 months, or were illiterate or uncooperative were excluded from the study.

An analysis of the sample characteristics revealed that there was no significant difference between the schizophrenia group and the normal controls in respect to age (χ^2= 0.841), education (χ^2=0.094), religion (χ^2=0.499), economic status (χ^2=0.121), marital status(χ^2=0.068) and place of residence (χ^2=0.764), but there was a significant difference in occupation (χ^2=0.008) between the two groups; the most likely reason for this would be the long stay of the patients in the hospital, due to which they are unable to cope with the demands of a job, so that most of them were unemployed.

Tools

Socio-Demographic and Clinical Data Sheet. A semi-structured form especially designed for the study was used. It consisted of questions covering all areas of socio-demographic details, such as age, sex, domicile, education, employment, marital status etc., and questions related to co-morbid psychiatric conditions, hearing or visual impairment or severe physical illness in the recent past.

Brief Psychiatric Rating Scale (BPRS, Overall & Gorham, 1962**)**. The BPRS is a well established and appropriate scale for assessing patients with a major psychiatric disorder, and so it was used to screen the patients with any active psychopathology. It is an 18-item scale measuring positive symptoms, general psychopathology, and affective symptoms, and all three dimensions are rated on a 7 point rating scale. A rating up to 3 indicates non pathological intensity of symptoms, while 4-7 indicates the pathological severity of symptoms.

General Health Questionnaire-12 (GHQ-12, Goldberg & Williams, 1988**). The** test consists of 12 questions designed to assess the general health of the individual. It was used to identify and exclude individuals for the normal control group.

Clock Drawing Test (**CDT,** Shulman et al., 1993). This test requires a pre-drawn circle, and the participants are given the following instruction "This circle represents a clock face. Please put in the numbers so that it looks like a clock and then set the time to 10 minutes past 11." Scoring ranges from 1 to 6, where a score of 1 indicates perfect drawing with no errors, and a score of 6 represents no reasonable representation of a clock. The scoring scheme of Shulman et al. (1993) was used, because it follows a verbal command and asks the patient to indicate the time of 11:10, which forces the patient to attend to both halves of the clock. It has the added advantage of uncovering any stimulus-bound errors that the patient may make. That is to say, the presence of the number "10" on the

clock may trap some patients and prevent the recoding of the command "10" into the number "2". Patients prone to stimulus-bound errors will fixate and draw the minute hand toward the number "10" on the clock.

Statistical analysis

The Statistical Package for Social Science-13 was used to analyze the data. Chi-squared was computed to compare the scores of patients with schizophrenia and normal controls on different parameters.

Procedure

Once the informed consent of the patient was given, the initial information regarding the participants was gathered through the socio-demographic and clinical data sheet. The patients were screened for any active psychopathology using the BPRS, and normal controls were screened with the GHQ-12. Then the Clock Drawing Test (Shulman et al., 1993) was administered and scored using the standard procedure.

RESULTS

The results of the study can be summarized as follow:

Table 1 illustrates the performance of patients with schizophrenia and normal controls. The results revealed that most of the normal controls had drawn perfect figures, and only a few had shown minor errors, whereas most of the patients with schizophrenia had shown mild to severe errors; some patients had even drawn a completely distorted figure.

Table 2 reveals the common errors observed in the drawings of patients with schizophrenia and normal controls. The most common error observed was that there was no distinction between the minute hand and the hour hand; this error was prominent in the patient group (33%), but it was also committed by a few normal controls (8%). Another error that was common among the patients with schizophrenia and normal controls was that the numbers were drawn upside down, but only 3% of the normal controls had shown this error, whereas 10% of

Table 1. Comparison of patients with schizophrenia and normal controls on the CDT

Clock Drawing Test Scores	Schizophrenia group	Normal controls	χ^2
Perfect Figure	16	53	
Minor	14	7	
Mild- Moderate	10	0	.000***
Severe	15	0	
Complete distortion	5	0	

***P<0.001

Table 2. Common errors observed on the CDT

Specific Features	Schizophrenia Group	Normal Group
No distinction between minute and hour hands	33%	8%
Numbers upside down	10%	3%
Inaccurate time	16%	0
Omission of numbers	21%	0
3/4th circle used to indicate numbers	15%	0
Less than 3/4th circle used to indicate numbers	25%	0
Time shown in words	3%	0
Complete distortion	3%	0
Hands omitted	25%	0
Perseveration of numbers	6%	0

the patients had done so. All the other errors were only observed among the patients. Most of the patients with schizophrenia had omitted the hands of the clock, or used less than ¾ of the space provided to draw the numbers of the clock. Some patients had omitted all the numbers, showing only the numbers that were needed to specify the time, i.e. 11 or 10. Most of the patients also had shown inaccurate time, and some had completely distorted the face of clock.

Table 3 highlights the results of different types of schizophrenia, i.e. undifferentiated schizophrenia and paranoid schizophrenia. The results reveal that in comparison to undifferentiated schizophrenia, patients with paranoid schizophrenia committed a very limited number of error. Most of the patients with paranoid schizophrenia had drawn perfect figures, except for a few showing mild to moderate errors.

Table 4 present the effect of age at onset of illness on the severity of errors. The results show that individuals with early and late onset of illness had the same amount of deficits, as observed in their drawings.

Table 3. Results of Different Types of Schizophrenia on CDT

Clock Drawing Test Scores	Undifferentiated Schizophrenia	Paranoid Schizophrenia	χ^2
Perfect	5	11	
Minor	5	9	
Mild- Moderate	4	6	.005**
Severe	13	2	
Complete distortion	5	0	

**P<.01

Table 4. Effect of age at onset of illness on the CDT

Clock Drawing Test Scores	15-25 years	25 & above	χ^2
Perfect	7	9	
Minor	5	8	
Mild- Moderate	3	7	.937(NS)
Severe	7	8	
Complete distortion	2	3	

Table 5. Effect of duration of illness on the CDT

Clock Drawing Test Scores	0-2 years	2-4 years	4-6 years	6 & above	χ^2
Perfect	4	4	1	7	
Minor	2	8	1	3	
Mild- Moderate	3	1	5	1	.012**
Severe	0	3	3	9	
Complete distortion	0	0	1	4	

**p<.01

Table 5 reveals the effect of duration of illness on the severity of deficits. The results shows that longer the duration of the illness, the greater the number of errors committed, hence the greater the deficits in the patients.

DISCUSSION AND CONCLUSIONS

The results of the study reveal that the visuo-spatial and constructional ability of patients with schizophrenia is significantly impaired in comparison to normal controls. This is consistent with the findings of Cermak et al. (1992) and Krish-nadas et al. (2004). The overall test results highlight that the patients were able to comprehend the instructions and were able to produce the face of a clock, thus revealing at least fair verbal comprehension. They were also able to produce the visual engram of a clock from memory, with numbers ranging from 1-12, as well as the hands of the clock, indicating their intact recall of long term information. Some of the patients were also able to retain the instructions regarding the time to be shown, and thus provided the correct time, which reveals fair short term storage of information, but many others had difficulty in retaining the information received. Hemi-spatial neglect was also not noticed in any of the figures, nor was any perseveration of numbers observed. This is consistent with the findings of Heinik et al. (2000), who reported that perseveration is more common among patients with dementia.

Besides short-term storage of information, the main error observed among the patients was related to spatial planning and spatial organization, i.e. inadequate

use of the space provided to place the numbers, difficulty in discriminating the size of the hands, and difficulty in planning to organize and place the numbers at the appropriate space, leading to a divergence of the numbers from the contour. This suggests that the patients have difficulty in planning, organizing and using information. This is consistent with the findings of Ghamari and Ghasemnejad (2008). These abnormalities of executive planning suggest frontal pathology. Cohen et al. (2000) suggested that abnormal responses related to frontal lobe dysfunction generally include difficulties which are secondary to organizational and planning deficits (e.g., errors in number position and hand proportion), with perseverations observed less frequently (Freedman et al., 1994), while the basic conceptualization of a clock remains intact. Shah (2001) in his review also found that the CT scan of patients with irregularly spaced drawings and numbers quite noticeably diverging from the contour had a large mass lesion in the left fronto-parietal region. Thus the integrity of the frontal lobes is also implicated in the performance of clock construction (Freedman et al., 1994). In fact, poor clock drawing performance has been related to known or suspected lesions in the frontal lobes (Albert & Kaplan, 1980) and has been found to correlate with measures of executive functioning (Libon et al., 1993).

The scores of the study also suggest that, in comparison to undifferentiated schizophrenia, patients with paranoid schizophrenia had very minor deficits. The probable reason for this may be the fact that patients with paranoid schizophrenia have more systematic thought process and a higher level of adaptive coping and cognitive integrative skills in comparison to other schizophrenia types.

The study also indicates that age of onset of illness has no significant contribution to the amount of impairment observed among the patients. But the results reveal that the longer the duration of illness, the greater the number of errors committed by the patients. This is consistent with the findings of Heinik et al. (1997), who found that CDT related to illness duration but not to length of hospitalization; however, different results were found in a later study by Heinik et al. (2000) and one by Heaton et al. (1994).

Overall, the findings of the study indicate that patients with schizophrenia have significant visuo-spatial, constructional and executive impairment. The findings also reveal that a single test is able to identify multiple cognitive deficits, indicating the use of the CDT as a screening tool for cognitive deficits in the psychiatric population as well. The test is certainly easily administered, easily scored, and free of culture and language bias. No effect of age was observed on the amount of errors committed by the individuals (χ^2=0.11). The study also revealed that even patients with higher education (graduate and post-graduate) showed mild to severe errors on the test (χ^2= 0.085), revealing that the test is not influenced by the educational level of the patient. This is similar to the findings of Heinik et al. (2000), who found that the test when administered to elderly patients with schizophrenia is independent of education. But the inter-rater and test-retest reliability of the test could not be assessed in the present study. Therefore, the conclusion that the test can be used as a screening tool appears to be premature and require more study in this direction.

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