COLOUR VISION IMPAIRMENT IN DIABETIC RETINOPATHY

Ophthalmology

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ABSTRACT

Background & objectives: Colour vision defects associated with ocular disease have been reported since the 17th century. Objectives were to study prevalence of colour vision abnormalities associated with diabetic retinopathy & to study the type of colour vision defect associated with diabetic retinopathy.

Methods: A longitudinal descriptive study was conducted. 70 patients diagnosed with Diabetic Retinopathy were selected. Colour vision was tested by using Ishihara & HRR Pseudoisochromatic charts.

Results: When Evaluated using HRR plates 29 (41.42%) patients were found to have colour vision impairment. Among them 20 (68.96%) patients had colour vision impairment of the blue-yellow axis purely & 3 (10.34%) patients of red-green axis purely & 6 (20.70%) patients of both axis.

Interpretation & conclusions: Colour vision especially of the blue-Yellow axis was found to be affected in this study. Colour vision and visual testing can be used as cheap, quick, non-invasive, portable tool for screening of diabetic retinopathy.

KEYWORDS

Colour vision impairment; Diabetic Retinopathy; HRR Plates; Colour vision defects

INTRODUCTION

The World Health Organization predicts that by the year 2030, 350 million people will be suffering from type 2 diabetes^[1] which is a prominent cause of acquired blindness or severe visual impairment^[2]. Diabetic microvascular complications affecting the retina lead to retinopathy which has a prevalence of about 40% & could be very detrimental to a patient's life^[3-4]. Diabetic macular edema is the commonest cause of visual loss in diabetic retinopathy^[5].

The general consensus from most previous studies is that diabetes mellitus leads to a tritan colour vision defect (i.e., loss of discrimination along the blue/yellow axis)^[7]. Tritan defects have been explained by higher susceptibility of short-wavelength cones in the retina^[6] and early yellowing of the lens in the diabetic eye^[7]. A few studies, however, have reported diffuse colour vision impairment in diabetic patients in which discrimination along both the blue/yellow and red/ green axes is affected^[8-9]. Such a defect is thought to be associated with additional inner retinal damage. Overall, colour vision losses correlate with the degree of diabetic retinopathy or macular edema when these conditions are present^[10-11]. In many cases, however, they may precede clinically detectable retinal vascular abnormalities^[12].

The equipments for evaluating Diabetic Retinopathy may not always be available especially in rural areas of developing nations. There is hence a need to find a cheaper alternative which is easily available, preferably non-invasive & can be used on a large scale by even non ophthalmologists. Colour Vision is a parameter rarely checked by Ophthalmologists in developing countries. The use of instruments to check blue-yellow axis colour vision is mostly restricted to armed forces, Ophthalmology Research Institutes & very rarely private ophthalmologists. It is hence essential to promote use of equipments in India to check blue-yellow axis colour vision defects which constitutes most of the acquired colour vision impairments. Changes in colour vision can be used measure defects in the early stage of diabetic retinopathy, particularly in patients who are unaware of their retinopathy; and hence can be used as good screening tools. It can also be used in Primary Health Care centres where facilities & specialists are not available in developing countries.

The aims & objectives of this study were to study the prevalence of colour vision abnormalities associated with diabetic retinopathy & to study the type of colour vision defect associated with diabetic retinopathy.

MATERIAL & METHODS

A cross sectional descriptive, hospital based study was conducted in the Ophthalmology Department OPD & Ward of a Tertiary Care Hospital for a period of 2 months from 13th June 2015 to 12th August 2015 after seeking ethical approval from the institutional ethics committee. 70 patients diagnosed with Diabetic Retinopathy were included in the study by a non randomised convenience based sampling. Patients having visual acuity of 6/60 or worse, congenital colour blindness, history of ophthalmic disease, advanced cataracts and any other chronic disease not associated with diabetes that could affect visual system were excluded from the study.

Detailed information was given understandable in the patient's language & then an informed consent was taken from patients by assuring full anonymity of the data. Each patient was assessed for best corrected visual acuity (BCVA) using the Snellen chart. Colour vision was tested by using Hardy, Rand, Rittler (HRR) Pseudo-isochromatic Plates & Ishihara Pseudo-isochromatic Charts. The type of colour vision deficiency was differentiated with the help of key provided with the chart. The results of the test and retinopathy status for each patient was obtained in a masked and independent manner. Each patient was investigated for Blood sugar level (both fasting & Post-Prandial), Serum Creatinine, Haemogram, ECG & anaesthesia fitness for Fluorescein angiography. It was then followed by Fluorescein angiography in maculopathy patients to confirm the severity of Diabetic Retinopathy.

Patients with mild & moderate Non Proliferative Diabetic Retinopathy were continued on their medical treatment for control of Diabetes & were given vitamin E additionally. Those with Severe & Very Severe Non Proliferative Diabetic Retinopathy or Proliferative Diabetic Retinopathy with significant macular edema were given Photocoagulation therapy with double frequency YAG laser. Data of each case was entered in a specially designed pro-forma. This data was then entered & analysed using SPSS v22 software.

RESULTS

After following the inclusion & exclusion criteria's 70 Patients were selected. Among them 38 were males & 32 were females. Age group of patients was between 30 to 80 years [Table I] & mean duration of diabetes was 7 ± 4 years. The mean fasting blood glucose was 164 ± 32 mg/dl & postprandial glucose was 242 ± 38 mg/dl, respectively [Table II & III].

Table I

X axis - Age group of Patients
Y axis - Number of Patients

Table II

X axis - Fasting Blood Sugar Level of Patients
Y axis - Number of Patients

Table III

X axis - Post Prandial Blood Sugar Level of Patients
Y axis - Number of Patients

On ophthalmological evaluation among those patients, 47 (67.14%) had Non Proliferative Diabetic Retinopathy & 23 (32.86%) had Proliferative Diabetic Retinopathy. In the Non Proliferative Diabetic Retinopathy patient group, 14 (29.78%) had mild NPDR, 15 (31.91%) had moderate NPDR, 11 (23.40%) had Severe NPDR & 7 (14.91%) had Very Severe NPDR. Among the Proliferative Diabetic Retinopathy 8 (34.79%) cases did not have any High Risk complications (Early) while 15 (65.21%) were cases with High Risk Complications (Advanced). 31 (44.28%) cases were associated with maculopathy [Figure 8]. Among the maculopathy cases 10 (32.25%) were focal exudative maculopathy, 14 (43.16%) were diffuse exudative maculopathy, 5 (16.12%) were ischaemic maculopathy & 2 (6.47%) were mixed maculopathy.

On Evaluation with Ishihara Pseudo-isochromatic colour plates 9 patients (12.85%) were found to have acquired colour vision impairment. Among those 3 (4.28%) were Red-Green axis defects & 6 (8.57%) were complete. When Evaluated using HRR plates 29 (41.42%) patients were found to have colour vision impairment [Figure 1]. Among them 20 (68.96%) patients had blue-yellow axis defect, 3 (10.34%) patients had red-green axis defect & 6 (20.70%) patients had complete impairment. [Figure 2]. Among the blue-yellow axis impairment 11(55%) patients had a medium Blue-Yellow colour vision impairment while 9 (45%) patients had strong Blue-Yellow colour vision impairment [Figure 3].

Figure 1: Presence of Colour Vision Impairment

Prevalence = 0.414
S.E. = 0.05887
95% confident interval range - 0.298614 to 0.529386

Figure III: Type of Blue-yellow vision impairment present

The 29 people who developed colour vision impairment consisted of 42.10% of the male patients 28.12% of the female patients. [Table IV].

Table IV: Sex wise distribution of colour vision impairment

p = 0.272

38.29% of the NPDR patients developed colour vision impairment & 47.82% of PDR patients developed [Table V]

Table V - Prevalence of colour vision impairment with type of Retinopathy

p = 0.447

66.74 of the patients with maculopathy developed colour vision impairment while among the patients with no maculopathy only 20.51% developed [Table VI].

Table VI - Prevalence of colour Vision impairment with maculopathy status

p = 0.003

There was an increase in prevalence of colour vision impairment with duration of diabetes [Table VII].

Table VII - Prevalence of colour vision impairment with duration of diabetes

X axis – Duration of Diabetes of Patients

Y axis – Number of Patients

P = 0.035, degree of freedom = 2, Chi Square value = 6.707

DISCUSSION

The main aim of this research was to investigate the prevalence of colour vision impairment in diabetic retinopathy. Prevalence of Colour vision impairment was found in this study similar to the previous studies mentioned earlier. 29 patients were found to have colour vision impairment. At 95% confidence interval the prevalence of colour vision impairment in Diabetic Retinopathy patients was found to lie in the range of 0.298614 to 0.529386. 3 patients had red-green defect, 20 had blue-yellow defect & 6 had complete defect. The impaired red/green discrimination and blue-yellow loss in diabetic patients suggest the existence of different causes of the functional defect other than the susceptibility of S-cones and early yellowing of the lens, which were previously considered to be the causes of diabetic visual defects^[13]. According to the Verriest classification of colour vision defects and the Kollner's rule red/green defects are attributable to damage of the inner retina, whereas tritan defects are attributable to photoreceptor damage^[14]. The visual impairment of eyes with retinopathy was due to retinal neurodegeneration caused by diabetes^[15]. It was shown to be related to mitochondrial dysfunction, retinal capillary death, and formation of acellular capillaries^[14-15].

Previous studies also state that patients having maculopathy were found to be significantly more susceptible to colour vision impairment^[14]. Prevalence of colour vision defect was more in them in this study & the difference was found to be statistically significant ($p = 0.003$). The defect increased in magnitude with increasing severity of macular edema. Macular edema decreases the transmission of light to the photoreceptors. The blue colour may be affected to a larger extent, either due to the lower density and number of blue cones in the foveal region; or due to the oblique orientation of photoreceptors following fluid accumulation^[14].

Ishihara chart could only detect 9 cases (31.04%) of colour vision impairment while the rest 20 (68.94%) were only detected on using HRR plates. This shows the need to promote use of equipments to measure along blue-yellow axis colour vision defects in developing countries. Males with Diabetic Retinopathy were found to be slightly more susceptible to colour vision impairment than females in this study with an approximate ratio of 1.5 but the difference in results were not statistically significant ($p = 0.272$), hence suggesting lack of association with gender. Patients with Proliferative Diabetic Retinopathy were more prone to develop colour vision impairment than the patients with Non-Proliferative Diabetic Retinopathy but this difference was also not found to be statistically significant ($p = 0.447$). Prevalence of colour vision impairment with duration of diabetes showed increase in prevalence with duration it was mostly because the cases with more duration of diabetes were mostly Proliferative Diabetic Retinopathy cases.

The present data also suggests that the observed colour vision impairment is associated with the long-term effects of the disease. There were correlations between colour vision thresholds and the time since diagnosis ($p = 0.035$). These results suggest that the longer duration of the disease is associated with greater chronic hyperglycemia and subsequently greater colour vision defects.

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