Determination of Congenital Color Blindness in Phase II Students of Başkent University Medical Faculty

Mehmet Kemal Gündüz[1]

ABSTRACT

Purpose: Determination the rate and type of congenital color blindness in Phase II students of Başkent University Medical Faculty.

Materials and Method: Başkent University Medical Faculty Phase II students, with no known systemic and ocular disease and whose visual acuities corrected or non-corrected were 10/10 in Snellen chart were included in the study. Visual acuity determination was done under relatively at the same illumination levels and at 6 meters from the chart for all participants. The color discrimination screening test was made by commercially available Ishihara test plates under standard illumination for all participants. To avoid any cheating and habituation to the test plates, the order of presentation was changed every time the test applied and some plates were shown repetitively.

Statistical method: "One sample test of a proportion" was used in the study. Frequency (n) and percentage (%) values were given for determinant statistics. While N is known (N=137, a=0.05, d=0.1 ve p=0.50) to calculate the necessary sample prediction of the population, minimum sample number can be deducted from the:

$n = \frac{N * Z^2_{a/2} * p * (1-p)}{(N-1) * d^2}$ formula. Accordingly minimum sample number to be included in the study was 97 students.

Results: Of the tested 100 subjects, 63 were females and 37 were males. None of the females had color vision defects but one male had red-green color vision defect (2.7%). Protan defect was medium but green defect was severe.

Discussion: In our study the rate of color blindness, compared to other percentages in the literature was low. This is due to the fact that our population included smaller numbers of participant males. Regarding the fact that the study was carried out in only phase II students of medical faculty, it was quite hard to bring the participants into the testing room because of the study time was limited. In order to obtain comparable results with the literature, determination of color blindness needs larger numbers of samples.

Keywords: Color vision defects, congenital, protanopia, deuterenopia

INTRODUCTION

Color blindness (color vision deficiency) is defined as decreased ability to see color or differences in color. People with color blindness have difficulties in selecting colored objects and reading traffic lights. Color blindness may make some occupational activities more difficult. Some of the people in armed forces, aircraft pilots, ship captains, occupations dealing with colors and colored objects, heavy-weight vehicle drivers and crane operators need not to be color blind. People with total color blindness (achromatopsia) may also be uncomfortable in bright environments and have decreased visual acuity. The genes responsible for the most forms of color blindness are located on the X chromosome and males are more prone to acquire color blindness. Non-color-blind females can carry genes for color blindness and pass them on to their children.[1-4]

Color blindness may be congenital or acquired. Congenital color blindness generally occurs as a difficulty or loss of perception of red and green colors. In various populations around the world, congenital color blindness affects 8% of males and 0.5% of females.[5-7] The commonest forms of congenital colour vision deficiency are inherited in an X-linked recessive manner.[8] Some of the inherited diseases such as cone dystrophy, cone-rod dystrophy, achromatopsia (rod monochromatism, stationary cone dystrophy or cone

1- MD, PhD, FEBO, Başkent University Medical Faculty Department of Physiology, Ankara, Türkiye

Participating Phase II Students (Surnames In alphabetical order)

Elif Öykü Ateş
Duru Deniz Çelik
Ödül Derin Demiray
Süeda Gür
Ezgi Karapınar
Neşe Selin Mirza

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Correspondence Adress:
Mehmet Kemal Gündüz
Başkent University Medical Faculty Department of Physiology, Ankara, Türkiye

Phone: +90 532 285 9075
E-mail: mkemalgunduz@yahoo.com

dysfunction syndrome), blue cone monochromatism (blue cone monochromacy or X-linked achromatopsia), Leber's congenital amaurosis and retinitis pigmentosa (initially affects rods but can later progress to cones and color blindness occurs). In all conditions vision is severely affected either early in childhood or during puberty[8-10].

Acquired color blindness can occur in individuals who have completely normal color vision but somehow had optic nerve and retinal inflammations and degenerations due to many reasons, and in demyelinating diseases of the central nervous system.[11-13] Color blindness can also result from physical or chemical damage to the eye, to the optic nerve, or parts of the brain in acquired forms.[(11-13)] In diabetes which impairs the structure of the retina (diabetic retinopathy), in argon-laser users for the treatment of diabetic retinopathy, in glaucoma and in ocular hypertension, acquired blue-yellow color vision defects are seen.[14-16]

There are various methods for color vision testing. From the simplest (colored wool-ball test) to the most sophisticated chroma test.[17,18] However color vision tests can be divided into two types which are the screening tests that can detect the presence of a color vision problem and the more in-depth tests that can detect a color vision deficiency and can measure how severe it is.[17,18]

The Ishihara test is a color perception test for red-green color deficiencies, the first in a class of successful color vision tests called pseudo-isochromatic plates ("PIP"). It was named after its designer, Shinobu Ishihara, a professor at the University of Tokyo, who first published his tests in 1917, although pseudoisochromatic plates were first introduced by Stilling in 1873.[19]

Since Ishihara color vision test is an easy and quick screening procedure for color vision testing, standard Ishihara test plates were used to detect congenital color vision defects.

MATERIALS AND METHODS

Başkent University Medical Faculty Phase II students, with no known systemic and ocular disease and whose visual acuities corrected or non-corrected were 10/10 in Snellen chart were included in the study. Visual acuity determination was done under relatively at the same illumination levels and at 6 meters from the chart for all participants. The color discrimination screening test was made by commercially available Ishihara test plates under standard illumination for all participants. To avoid any cheating or habituation to the test plates, the order of presentation was changed every time the test applied and some plates were shown repetitively. Those wearing tinted glasses were asked to take off their glasses before the onset of screening test procedure.

This study was approved by Başkent University Institutional Review Board (Project no: KA21/510) and supported by Başkent University Research Fund. Before the procedure an explanation of the test was made and written ethical permission consent was obtained from all participants. All subjects were aware of the procedures which they were going to follow.

STATISTICAL METHOD

"One sample test of a proportion" was used in the study. Frequency (n) and percentage (%) values are given for determinant statistics. While N is known (N=137, a=0.05, d=0.1 ve p=0.50) to calculate the necessary sample prediction of the population, minimum sample number can be deducted from the: $n = \frac{N * Z^2_{a/2} * p * (1-p)}{(N-1) * d^2}$ formula. Accordingly minimum sample number to be included in the study was 97 and we included 100 subjects.

RESULTS

Of the tested 100 subjects 37 were males and 63 were females. None of the females had color vision defects but one male had red-green color vision defect (2.7%). Protan defect was medium but green defect was severe. Some of the participants in the study had some minor doubts in differentiating some of the plates concerned with green discrimination however they experienced no difficulty in red-green color matches especially in plates 16 and 17. This condition was checked by changing the order of diagnostic plates which are used for the discrimination and severity of the deficiency whether it is medium or high.

DISCUSSION

The Ishihara color test consists of a number of plates, which consists of colored dots appearing randomized in color and size. There are demonstration plates (designed to be perceived by normals and color blinds), transformation plates in which color blinds see a different figure, vanishing plates which normal color vision individuals can see, hidden digit plates which color vision defective individuals can see, diagnostic plates which are intended to determine the type of color vision defect (protanopia or deuteranopia) and the severity of it and tracing plates for instead of reading a number, subjects are asked to trace a visible line across the plate. All these features make Ishihara test a good standard for a screening test of color vision provided that

it is done under standard illumination and administering the test by changing the order of plates because the test has some drawbacks as it is possible to affect test scores by using colored glasses or by using red light illumination or by memorizing the order of appearance of test plates. The computerized Ishihara tests may not give equivocal results as the standard Ishihara test because the illumination of the screen and glare effect of images may encounter false results.

Surveys on congenital color blindness are mainly carried out using Ishihara plates. If possible, this test is better administered in natural daylight by avoiding direct sunlight. An evenly and moderately illuminated room is also acceptable. Plates 1-15 serve to determine normality and color defectives. The normal range for normality is 13 or more plates are read correctly. If correct readings are less than 9, then the color vision can be regarded as red-green deficient. The plates 16 and 17 are used to differentiate protan and deutan types of color deficiency.[7] There are tests available to be used confirmatory to the Ishihara test which allows the classification of severity into mild, medium and strong.[20,21] Despite all measures, Ishihara test does not allow the examiner to discriminate accurately between complete and partial color blindness.[6,22] Nevertheless, Ishihara test is still a golden screening test to detect color blindess.

The surveys concerning congenital color vision defects have postulated various results. In a study by Citirik et al.[6] 941 men have been tested and 69 congenitally blind persons were found (7.33%). Protanopic and deuteranopic persons were 48 and 21 in number, respectively. The largest percentages of color blind persons were found in regions where the educational levels were low and the consanguinity was high. The survey of prevalence of color vision deficiency among medical students and health personnel which included 1427 participating individuals revealed red-green color blindness in males 6.7% and in females 0.4%.[7]

The prevalence of color blindness varies in different countries. In a study by Harrison[23], the color blindness percentage was 10.0% in Arabs (Druzes), 9.2% in Russians, 9.0% in Norweigans, 8.6% in French, 8.0% in Swiss and 4.0% in Japanese populations. The prevalence of color blindness in Turkish population have shown to vary in different regions.[24] Being highest in Southeastern Anatolia (10.0%) and lowest in the Aegean region (3%). The studies by Say et al.[25], Tümerdem et al.[26], Gökbel et al.[27], Ayhan et al.[(28)] and Işıklı et al.[(29)] show that the overall prevalence of color blindness is 6.34% in Turkey.

In our study the rate of color blindness, compared to other percentages in the literature was low. This is due to the fact that our population included smaller numbers of participant males. Regarding the fact that the study was carried out in only phase II students of medical faculty, it was quite hard to bring the participants into the testing room because of the study time was limited. The participating students of the study did their best to comply to allotted times and performed all visual acuity measurements and color vision testings under supervision after getting education for performing the tests and evaluations.

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