



Original Article

Comparison Between Conventional Color Vision Tests And Computer Based Electronic Color Vision Tests

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BACKGROUND: Color vision is a very fundamental visual function. Assessment of color vision is very important and depends upon every clinical setting. I compared two different methods of testing color vision i.e. conventional color vision tests and computer based electronic color vision tests.

OBJECTIVE: To find out the most efficient and reliable method to test color vision.

PATIENTS AND METHODS: Patients were selected from Mayo Hospital Lahore and College of Ophthalmology and Allied Vision Science, Lahore. It was a comparative study based on 50 individuals that included both emmetropes as well as ametropes (i.e. having some degree of refractive errors), and who underwent color vision assessment tests i.e. Ishihara and Farnsworth D-15 first by conventional plates and equipment and then by electronic version of these tests available now a days. This study includes the comparison between these two testing techniques i.e. conventional and computer based. Results were obtained by asking the patient to fill a structured proforma.

RESULTS: By conventional D-15 test 42 patients gave 100% results while 8 patients gave 75% results. By electronic D-15 test 35 subjects gave 75% results while 11 subjects gave 50% results. Only 4 patients gave 100% results through electronic D-15 test. By conventional Ishihara test 42 individuals gave 100% results while 8 individuals gave 75% results. 30 subjects gave 75% results from electronic Ishihara and 13 subjects gave 50% results from electronic Ishihara color vision test. Only 7 subjects gave 100% results from Ishihara electronic color vision testing.

CONCLUSION: Computer based colour vision assessments tests are more appropriate for younger and co-operative individuals. Manual colour vision assessment tests are more suitable for older individuals and for children. Computer based tests require more strict instructions to patients. Efficiency of both testing methods is equal if performed accurately.



INTRODUCTION:

Color vision is the ability of visual system to discriminate light on the basis of wavelength composition. Color vision results from the combined effect of various types of photoreceptors in the retina which differ in spectral sensitivity. Different wavelengths of light excite different photoreceptors which are then perceived by the visual system as different colors. Each set of photoreceptors is specific in perceiving a particular wave length of light.¹

Persons with normal color vision are called trichromats. They have all the three types of photoreceptors to detect the primary colors. Any anomaly in one of these photoreceptors results in abnormal or defective color vision and these individuals are called anomalous trichromats. They have one or two types of defective photoreceptors due to which they are unable to differentiate the respective colors.²

The color vision testing science has evolved since its inception. Gross techniques of comparing color names are now being replaced by more sophisticated methods. Today in clinical practice commonly used tests are arrangement tests, anomaloscopes, isochromatic plates and lantern tests. Each category of these techniques has its own specific attributes that make it appropriate for a particular clinical situation. So a clinician should be well aware of the requirements for applying a particular test type in a particular scenario. To set up a proper color vision lab factors such as the illumination and field of view are important. For congenital color vision defects, no treatment exists currently. However diagnosis of these defects early in life can help a lot to adjust better to the surrounding and to accompany routine activities. Acquired color vision defects indicate ocular pathology. To diagnose different color vision defects, different testing techniques are used.³

In this study two tests are being used i.e. Farnsworth D-15 and Ishihara pseudo isochromatic plates. Farnsworth D-15 consists of 16 caps. In the standard test mean Chroma is 4.20 and the mean value is about 5. This test was designed to distinguish those individuals who have a mild to moderate color vision loss to those who have very severe color discrimination loss. Design of D-15 has been proved effective. Test is easy to administer and score. It can be applied to children of 8 years of age. It can also be used in acquired color vision defects. For that purpose another version of test is used i.e. desaturated panel D-15 which appears to be paler and lighter that's why it is more sensitive. Results are plotted on a specifically designed score sheet.⁴

The Farnsworth D-15 test is used mostly for the evaluation of color discrimination in both congenital and acquired color vision defects. This evaluation of type of color vision defect and its severity is based on hue confusions on the score sheet. This test can be performed via a conventional

instrument or by a computerized D-15 test.⁵

Ishihara pseudo isochromatic plates contain different types of plates: Transformation plates: individuals with defective color vision see a different figure from the normal trichromats. Vanishing plates: only those individuals who have normal color vision can recognize the digits or pattern. Hidden digit plates: only the color deficient individuals can read these plates. Diagnostic plates: these are designed to determine the color vision defect type and its severity.

As mentioned earlier, hidden digit plates can only be read by color deficient individuals however, some normal trichromats can also read these plates. By using their chromatic differentiation ability along the L/ (L+M) axis, Individuals who have normal color vision can read these plates. Color deficient individuals rely on S-cones in reading these plates. So some individuals who have normal color vision can read these plates because despite of distraction from L/ (L+M) axis, they can extract S-cone differences.⁶

Most commonly used method to detect the color vision defects is based on pseudo isochromatic plates. A computer-based method based on anomaloscopes simulator to detect red-green defects gives good results in the study related to red-green discrimination. This computer-based method discriminates normal trichromats from color defective individuals.⁷ The web-based color vision test is a reliable and appropriate screening test with excellent consistent results under uncontrolled examination conditions as well.⁸

Projected slides of Ishihara plates instead of standard method are an effective and rapid method for detecting color vision anomalies. It is suggested as a mass-screening test and can be very useful in detecting color deficient individuals in large populations e.g. soldiers and students.⁹ A new computer-based color vision test, Portal color sort test can be used effectively for screening purpose as it is comparable to Ishihara pseudo isochromatic plates and Farnsworth D-15. It can also be used for grading color discrimination capability of individuals as it is comparable to Farnsworth Munsell 100-hue test.¹⁰

The Waggoner computerized color vision test has many advantages and it is an appropriate color vision screening test. It provides accurate diagnosis of color vision defect type. In a color vision test battery it can be used in conjunction with other tests for color vision.¹¹ Color defective individuals and normal trichromats with a best-corrected visual acuity greater than and equal 6/12 were compared using a standard manual Farnsworth Munsell 100-hue test and a computer-based Farnsworth Munsell 100-hue test. The computer-based Farnsworth Munsell 100-hue test is an effective and accurate method for detecting, evaluating and grading color vision defects.¹²

For detecting red-green color anomaly Ishihara is most

commonly used screening test. Overall sensitivity of the transformation and vanishing plates of 38 plate version of Ishihara is 99 percent on 3 errors, 97.5 percent on six errors and 95.5 percent on eight errors. Hidden digit plates identified only 50 percent color defected individuals. Classification plates for protanopia and deuteranopia are more effective for deuteranopia than for protanopia. So overall efficiency of Ishihara plates for screening out congenital red-green defects is very good.¹³

A new pseudo-isochromatic color test i.e. 'color vision testing made easy' has been introduced recently. It can be used for individuals of all age groups including pre-school children. The pass-fail results of adult individuals are compared effectively with the anomaloscopes. This test has 100 percent specificity and 90.5 percent sensitivity. Testability of pre-school children is found to be 100 percent. This study proves that 'color vision testing made easy' test is an excellent screening tool for red-green color anomalies in adults and appears to be a useful test for evaluating color vision in children of 5-7 years of age.¹⁴

In a computer graphic system 256 colors are selected and are displayed on a screen. A high quality monitor is derived by an eight-bit digital-to-analogue converter. This system for calculating color contrast thresholds with gratings is very appropriate in normal subjects. This method shows an increase in contrast threshold in individuals with mild fundus damage in whom all other visual function tests are normal. With this system gross defects in color contrast threshold can be seen.¹⁵

PATIENTS AND METHODS:

It was a comparative study based on 50 individuals who were either emmetrope or were having some degree of refractive errors who performed color vision assessment tests i.e. Ishihara and Farnsworth D-15 first by conventional plates and equipments then by electronic version of these tests available now a days. This study includes the comparison between these two testing techniques i.e. conventional and computer based. Results were obtained by asking the patient to fill a structured proforma.

RESULTS:

Table no 1: Results on Conventional D-15 Test

	Frequency	Percent
100%	42	84
75%	8	16
Total	50	100

Table no.1 shows that by conventional D-15 test 42 patients gave 100% results while 8 patients gave 75% results.

Table no 02: Results on Electronic D-15 test

	Frequency	Percent
100%	4	8
75%	35	70
50%	11	22
Total	50	100

It shows that by electronic D-15 test 35 subjects gave 75% results while 11 subjects gave 50% results. 4 subjects gave 100% results.

Table no 03: Results on Conventional Ishihara Test

	Frequency	Percent
100%	42	84
75%	8	16
Total	50	100

Table no.3 shows that by conventional Ishihara test 42 individuals gave 100% results while 8 individuals gave 75% results.

Table no 04: Results on Electronic Ishihara Test

Results	Frequency	Percent
100%	7	14
75%	30	60
50%	13	26
Total	50	100

Table no.4 shows that 30 subjects gave 75% results from electronic Ishihara and 13 subjects gave 50% results from electronic Ishihara color vision test. Only 7 subjects gave 100% results from Ishihara electronic color vision testing.

CONCLUSION:

Conventional tests for color vision are more efficient and easy to perform. Conventional can be administered on illiterate, old age and on children as well. Conventional tests do not require strict instructions. Electronic tests require more strict instructions. Limitation to use electronic tests is that they cannot be performed in such setting in which there is no internet facility because they are usually available online.

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