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Original Article

Comparing the Validity of Electronic Color Vision Test with Conventional Ishihara Pseudoisochromatic Plate Test

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ABSTRACT

Many ocular diseases can affect color vision of a patient which will ultimately reduce many daily based activities. Measuring color vision of a patient can help deciding any management plan for that patient. **Objectives:** To compare the validity of electronic color vision test with conventional pseudoisochromatic ishihara plates and to findout easiest and appropriate method of color vision testing. **Methods:** This was a cross-sectional study involving the use of structured proforma and questionnaire to evaluate the validity of electronic color vision test and conventional ishihara plate test. A sample size of 80 individuals with normal and mild degree of refractive error was examined and results were recorded in self-designed proforma. **Results:** Eighty individuals were enlisted; 35 were males (43.8%) and 45 (56.3) were female; age ranged from 14 to 56 (average 34.2+ 12.2) years. By conventional ishihara testing 68 patients gave 100% results (n = 68; 85%) and 12 gave 75% (n = 12; 15%) results. In electronic color vision test 69 individuals gave 100% (n = 69; 86.3%) results and 11 gave 75% (n = 11; 13.7%) results. 45% peoples are satisfiedwith their electronic color vision test, 20% satisfie with both methods however 35% are satisfiedwith conventional method. Prevalence of color vision defect is higher in males as compared to females. **Conclusions:** This study found that the sensitivity and specificity of electronic color vision test and conventional ishihara test is nearly similar (p< 0.05). Electronic Ishihara color vision test is also a way of self assesment and also has the advantage of reducing the cost through decreasing resources and the time to analyze the results.

INTRODUCTION

Color vision is the ability to differentiate between differentcolors. Color of object is obtain by the wavelength emit or reflect from the surface of object [1]. Color vision is the fundamental visual function which discriminate the different colors excited by light of different wavelengths. Human eyes can perceive color wavelengths ranging from400 to 700nm. Below 400nm wavelengths knows asultraviolet and above 720nm known as infrared rays [2]. Color vision is due to the presence of cones in the retina.Cones are the photoreceptor cell of retina which areresponsible for color vision and perception of object detail. Cones are less sensitive towards low illumination and shorter from rod cells which are responsible for scotopic vision (vision in dim light) [3,4]. Cones are located within the central retina. In comparison the outer retinal area constists of few cones and many rods. Chemical changes that occur when light strikes the cones are responsible to stimulate impulses to optic - nerve fibers that enter the brain [5]. Retina have three different types of cones containing a different photo receptors which are sensitive towards light of short(419nm), middle(531nm) and long (558 nm) wavelength, blue, green and red respectively [6]. People having no color vision defect if retina contain all cones, no cone deficiency term as trichomacy. Trichomacy defined as normal color vision uses all three types of light cones correctly. But all personsare not trichromatic, however

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some are partially color deficient and some are totally color blind [7,8]. Different colour vision defects are anomalous trichromacy, dichromats and monochromacy. People with anomalous trichromacy vision are colour blind to a point and are called as anomalous trichromats. The people with this imperfection have all of their three cone types are present to look at light colors but one sorts of cone observes light somewhat out of orientation. The fore most typical kind of colour defect and tritanomaly which could be a reduced sensitivity to blue light and is extremely rare [9].

People with dichromatic colour vision have only two types of cone Deuteranopia, protonopia and tritanopia specify absence of green, red and blue cone function respectively [10]. People with protanopia are unable to observe red light, with deuteranopia are unable to observe green light and people with tritanopia are unable to perceive blue light. Red-green color deficiency is the most common color vision defects. Tritanopia is rare. Prevalence of red-green color deficiency among males is greater as compared to females [11,12]. People with congenital disorder can see no color. A monochromatic world consists of various reminder of the gray ray color they only see reaching from black to white like only seeing the globe on an old black and white Google box.

Monochromes are extremely rare, occurring only in around 1 person out of 33,000 and its symptoms can make life very difficult. People with monochromacy will must to wear specs glasses inside in normal light conditions[13,14,15]. Ishihara test is conducted for assessing color vision deficiencies based on number of colored plates named as pseudoisochromatic or ishihara plates. Plates having figure or symbol composed of color dots of different sizes embedded with background of different colored dots. Within the pattern dots form a number or shape clearly visible to trichromatic peoples, and people with color vision defects found difficulty to see [16,17].

The full test consists of 38 plates, but the presence of a color vision deficiency is usually assess with the help of few plates. Ishihara tests also present with 10, 14 or 24 test plates, and also in the form of tracing a line rather than read a number or digit [18,19]. This study will assess the validity of electronic version of ishihara plates as compared to conventional and find out the more appropriate method of testing color vision among individuals. It will also find out the way of self assessment of color vision via electronic or online platform which is helpful for individuals to assess their color vision without visit to eye clinic.

METHODS:

Comparative cross-sectional study design. Superior college university campus, Lahore. Three months from March to May 2021. 80 Non- Probability purposive convenient sampling technique. Individuals with normal visual acuity of any gender and age. Individuals with low refractive error. Un-cooperative individuals. Individuals with high refractive error. Mentally retarded individuals. Individuals with low vision. Any other ocular or systemic disorder which effected on color vision. Conventional ishihara booklet. Laptop or mobile phone for electronic ishihara plates. Trial frame Occluder. Data was collected by clinical examination and by using self-designed proforma. After taking their consent, complete history and ocular functions like visual acuity and color vision was recorded by using Snellen chart for visual acuity and conventional and electronic ishihara chart for color vision. For color vision testing proper light intensity and all necessary conditions and guidelines was followed. For conventional color vision testing new 38 plate's edition of ishihara booklet was used and for electronic color vision test ishihara color blindness test app was used on laptop screen.

Data Analysis Procedure

All data entered into statistical package for the social sciences (SPSS) version 25. Variables set according to data. Descriptive frequency test applied to assess the frequency of the variables. Chi square test applied to findout the level of significance of data due categorical and comparative data. Result shows level of significance p-value less than 0.05.

RESULTS:

Eighty individuals were enlisted; 35 were males (43.8%) and 45 (56.3) were female; age ranged from 14 to 56 (average 34.2+ 12.2) years. Color vision of all participants was tested with both methods; electronic color vision (color blindness test) and conventional ishihara color vision test.

Validity	Frequency	Percentage
Number of participants which give 100% results	68	85%
Number of participants which gives 75% results	12	15%
Total	**80**	**100%**

Table 1: Validity of Conventional Ishihara Color Vision Test

This table shows that in conventional ishihara test 68 individuals out of 80 gave 100% (n = 68; 85%) results and 12 individuals gave 75% (n = 12; 15%) results.

Validity	Frequency	Percentage
Number of participants which give 100% results	69	86.3%
Number of participants which gives 75% results	11	13.8%
Total	**80**	**100%**

Table 2: Validity of Electronic Color Vision Test

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This table shows the summary of results; Eighty individuals were enlisted; 35 were males (43.8%) and 45 (56.3) werefemale; age ranged from 14 to 56 (average 34.2+ 12.2) years. By conventional ishihara testing 68 patients gave 100% results (n = 68; 85%) and 12 gave 75% (n = 12; 15%) results. In electronic color vision test 69 individuals gave 100% (n = 69; 86.3%) results and 11 gave 75% (n = 11; 13.7%) results. 45% people are satisfied with their electronic color vision test, 20% satisfied with both methods however 35% are satisfied with conventional method. Prevalence of color vision defect is higher in males as compared to females.

Variables	Electronic color vision test	Conventional ishihara test	Equality
Obtained 100% results	69	68	1 digit difference
Obtained 75% results	11	12	1digit difference
Normal color vision	69	69	Same
R-G defect	11	11	Same
Level of satisfaction	45%	35%	20%

Table 3: Comparison of electronic color vision test and electronic color vision test

DISUSSION:

In this cross-sectional study; on comparing the results of both methods similarity in result is founded. Only one digit difference in result is recorded. Variation may be due to light intensity and illumination of plates. However no big difference was found in result. So efficacy and sensitivity of both methods is appropriate. Different test had been used for detection of color vision defects. Studies shows that ishihara plates test are highly appropriate and acceptable for color vision assessment. Further tests which are used for color vision test are Fransworth-Munsell 100-hue test and Anomaloscope. However most commonly used for color vision assessment are ishihara plates[20]. Pseudoisochromatic ishihara plates are the most popular, easy and more reliable test for screening color vision defects or deficiencies. Many studies show that ishihara plates are highly acceptable for color vision assessment and it also easily detect R-G defects of color vision. However printing technology could affect the result of this test[21,22].

In 2018 Diana has studied a population of 120 sample size with electronic color vision test and conventional ishihara test. In her study, she suggested that electronic color vision test is appropriate for color vision assessment and results which obtained from both methods are slightly different from each other. She suggests that electronic color vision test is significant as conventional ishihara test. Variations in results may be due to light intensity and illumination of slides [23,24]. There are various attempts to develop electronic ishihara plates in 2007 Kuchenbecker designed a German web-based color vision test which consist of 25 pseudoisochromatic ishihara plates. In this study participants are tested with both methods electronically and conventionally and results are same[25].

CONCLUSIONS:

Electronic color vision test is appropriate and reliable for color vision assessment (p-value<0.05) . It is easy to conduct with cooperated and younger patients. Sensitivity of both electronic color vision and conventional ishihara plates are equal. Both are most appropriate for color vision assessment. efficacy of both tests is equal if performed properly.

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