ACQUIRED COLOR VISION DEFICIENCY IN PARKINSON'S DISEASE

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Abstract- Acquired color deficiency in the tritan axis in Parkinson's disease has already been reported, manifesting itself as impaired performance in various visual tasks. However, its clinical significance has always been controversial. In this study we evaluated the performance of Parkinson's disease patients in Lanthony 15-desaturated clinical test and for the first time, compared it with the standard Farnsworth-Munsell 15-dichotomous test, in order to determine the clinical value of the color vision deficiency in these shorter tests and their relationship with other factors such as age, duration and severity of the disease, and the presence of signs and symptoms of depression and hallucinations. This blind case-control study was performed on 39 definitely diagnosed patients (of which 14 patients were excluded because of confounding variables) and 25 sex and age-adjusted controls in a neurologic referral center. The subjects were selected by consecutive sampling. Eleven patients in Farnsworth-Munsell and 3 patients in Lanthony showed normal function, however, overall patients had significantly weaker performance than controls (P-value=0.003 and 0.000 for FM and Lanthony respectively). The pattern of responses in Lanthony was consistent with a mild tritanomalia and had a significant correlation with the severity of motor signs and symptoms (Spearman coefficient=0.44, P-value=0.027). The weaker correlation of color deficiency with age in patients (Spearman coefficient=0.42) in comparison with controls (Spearman coefficient=0.60) also signifies the role of the pathophysiology of the disease. We concluded that color deficiency is a clinically significant visual dysfunction in patients with Parkinson's disease.
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Key Words: Parkinson's disease, color vision, color perception, vision tests, color perception tests

INTRODUCTION

Sir James Parkinson in his landmark description of Parkinson's Disease in 1817, made no mention of any dysfunction in the senses or the intellect (1). Even later essays contain no reference to any sensory dysfunction in this disease. It was not until the late 1980s that visual dysfunction was first noticed (2,3). The role of dopamine in the function of the amacrine cells in the retina (4) and its decrease in Parkinson patients was also documented by 1990 (5,6). Color vision dysfunction was first observed in 1992 by Price et. al. who showed delay of color VEPs and electro-retinograms in Parkinson patients in comparison with aged-matched controls (7) and was later confirmed by impaired function in various visual tasks such as computer-aided psychophysical tests for color contrast sensitivity (8-11). Clinically, the impaired function has been detected in Farnsworth-Munsell 100 Hue Test (FMT) (11-17) even to the point of its usage in monitoring patients' responses to Parkinson disease medications (18,19), but the result of shorter tests such as Lanthony 15 desaturated Test has remained controversial. Some studies report impaired performance of patients in Lanthony (20), while others claim not having found any impairment in this or other short clinical tests (9,16,21). The correlation of visual impairment with severity of motor signs and symptoms is similarly the subject of much debate (13,15,22), however this issue is particularly important in clinical settings, and even potentially in predicting prognosis and monitoring the therapy. In this study we evaluated the performance of Parkinson patients in Lanthony test and this time compared it with Farnsworth-Munsell 15 Dichotomous test which according to its manufacturer (Luneau), is the standard test for evaluating the results of the more sensitive Lanthony. We also studied the potential correlation between color vision performance and the severity of motor signs and symptoms, duration of disease and treatment, presence of signs and symptoms of depression and hallucinations. In short, the aim of this study was to determine the value of short and handy clinical tests in detecting visual dysfunction in the clinical setting and its relationship with other more established signs and symptoms of the disease.

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MATERIALS AND METHODS

39 definitely diagnosed Parkinson disease patients who regularly consult a neurologic referral center were selected by convenient sampling. After history taking and the initial physical examination for signs and symptoms of Parkinson disease, depression and hallucinations, 25 of the patients (6 women and 19 men) in whom none of the exclusion criteria were detected, were chosen to enter the study. These criteria included: any evidence of hypertension, diabetes mellitus, CNS pathology, dementia, or ophthal-mopathy, according to patient's previous records, or detected on physical examination; consumption of certain drugs including neuroleptics, ß-blockers, antiepileptics, and digitalis; and congenital color blindness according to Ishihara plates. Treatment for Parkinson disease was allowed. Twenty five sex and age-matched healthy controls were also examined for the exclusion criteria. Age range of patients and controls were 50-86 years (mean=66.24 yrs) and 54-88 years (mean=68.36 yrs), respectively. All patients and controls had visual acuity> 0.6 by Snellen chart and normal retina fundoscopy. An optometrist, for blinding purposes, as examined performance of the both groups in color tests. Informed consent was obtained from all subjects before participating in the study.

Color tests

All patients and controls first underwent the Farnsworth-Munsell 15 Dichotomous (FMT), and then Lanthony 15 Desaturated as its retest. The tests were performed after complete training of the subjects and under the circumstances recommended by the manufacturer (Luneau Ophtalmologie, 3, Rue d'Edimbourg, Paris). The results were plotted and evaluated. The total error score was also calculated by the following formula:

$$(? |n- (n-1)|) –15$$

Staging of motor signs and symptoms

Both Hoehn and Yahr Staging of Parkinson disease, and Schwab and England Activities of Daily Living were used to evaluate the severity of motor signs and symptoms. Unified Parkinson Disease Rating Scale (UPDRS), though more objective, was too time-consuming to perform.

Statistics

As the data on total error score are ordinal-level, the Mann-Whitney U test for independent samples was used to compare the patients' total error scores on both of the color tests with those of controls. The same method was used to compare patients with signs and symptoms of depression and hallucination, with those free of these signs. Wilcoxon Signed Ranks Test was used to compare the performance of each subject in FMT with his own performance in Lanthony.

The statistical error probability of significance at the level of 0.05 was considered as the minimum requirement for significance.

In order to evaluate the possible correlation of visual dysfunction with age, duration of the disease and treatment, the severity of motor signs and symptoms measured by Hoehn and Yahr Staging, Schwab and England Activities of Daily Living, Spearman nonparametric correlation and linear regression analysis were used. All of the data were gathered and processed by the statistical software SPSS version 10.00 for windows.

RESULTS

1) The mean ranks of total error scores in FMT for patients and controls were 31.54 and 19.46 respectively (P=0.003). Mean ranks for Lanthony test in patients and controls were 33.52 and 17.48, respectively (P=0.000). The response patterns, plotted according to recommended format by the manufacturer, were consistent with a mild tritanomalia in Lanthony, but no specific anomaly could be inferred from the response patterns in FMT. Both patients and controls performed much better in FMT rather than Lanthony, with difference in mean ranks equivalent to 10.42 and 12.50, respectively (p=0.000 in both groups), yet the performance of depressed patients was rather opposite but not significant.

2) No significant difference at the level of 0.05 was observed between performances of patients with and without signs and symptoms of depression and hallucinations.

3) The Spearman correlation of the total error scores with the duration of the disease or treatment was not significant at the level of 0.05 in the tests.

Table 1. The correlation between the total error scores and age of the patients and controls

Group	Correlation between age and total error score in FMT		Correlation between age and total error score in Lanthony	
	Spearman coefficient	P- Value	Spearman Coefficient	P-Value
Patients	0.34	0.093	0.42	0.037
Controls	0.56	0.004	0.60	0.001

Table 2. The correlation between total error and the severity of the disease in patients

Staging System / Color test	Hoehn and Yahr Staging		Schwab and England Activities of Daily living	
	Spearman coefficient	P-Value	Spearman coefficient	P-Value
Farnsworth Munsell 15D	0.18	0.392	-0.25	0.238
Lanthony 15D	0.44	0.027	-0.53	0.007

4) The Spearman coefficients for the correlation of total error scores in each of the tests with the age of all of the subjects are presented in table 1.

5) The Spearman coefficients for the correlation of total error scores in each of the tests with the severity of the disease in the patient group and their regression analyses are presented in table 2.

6) The mean ranks of the performance of the patient group with and without history of consuming trihexyphenidil were 23.5 and 37.5, respectively in Lanthony (P-value=0.023). The means for FMT were 6.7 and 9.7 respectively (P-value=0.21).

DISCUSSION

The consistently poorer performance of patients in comparison with controls indicates the clinical significance of color vision dysfunction in Parkinson disease patients. Yet the results of the Farnsworth-Munsell test are not much reliable as the response patterns are not homogenous. The relatively poor performance of depressed patients also raises the possibility of interference of other factors, such as unfamiliarity with the test. On the other hand, we can conclude that poorer performance of patients in Lanthony compared to FMT signifies a real dysfunction, as the possibility of unfamiliarity with the test or the interference of cognitive and motor dysfunctions is already ruled out by patients' much better previous performance in FMT. Also, the homogenous response patterns compatible with mild tritanomalia confirm these patients' color vision deficiency. According to the results, Parkinson disease medications (notably Arthane) do not seem to influence the performance of patients either. The insignificant correlation of the total error scores with the duration of the disease strengthens the hypothesis that the course of the disease itself may play little role in this dysfunction. On the other hand, the strong correlation of visual dysfunction with the severity of the disease and its relatively weaker correlation with age in patient group in comparison with controls may be considered as an indicator of the role of the pathophysiology of Parkinson disease. In short, we came to the conclusion that the color vision deficiency in the tritan axis is a clinically significant dysfunction in Parkinson disease patients, even to the extent to be considered as one of the overt signs of the disease. Yet, no clues to the anatomic location of this dysfunction (retinal, cortical, or anywhere in the visual pathway) can be inferred from these results. Although patients with any signs and symptoms of dementia were excluded from the study, we can not negate the possibility of a more generalized cognitive and mental dysfunction underlying all kinds of sensory dysfunctions including vision and color vision deficiency. This mandates further studies on other sensory functions as well and their possible correlation.

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