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EFFECTS OF GLYCEMIC CONTROL ON COLOR VISION IN DIABETIC PATIENTS WITHOUT CLINICALLY VISIBLE DIABETIC RETINOPATHY

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HIGHLIGHTS

- This cross-sectional study was performed on 200 diabetic patients.
- The mean age of patients was 46.41±3.17 years while 45.5% were female and 54.5% were male patients.
- Controlled diabetes was observed in 64.5%(129) while 35.5%(71) patients showed uncontrolled diabetes. The chi-square test shows a highly significant (p=0.02) association of glycemic control on color vision in patients with diabetic mellitus.

ABSTRACT

Background: Diabetes mellitus is a prevalent non-communicable disease with deleterious consequences. About 10-30% of the patients coming from general medical OPD diabetic retinopathy and 2/3rd of diabetics have an increased risk of visual impairment.

Objective: To check the effects of glycemic control on color vision in diabetic patients without clinically visible diabetic retinopathy.

Material and Methods: This descriptive cross-sectional study was conducted at Al-Nafees Medical College Hospital, Islamabad, in which two hundred patients fulfilling the inclusion criteria were selected for this study. Informed consent was taken from every individual. Visual acuity of each subject was measured and recorded on researcher administered questionnaire, farsightedness was assessed with a liquid crystal display Snellen chart and nearsightedness was checked by using a Roman chart. After the visual acuity measurement, subjective refraction was performed to obtain the binocular single vision. After the best corrected visual acuity color vision of the individual was assessed with Ishihara 24 plate chart then dilated fundus examination was performed with a +90 D lens to rule out diabetic retinopathy. The chi-square test was applied for the correlation of diabetic status (controlled/uncontrolled) with color blindness.

Results: The frequency of females was 45.5% and males were 54.5% with a mean age of 46.41±3.17 years. Out of 200 patients, 68%(136) showed normal color vision, 24%(48) of total subjects had reduced color vision and 8%(16) had color vision impairment. Controlled diabetes was observed in 64.5%(129) while 35.5%(71) patients showed uncontrolled diabetes. The chi-square test showed a highly significant (p=0.02) association of glycemic control on color vision in patients with diabetic mellitus.

Conclusion: There was a highly significant association between the status of diabetes with color vision.

Keywords: binocular single vision, color vision, diabetic retinopathy, diabetes mellitus, glycemic control

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INTRODUCTION

Diabetes mellitus (DM) is a prevalent non-communicable disease with deleterious consequences. In diabetes mellitus, the human body produces a very limited amount of insulin or the body develops insulin resistance, in both cases, it affects the glucose transport to the skeletal, which means high dextrose levels.[1] Type 1 and 2 diabetes is about and 5 to 10% and 90 to 95% respectively of all diagnosed cases of this disease.[2]

There are almost 30.2 million people in the united states aged 18 years or above who are affected by diabetes.[3] Pakistan is in fourth position worldwide and second position amongst 21 Middle East and North African countries in diabetes.[4] Among both type 2 is most prevalent which is about 90%.[5]

In the underlying mechanism of DM, blood glucose levels rise above the normal level, which signals the nervous system and alters the metabolism to fulfill the energy requirements of the body. It also affects the metabolism in brain tissues by shifting mechanisms from glucose to ketone bodies and also causes different shifts in energy metabolic pathways.[6] All the above shifts in metabolic pathways occur before changes in vascular stability, refractive changes and color vision.[7]

About 10-30% of the patients coming from general medical OPD diabetic retinopathy and 2/3 of diabetics have an increased risk of visual impairment.[8] World Health Organization reports that about 285 million people are visually disabled and adds that defects in color vision are one of the leading causes of visual disability in the normal population. From a worldwide perspective, the leading causes of blindness include eye disease caused by high blood sugar from diabetes with color vision deficiency, defective achromatic vision and abnormality of contrast sensitivity. But it can be prevented with the help of proper glycemic control.[9]

Various studies have projected that diabetic retinopathy patient can have impaired color vision. Moreover, the severity of impaired color vision is directly proportional to the blood glucose levels, the period with diabetes, or both.[10] Impairment in color vision due to other systemic disorders is called acquired color blindness. In acquired color blindness, the patient is unable to differentiate between different shades of a single color. Universally data showed that 0.5% and 8% of females and males respectively suffered from color blindness.[11] It is also reported that patients having diabetes mellitus may also face the problem of a slow decrease in color vision which may negatively affect everyday performance.[12] This study suggested measuring the color vision in every diabetic patient without clinically visible diabetic retinopathy as it could be helpful for the early detection of retinal abnormalities. It could also be beneficial to analyze the relationship between metabolic control and retinal function. It inspects the before-time color blindness alteration in diabetic subjects at a possibility of developing clinically demonstrable diabetic retinopathy (DR). Therefore the current study was designed to check the effects of glycemic control on color vision in diabetic patients without clinically visible diabetic retinopathy.

Material and Methods

This cross-sectional study was carried out at Al-Nafees Medical College Hospital, Islamabad from November 2020 to May 2021. All the patients with diabetes mellitus without clinical visible diabetic retinopathy of either gender or age ranges from 30 to 60 years were part of this study. A total of 200 subjects were included via the non-probability samplings. Non-diabetic patients, with visual acuity less than 6/18, any

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congenital disorders, history of glaucoma, cataract and any corneal abnormalities or patients with a history of any ocular surgical treatment and who were incapable to recognize or reply questions were excluded from the study. Every participant was asked to read and sign a written consent form before being part of the current research. Self-administered proforma was used to collect the information. Proforma was used to collect patients' general information such as (age, sex, the status of diabetes (controlled/uncontrolled), treated visual errors and color blindness of patients. A glucometer was used to determine the random blood glucose level to check the status of diabetes. After history taking and determination of blood glucose level visual acuity of both eyes was assessed with the help of a liquid crystal display (LCD) Snellen chart at a distance of six months. After the refraction and most achievable refractive improvement, the best corrected visual acuity of the patients was recorded to fulfill the inclusion criteria. After the best-corrected distance correction near vision of the patients was also assessed and then the color vision of the patients was measured with Ishihara 24 plates. The result is documented as normal if the participant read 1-15 plates without 10 seconds delay, if the subject studied < 10 plates the color vision was documented as reduced color vision and if the patients read <6 plates the color vision was recorded as impaired color vision. After color vision measurement patient was dilated for fundus evaluation.

Following the complete dilation, fundus assessment was done with the aid of a +90 D lens to figure out the subjects without clinically detectable diabetic retinopathy. The statistical analysis was done with the help of SPSS version 20. The chi-square test was applied for the correlation of diabetic status (controlled/uncontrolled) with color blindness. The p-value <0.05 was considered significant.

RESULTS

The total subjects included in this study were 200 and the mean age of the total subjects was 46.41±3.17 years. The data showed the frequency of males 45.5%(91) was lower than the frequency of females 54.5%(109). While documenting the color vision 68%(136) showed normal color vision, 24%(48) of the patients showed reduced color vision and only 8%(16) of the total subjects had impaired color vision. About 64.5%(129) of the total subjects had controlled diabetes while 35.5%(71) of total patients were observed with uncontrolled diabetes (Table I). The chi-square test showed a significant association (p=0.02) of glycemic control with color vision and there was no association of color vision with age and sex (Table II).

Figure I: Frequency of Color Vision Defects

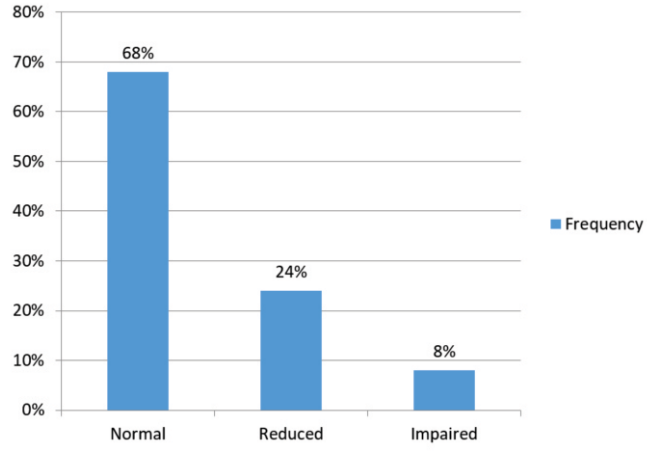

Table I: Descriptive Characteristics of Variables (n=200)

Variables		
Age	Mean age	46.41 ± 3.17
Gender	Male, n (%)	91(45.5%)

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	Female, n (%)	109(54.5%)
Color Vision	Normal	136(68%)
	Reduced	48(24%)
	Impaired	16(8%)
Status of Diabetes	Controlled	129(64.5%)
	Un-controlled	71(35.5%)

Table II: Association of Color Vision with Variables And Status of Diabetes

Variables		Normal	Reduced	Impaired	p-value
Age (mean±SD)	46.41±3.17				.421
Gender	Male n(%)	73(36.5%)	13(6.5%)	5(2.5%)	.391
	Female n(%)	63 (31.5%)	35(17.5%)	1(5.5%)	
Status of DM	Controlled n(%)	127(63.5%)	1(0.5%)	1(0.5%)	.020
	Uncontrolled n(%)	9(4.5%)	47(23.5%)	15(7.5%)	

DISCUSSION

Evaluation of color vision is one of the most excellent screening techniques for the assessment of early visual impairments in diabetic subjects without clinically visible DR. Color vision may also be impaired if visual acuity is normal.[13] This study's results illustrate a well significant association (p-value 0.02) between color vision and the status of glycemic control. These results correlate with another study carried out by Manisha which demonstrates a considerable relationship between color vision functions with the status of diabetes.[14] The findings of the current study also illustrate the comparable outcome with another study, that there was a considerable association between diabetic status (controlled/uncontrolled) with color vision.[15] Therefore, it was figured out that color vision function will be defective as the blood glucose level shows variations.

Rashm et al carried a similar research to find out the status of color vision and its associations with the duration of diabetes as well as with glycemic control. The conclusion of this study also showed the same results as this study color vision was drastically lesser in diabetic patients without retinopathy.[16]

Another similar study concluded the same results as this study. The referenced study ruled out color vision and visual acuity in patients having diabetes. Their results also observed that there was a significantly impaired color vision in subjects having diabetes mellitus without clinically visible diabetic retinopathy.[17]

The results of this study revealed the significant association of color vision with the status of diabetes. Another study concluded that there is a significant association between acquired color vision deficiency and the status of diabetes mellitus.[18] It also reported that patients who had the uncontrolled status of high blood glucose level showed more frequency of acquired color vision deficiency. So, it is recommended that the status of diabetes is liable for color vision status. Central vision is accompanied by a macula that has a great number of cones. As the macula is more affected in uncontrolled diabetic patients so these patients show a significant level of color vision deficiency.[19]

This study showed an insignificant association of color vision with the age and gender of patients. The conclusion of this study was also relatable to the conclusion of the referenced study observed that the diabetic status was independent of age, sex and history of ocular surgery.[20]

Another study was conducted by Gualtieri et al, to find out the color vision in diabetic patients without retinopathy. The finding of their study shows that there was a significant reduction of visual acuity and color vision in diabetic patients without diabetic retinopathy. Evidence exists

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which also suggests that both color vision and contrast sensitivity changes occur due to diabetes and reduced color vision depends on the duration of diabetes and poor diabetic control.[21] The finding of their study also matched this study which shows that color vision loss depends on the duration of diabetes and poor glycemic control.

Therefore, color vision assessment is a helpful screening tool for ruling out retinopathy. It seems to be beneficial in detecting the relationship between retinal function and metabolic control.[22] Another study recommended that reduced color vision in diabetic patients shows an association with raised blood glucose level.[23]

The result of this study also suggests that DM can have early retinal pathology even in patients who showed good visual acuity. Therefore, color vision assessment can also give more beneficial knowledge about visual dysfunction in diabetic patients that is unable to obtain from the assessment of visual acuity only.

CONCLUSION

The status of diabetes (controlled/uncontrolled) shows a significant association with color vision. Age and gender show no significant association with color vision. This study draws attention to assessing the color vision of each diabetic patient to overcome the progression of diseases.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

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Authors' contributions: All authors read and approved the final manuscript.

REFERENCES:

01- Beroz J, Royal C, Heading V. Ethnic identity and type 2 diabetes. Journal of diabetic complication and Medicine, 2012; 16: 624-632.

02- Keratape AS, Kose S, Egrilmze S. Factor affecting contrast sensitivity in healthy individuals: A pilot study.Turk J Ophthalmol, 2017; 47(2): 80-84.

03- Heravian J, Shoeibi N, Azimi N, Yasini S, Yekta AA, Esmaily H. Evaluation of contrast sensitivity, color vision and visual acuity in patients with and without retinopathy. Iranian Journal of Ophthalmology, 2010; 22(3):33-40.

04- Malik MY, Tariq H, Yasmeen A, Ahmed R, Naz A, AdilSO.Impaired Color Vision and Contrast Sensitivity in Patients with Diabetes Mellitus. Pakistan Journal of Ophthalmology, 2018; 34(1):30-37.

05- Virotti A, LobefaloL, PetittiMT.Relationship between Contrast Sensitivity and metabolic control in diabetic with and without diabetic retinopathy. Ann Med 1998; 30(4):369-374.

06- Anton A, Bohringer D, Bach M, Reinhard T, Birnbaum F. Contrast sensitivity with bifocal intraocular lenses is halved, as measured with the Freiburg Vision test, yet patients are happy. GrafesArch ClinExp Ophthalmol,2014; 252(3):539-44.

07- Khan MM, Mahmud S, Karim MS, Zaman M, Prince M. Case control study of suicide in Karachi, Pakistan. The British Journal of

DOI: 10.52229/ajahs.v7i4.1101

Psychiatry, 2008; 193(5):402-5.

08- Feitosa-Santana C, Oiwa NN, Paramei GV, Bimler D, Costa MF, Lago M, et al. Color space distortions in patients with type 2 diabetes mellitus. Visual Neuroscience, 2006; 23:663-8.

09- Moudgil T, Arora R, Kaur K. Prevalence of Color blindness in Children.International Journal of Medical and Dental Sciences, 2016; 5(2).

10- Sara S, Anoushiravan R, Afsaneh R, Hamid S, Mohmmad AA, Mojtaba M, Mehdi Y, Mohammad H, Frank AM, Edaurdo S, Hamid A. Contrast sensitivity in moderate and dim light conditions in patients with diabetes in the absence of diabetic retinopathy.BMJ Open Diab Rec Care,2017;5.

11- Gella. L, Raman. R, Kulothungan. V, Saumaya. S, Ganesan. S and Sharma. T. Impairment of color vision in Diabetes with no Retinopathy: Sankara Nethnaralaya Diabetic Retinopathy Epidemiology and Molecular Genetic Study. PLoS One. 2015; 10(6).

12- Gauri SS, Raju K.Visual functions and disability in diabetic retinopathy patients. Jouranl of Ophthalmology, 2014; 7(1):37-43.

13- Dean L, McEntyreJ.The genetic landscape of diabetes. National Information of Biotechnology Information, 2014.

14- Vaibhavee N, Manisha S.A study of Contrast Sensitivity Changes in normal individual and Diabetic Patients with and without diabetic retinopathy. International Journal of Research and Medicine Sciences, 2017; 5(11):4840-4845.

15- Lutty. G.A. Effects of diabetes on the eye. Invest Ophthalmol Visc Sci. 2013; 54: 13-129.

16- Rashmi S, Rejitha CV, Anupama B, Vidya H, Rashmi J, Himani K. Contrast Sensitivity in Diabetic Patients without Retinopathy and Its Correlation with the Duration of Diabetes and Glycemic Control. IOSR Journal of Dental and Medical Sciences, 2016; 15(8): 11-13.

17- Malukiewics. G, Lesiewska. J. H and Kazmierczak. K. Changes in color vision and contrast sensitivity in diabetic patients without retinopathy. KlinOszna. 2009; 111(7-9): 221-23.

18- McAnany. J.J and Park. J.C. Reduced contrast sensitivity is Associated with Elevated Equivalent Intrinsic Noise in Type 2 Diabetes Who Have Mild or No Retinopathy. Invest Ophthalmol Vis Sci. 2018; 59: 2652-2658.

19- Nolan. J. M, Power. R and Stringham. J. Enrichment of macular pigment enhances contrast sensitivity in subjects free of retinal disease: Central Retinal Enrichment Supplementation Trials-Report 1. Invest Ophthalmol Vis Sci. 2016; 3(4):29-39.

20- Sayin. N, Kara. N and Pakel. G. Ocular complications of diabetes mellitus. World J Diabetes. 2015; 6(1): 92-108.

21- Gulatieri. M, Santana. F.S, Lago .M, Mishi. M and Kenturi. D.F. Early Visual changes in diabetic patients with no retinopathy measured by color discrimination and electroretinography. Psycology& neuroscience.2013;6(2):227-234.

22- Neriyanuri. S, Pardhan. S and Gella. L.

DOI: 10.52229/ajahs.v7i4.1101

Retinal sensitivity changes associated with diabetic neuropathy in the absence of diabetic retinopathy. Br J Ophthalmol. 2017.

23- Li-Ting T, Kuo-Meng L, Yuh J, Fu-chang H, Wei-Chi W. Detecting Visual Function Abnormality with the contrast Dependent Visual test in patients with type 2 Diabetes. PLoS One Open access Journal,2016; 11(9).