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COMPARISON BETWEEN CONVENTIONAL D-15 AND ELECTRONIC D-15 COLOR VISION TEST

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ABSTRACT

PURPOSE: *To determine if the electronic D-15 test online version, elicit the same response as traditional caps of D-15 test when performed on color normal individuals.*

METHODS: *Descriptive cross-sectional study was conducted in the Ophthalmology department of Madina Teaching Hospital, Faisalabad.100 volunteers of both genders and ages ranging between 15-30 years were studied through non-probability convenient sampling technique. Visual acuity was tested from LCD Snellen at 6- meter distance Color vision was tested by both conventional and electronic Farnsworth D15 test. The test was performed after taking complete ocular, medical, surgical and drug history. Each eye was tested monocular and each subject was tested thrice.*

RESULTS: *Significant association was seen between both versions of D-15; 0.00 (p<0.005) by Kappa and comparison.*

CONCLUSION: *There is no specific difference between the results of conventional and computerized D-15 test. In clinical practice use of the computerized color vision test can allow getting faster and easier results than conventional D-15 test. As electronic D-15 test is easily accessible so it can be used in every small set-up because it can also be performed on tablets. When it will be used in every small set-up then pts with optic nerve diseases can be detected early and easily and can be treated in their early stage of the disease, in this way it is beneficial for eye health professionals and community.*

KEY WORDS: *Color vision, conventional D-15 test, Electronic D-15 test*

INTRODUCTION

Our ability to see colors depends upon variations in spectrum that based on absorption of light by photoreceptors[1].Humans are trichromatic it means there are three types of cones for the specific region of the wavelengths found in humans for color vision. Many people in the world have some kind of abnormality in one type of cone function, they are called color vision deficient.[2] Retinal (chromophore that is aldehyde of vitamin A) and the opsin protein (essential protein of plasma membrane) combined and form photo pigmentation. Isomerization of the retinal chromospheres occurs when photo pigments absorb photons resulting in visual response.[3] Three types of cones are L-cones that are also called red cones are sensitive for the wavelength of 560 nm, M-cones are green cones with peak sensitivity of 530 nm and cones with short wavelength sensitivity 420 nm are S-cones (blue cones).[4] Color blindness is a condition in which person is unable to clearly differentiate between colors, it ranges from mild moderate to severe. Colorblindness doesn't mean they are totally blind, rather they see limited colors or see no colors at all.[5] Accurate causes of color vision defect is still not known, it is mostly inherited. Some disease that may cause color vision deficiency are dystrophy of cone, optic neuritis, glaucoma, retinitis pigmentosa, Shaken baby syndrome, and cataract.[6] Colorblindness is an X linked trait, it passes from mother to son. Mother inherits it from her father and become carrier of this disease then passes it to her son. That's why this disease is more common in males then females.[7] The main types of color-blindness *Deuteron* (green), Protan (red) and *Tritan* (blue).Colorblindness occurs due to mutation of cones or cones are defective. Mutation of cones causes slight shift but defective cones causes' bigger shift in color perception. These results in six possible type of color blindness Deuteranomaly, Deuteranopia, Protanomaly, Protanopia, Tritanopia and Tritanomaly.[8]

Color vision assessment is an important part of assessment of retinal pathologies, congenital and acquired color vision defects.[9] Color vision is determined by difference between three colors qualities hue, saturation, brightness.[10] Arrangement test (Hue discrimination tests) is commonly used in clinical routine. They are not used as a screening tool; they are specially used for detecting the both acquired and congenital color vision defects and for assessment of red-green and blue-yellow defects.[9] Farnsworth D15 OR conventional D-15 color vision test were developed in 1940's. Farnsworth D15 color vision test is modification of Munsell-100 hue test. D-15 panel consist of 16 caps, these caps are numbered at back side. One is reference or fixed cap and other 15 caps are movable. Patient starts to arrange caps from fixed cap to end of caps according to closely related colors. Results are recorded in a circular plot of scoring sheet.[11] Computerized D-15 color vision test: Manual Farnsworth Munsel test is time consuming as a lot of time is required in administration of plotting graphs and scoring the MFM. The person performing the test becomes tired in such long duration. It should also require standard illumination provided by the international color vision standards.

In computer-based color vision tests spatio-temporal luminance technique is used. In this, uniform background is made by elements that are discrete spatially and which are equal in time so that according to background luminance averaged luminance is adjusted.[12]

Computerized online D-15 color vision test uses 15 color boxes. Subject has to arrange these boxes. Computer will calculate and give the results for that person.[13.]

METHODS

A descriptive cross-sectional study was conducted at the department of ophthalmology Madina teaching hospital, Faisalabad on both eyes of 100 colors normal subjects of either gender, aged between 15 and 30 years from all subjects. Informed consent was obtained. The test was performed after taking complete ocular, medical, surgical and drug history. Age 15-30 years and color normal subjects were included in study and Patient with any ocular surgery, patient with history of any medication(antibiotics, anti-tuberculosis drugs, high blood pressure medications, etc.),patient with any other eye disorder (macular degeneration, retinitis pigmentosa etc.).Patient with any systemic disease (diabetes mellitus, hypertension, Alzheimer's disease, leukemia, liver disease, etc.),any subject less than 15 years or more than 30 years, any protanope, deutranope or tritanope was excluded from the study. Non-probability convenient sampling technique was used. During measurement with conventional D15, subjects were instructed to arrange 15 caps based on hue, which were placed randomly on a white background while sitting at 50cm distance from caps in well-illuminated room (100V). Both the tests monocular and binocularly were performed thrice on each subject. With electronic D 15 test, the same subjects were asked to perform the same task using electronic D15 test. They were instructed to sit in front of the computer monitor, at a distance of 66 cm and to arrange randomly placed colors on screen and the results were interpreted by the computer itself. The measurements obtained monocularly from each subject were expressed as mean ± standard deviation. The analysis was done by entering whole data into the software (SPSS 20). Means of readings obtained by conventional and electronic D-15 were compared by applying Kappa and correlation test to compare electronic and conventional D-15.

RESULTS

Our study included 100 subjects from which (70%) were females and (30%) were males.

Comparison of conventional and electronic color vision test showed that there is no significant statistical difference between the two tests.

Table 1:

Electronic * conventional D-15 color vision test right eye						
		conventional D-15 test				Total
		Normal	Protan	Deutan	Tritan	
Electronic D-15 Test	Normal	76	3	1	2	82
	Protan	8	1	0	1	10
	Deutan	0	0	1	0	1
	Tritan	4	3	0	0	7
Total		88	7	2	3	100

In this table results of conventional D15 is shown, which shows that out of 100, 88 subjects were normal, 7 were protanopes, 3 were tritanopes and 2 were deutranopes, while electronic D 15 shows that out of 100, 82 subjects were normal, 10 were protanope, 1 was deutranope and 7 were tritanope.

Table 2:

Symmetric Measures (N=100)					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	0.21	0.105	2.1	.038[c]
Ordinal by Ordinal	Spearman Correlation	0.31	0.127	3.277	.001[c]
Measure of Agreement	Kappa	0.18	0.09	2.553	0.011

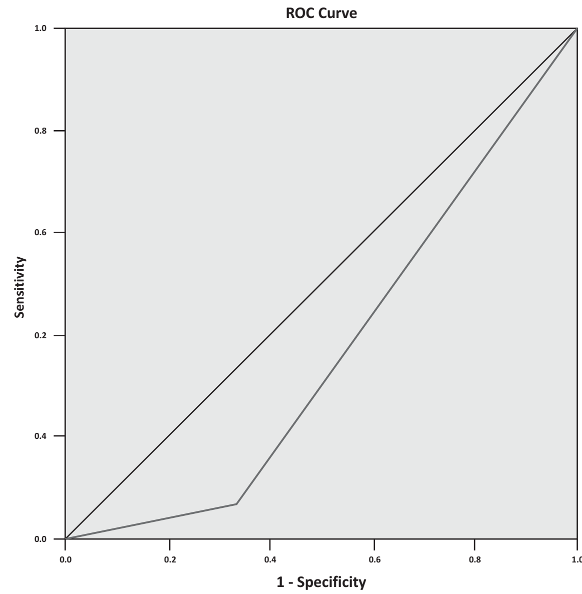
The above table shows the symmetric measures, where (Pearson's R Correlation) show that interval by interval results are 0.38% significant, (Spearman Correlation) ordinal by ordinal 0.01 % significant and measure of agreement shows results are .011% significant.

Cross tabulation shows that with electronic D15 92.7% patients were normal and conventional D15 shows 86.4% were normal.

Table 3:

Electronic * Conventional D-15 color vision test right eye			Conventional D-15 test				Total
			Normal	Protan	Deutan	Tritan	
Normal	Count		76	3	1	2	82
	% within	Electronic Test	92.70%	3.70%	1.20%	2.40%	100.00%
		Conventional Test	86.40%	42.90%	50.00%	66.70%	82.00%
Protan	Count		8	1	0	1	10
	% within	Electronic Test	80.00%	10.00%	0.00%	10.00%	100.00%
		Conventional Test	9.10%	14.30%	0.00%	33.30%	10.00%
Deutan	Count		0	0	1	0	1
	% within	Electronic Test	0.00%	0.00%	100.00%	0.00%	100.00%
		Conventional Test	0.00%	0.00%	50.00%	0.00%	1.00%
Tritan	Count		4	3	0	0	7
	% within	Electronic Test	57.10%	42.90%	0.00%	0.00%	100.00%
		Conventional Test	4.50%	42.90%	0.00%	0.00%	7.00%
Total	Count		88	7	2	3	100
	% within	Electronic Test	88.00%	7.00%	2.00%	3.00%	100.00%
		Conventional Test	100.00%	100.00%	100.00%	100.00%	100.00%

In case processing summary electronic D15 color vision test of right eye showed 82 positive and 18 negative results.



Diagonal Segments are produce by ties.

Figure 1:

In a receiver operating characteristic (ROC) curve the true positive rate(sensitivity) is plotted in function of the false positive rate(1-specificity) for different cutoff points. The curve shows 0.000 sensitivity and 0.000specificity

Table 4:

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.372	.080	.091	.216	.529

Area under the curve shows 0.80 standard error and asymptotic significance is 0.91

Table 5:

Coordinates of the Curve

Test Result Variable(s): conventional D-15 color vision test right eye

Positive if Greater Sensitivity Than or Equal To[2]		1- Specificity
.00	1.000	1.000
1.50	.073	.333
2.50	.037	.111
3.50	.024	.056
5.00	.000	.000

Coordinates of the curve shows 0.000 sensitivity and 0.000specificity

DISCUSSION

Color vision is important component of functional vision and integral part of routine eye examination. It is the ability to differentiate colors, based on spectral variations in light which is absorbed by the rods and cones. It can be assessed qualitatively and quantitatively by using different test. Farnsworth Panel D-15 is convenient and much more accurate in classifying color deficiency. Meeting the new trends, electronic version of D-15 is also available.

The Farnsworth panel D 15 also known as Dichotomous Test. It is convenient and considerably quicker test for clinical use because it consists of a box of only 15 colored tablets (caps). In this test hues are more saturated and they cover the spectrum so that patient will confuse colors for which they have deficient perception.

In present research main objective was to measure color vision using the conventional and electronic D-15 test and also to compare the conventional and electronic D-15 test.

Study was conducted on comparison between printed and projected Ishihara plates by Gundog in Turkey, his study concluded that Ishihara electronic slides are more reliable then printed plates[11].This study also found a statistically significant ($p<0.05$) relation between conventional and electronic D-15 color vision test.

Results of study by Marey H agreed with our results in such a way that according to them the computerized Ishihara has same sensitivity and specificity to conventional Ishihara plates. Study shows that Ishihara computerized test has 100% sensitivity and 98.78% specificity and purposes that computerizes Ishihara has same sensitivity and specificity to booklet or conventional Ishihara plates. Similarly, our results demonstrated that electronics D-15 test elicit same response as conventional D-15 test.[3]

Ivana and colleagues compared booklet and electronic Ishihara plates to diagnose color vision defects, outcomes of both tests demonstrated that color vision can reliably be tested on iPad version[5]. Parallel results were found by our research, our research also concluded that there is no difference between conventional and electronic D-15 test.

A prospective study was done on comparison between Ishihara plates and mobile phone apps, two smart phone apps were used. 42 color normal and 38 color deficient subjects were taken three different test were performed, each test was individually analyzed, according to this study printed Ishihara was considered more easy and comfortable than mobile phone app.[7] However, in this study we took 100 individuals from Madina teaching hospital (MTH) and students of The University of Faisalabad (TUF) both conventional and electronic D-15 color vision test were performed. Results of this study are (100%) significant, both test gives similar response.

In 2013 Ghose and his co-workers conducted a research on comparison between manual and electronic Munsell-100 hue test in both color normal and congenitally defective color vision subjects. 200 normal individuals and 50 individuals with deficient color vision were taken. Both manual and electronic 100 hue tests were administered under adequate condition, according to them electronic FM 100-hue is quick method for detection and grading color vision anomalies. Contrary to this, our study shows that both electronic and conventional D-15 color vision test are equally effective for detection of color vision defects.[5]

CONCLUSION

According to this study there is no specific difference between the results of conventional and computerized D-15. In clinical practice use of the computerized color vision test allow us to get better results and more authentic algorithms as computerized version of D-15 color vision test become more wide spread.

Computerized color vision tests are easy to administer as they automatically score results and form consistency in testing environments. In modern era of technology, health industry adapting computerized records and other computerized equipment's. It is economically helpful to introduce digital color vision test as it is cheap and easy to perform and it does not require special lighting conditions and storage space in clinical set up.

As comparing with conventional D-15 test it is easy to place its caps and there is no danger for caps for scratches and gets broken by the patient. It is also useful for evaluation of color vision by patient himself. Computerized color vision test can be advised to check progression of the disease and improvement in color vision with treatment.

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