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RESEARCH ARTICLE

Color Vision in Diabetic and Non-Diabetic Retinopathy Patients

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METADATA

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ABSTRACT

Background: Diabetes (DM) is a widespread and significant health concern that can lead to various complications. Among its many effects, ocular problems are among the most prevalent and rapidly growing causes of morbidity worldwide.
Objective: To evaluate the color function in diabetics and non-diabetics.
Methodology: The study was cross-sectional type and carried out at the Madina Teaching Hospital Faisalabad. Total 58 participants, male and female, aged 35 to 75 years selected using a convenient sampling method. The study took place from September 2018 to February 2019. Color vision was assessed using the conventional Farnsworth D15 test. Retinopathy severity was evaluated with a slit lamp and a +70D lens, following proper patient consent. A comprehensive medical, surgical, ocular, and drug history was taken for each participant. Each pseudophakic eye was tested monocularly, with each participant undergoing the test three times.
Results: A significant correlation was found between color vision impairment and pseudophakic diabetic patients ($p<0.05$), using Pearson's Chi-Square test. The mean score for color vision using the Farnsworth D15 test was 2.17 ± 1.05, while the pseudophakic group showed a mean score of 1.05 ± 0.116.
Conclusion: Diabetic patients with pseudophakia exhibit color vision defects, particularly affecting the blue axis. Color vision defects are more prevalent in patients with uncontrolled diabetes compared to those with controlled diabetes. Additionally, the severity of color vision defects tends to increase as the retinopathy progresses.

INTRODUCTION

Diabetes (DM) is a widespread and significant health concern that can lead to various complications (Papatheodorou *et al.* 2018). Among its many effects, ocular problems are among the most prevalent and rapidly growing causes of morbidity worldwide. Even after cataract surgery with intraocular lens (IOL) implantation, vision can still be affected in diabetic patients, and the progression of retinopathy may worsen as a result of the surgical procedure (Sayin *et al.* 2015).

Diabetes is a complex disorder in which the body may not produce enough insulin or do not effectively use the insulin it produces. Insulin is vital for regulating blood sugar levels and ensuring that glucose is transported into cells for energy. The two main types of diabetes are Type 1 and Type 2, which were previously referred to as insulin-dependent and non-insulin-dependent, or juvenile onset and adult onset, respectively (Taware 2012).

Globally, over 285 million people are diabetic. The utmost difficulty is diabetic retinopathy; this is because of harm to the blood vessels within the retina because of diabetes-caused microangiopathy. In addition to retinopathy, diabetes can result in cataracts, glaucoma, nephropathy, and neuropathy (Krepler *et al.* 2002). The risk of growing retinopathy will increase with age and is similarly enhanced by poorly controlled blood sugar degrees, high blood pressure, excessive cholesterol, and relatives records of intense diabetic retinopathy (Kelkar *et al.* 2018). Color vision testing is a powerful way to know about the status of retinal damage. In diabetic people, visual function can be considerably altered depending on the severity of the disorder. Color vision defects are often an early sign of retinopathy and continues changes in color interpretations of patient can precede declines in visual acuity. Color deficiencies also can be as a result of other situations, together with glaucoma, macular degeneration, Alzheimer's disorder,

Parkinson's disease, and even chronic alcohol use (Male *et al.* 2022). Studies have proven that the outcomes of cataract surgical treatment are frequently worse in diabetic sufferers, especially people with diabetic retinopathy (Hwang *et al.* 2015). High glucose levels can cause the development of cataracts through glycosylation procedures, contributing to ocular complications (Hassan *et al.* 2010).

MATERIALS AND METHODS

A cross-sectional study was conducted at the Ophthalmology Department of Madinah Teaching Hospital, Faisalabad. Total 58 participants, both male and female, were enrolled in the study using a convenient sampling method. The study was carried out between September 2018 and February 2019. Pseudophakic diabetic patients and without diabetes were included in the study, with both Type 1 and Type 2 diabetes patients aged 35–75 years, with reliable mental and systemic health.

Exclusion criteria included patients with a history of laser treatment, ocular conditions that might alter color vision, systemic diseases unrelated to diabetes, intraocular pressure more than normal ranges, posterior capsule opacities, clinically significant macular edema, and proliferative retinopathy.

The conventional Farnsworth D-15 color vision test was used to assess color perception. In this test, participants were asked to arrange 15 color caps according to hue, which were placed randomly on a white background. The test was performed in a well-lit room at a distance of 50 cm, both monocularly and binocularly, and each subject was tested three times. To assess the severity of retinopathy, a slit-lamp examination and +70D lens were used after obtaining informed consent from patients. Data was analyzed using SPSS software version 20, and the association between color vision defects and pseudophakic diabetic patients with background retinopathy was evaluated using Pearson's Chi-Square test. Ethical approval was obtained prior to conducting the study.

RESULTS

About 58 participants were enrolled. Depending on age criteria two groups formed. The distribution of color vision defects in the group was calculated, with the most common color defect being blue (61%), followed by red-green defects (10.2%). The mean score for color vision on the D-15 test was 2.17 ± 1.05 for the general population, whereas the pseudophakic diabetic group had a mean score of 1.05 ± 0.116. A Chi-Square test was used to assess the relationship between color vision defects and pseudophakic diabetic patients, with $P = 0.05$ indicating statistical significance. This result suggests that color vision declines as diabetes progresses. The most common color vision defect in patients with retinopathy was observed in the blue axis, rather than the red-green axis (Fig. 1).

In the study, we categorized participants into two age groups: Group 1 (35–55 years) and Group 2 (56–75 years). In Group 1, there were 7 non-diabetic individuals, 10 with Type 2 diabetes, and 1 with Type 1 diabetes. In Group 2, there were 14 non-diabetic participants, 1 with Type 2 diabetes, and 10 with Type 1 diabetes. Notably, Type 2 diabetes was more prevalent in older age group (Fig. 2).

DISCUSSION

A previous study by Gella *et al.* (2015) explored the impact of cataract surgery on color vision in both diabetic and non-diabetic pseudophakes. The study found that color vision declined after cataract surgery in both groups, but the severity of the decline was more pronounced in diabetic individuals. In this study, 22 diabetic pseudophakes with no retinopathy, 23 with background retinopathy, and 34 non-diabetic pseudophakes were examined. The results revealed that red-green perception sensitivity was significantly worse in the diabetic pseudophakes (normal versus retinopathy: $P = 0.057$), with tritan discrimination sensitivity being worse in those with retinopathy (Gella *et al.* 2015).

In another study conducted by Gella *et al.* (2017), color vision defects were examined in 21 diabetic patients (16 with insulin-dependent diabetes mellitus, IDDM, and 5 with non-insulin-dependent diabetes mellitus, NIDDM) and 19 non-diabetic individuals. All subjects had undergone cataract surgery, and their color vision was tested using the Farnsworth-Munsell 100 hue test. Diabetic patients had significantly higher error scores, particularly in the tritan axis ($P = 0.02$). The study also excluded participants with secondary cataracts, glaucoma, or diabetic macular edema, as these conditions specifically affect foveal vision.

Our study aimed to evaluate color vision in pseudophakic diabetics with background retinopathy in the age group 35–75 years. A total of 58 participants were included, divided into two groups: Group 1 (35–55 years, n=20) and Group 2 (56–75 years, n=38). The study included 26 males and 32 females, with 21 non-diabetic individuals, 13 IDDM diabetics, and 24 NIDDM diabetics. NIDDM diabetes was more prevalent (40.68%) compared to IDDM (22.03%). Females had a higher prevalence of diabetes than males.

Visual acuity for all participants was measured, and those with clinically significant macular edema (CMO) or pre-proliferative/proliferative retinopathy were excluded from the study. Color vision impairment was most pronounced along the tritan axis, particularly in diabetic pseudophakes with background retinopathy. A significant association was found between color vision defects and the presence of background retinopathy ($P = 0.05$). The distribution of color vision defects in the study population was as follows: 16.9% with normal color vision, 10.2% with red-green defects, and 61% with tritan defects. Tritan discrimination sensitivity changes were determinant for figuring out patients liable to excessive retinopathy. The

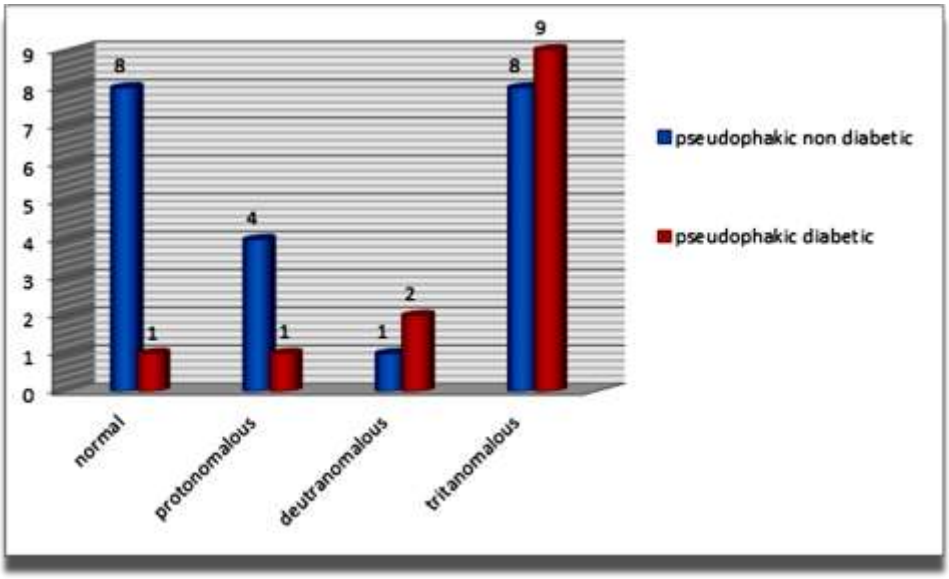

Fig. 1: A bar graph illustrating the presence and absence of color vision defects in pseudophakic diabetic patients with background retinopathy, showing normal color vision, protanomalous, deutranomalous, and tritanomalous conditions.

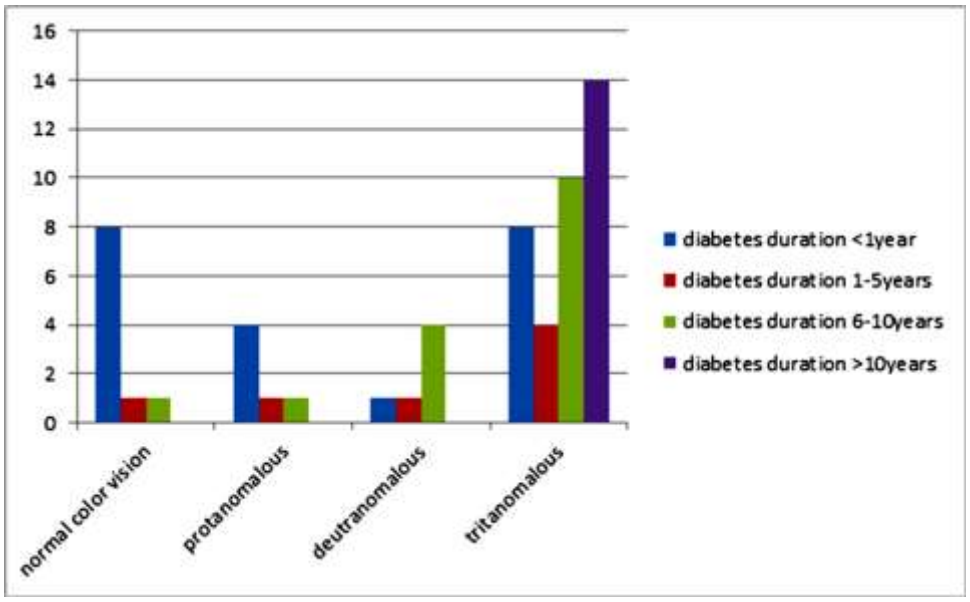

Fig. 2: Bar chart for relation of increase color defects with diabetes duration**.**

poorer color changes following cataract surgical operation in diabetic pseudophakes can be due to extended short-wavelength transmission thru the intraocular lenses, that could lead to retinal damage. This is mainly true inside the case of phacoemulsification, in which there's a shorter period of exposure to radiation all through lens removal, probably aggravating retinal harm.

CONCLUSIONS

There was great effect on color vision for pseudophakic diabetics. The color vision declines more seriously alongside the tritan axis, particularly in patients with retinopathy. These consequences spotlight the importance of incorporating color vision evaluation as an everyday part of pre-operative and submit-operative tests for diabetic sufferers encountering the process of cataract surgical procedure. Early detection of color impairment could assist within the management and tracking of diabetic retinopathy.

AUTHOR CONTRIBUTIONS

NG: Concept, data collection, write up; RS: Formatting

CONFLICTS OF INTEREST

The authors affirm that they possess no conflicts of interest.

DATA AVAILABILITY

The data will be made available on a fair request to the corresponding author

ETHICS APPROVAL

Approved by Institutional Ethical Review Board at its meeting held on May 23, 2019.

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