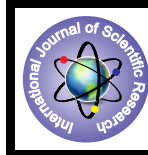


Correlation of colour vision, contrast sensitivity and visual acuity in cases with diabetic macular edema



Medical Science

KEYWORDS : Diabetic Macular Edema, Colour Vision, Contrast Sensitivity, visual acuity.

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ABSTRACT

Diabetic macular edema is a common ocular complication in patients with both type 1 and type 2 diabetes mellitus. It is a major cause of visual loss in patients with non proliferative diabetic retinopathy. A cross sectional non randomized study including thirty diabetic patients with clinically significant macular edema and thirty non diabetic patients who were age and sex matched; was undertaken at a tertiary eye care hospital to find out the correlation of colour vision, letter contrast sensitivity and visual acuity. T-Test was used for statistical analysis. A significant deterioration in the visual acuity, colour vision and contrast sensitivity was found in all diabetic patients with macular edema compared to the non diabetic population. Visual acuity, colour vision and contrast sensitivity can be used as cheap and effective screening tools to assess the damage done to the visual pathway of diabetics.

INTRODUCTION

Diabetics have a 20-25 times greater risk of blindness as compared to the normal population [1]. Diabetic macular edema is the commonest cause of visual loss in diabetic retinopathy. The Wisconsin epidemiological study found an incidence of 20.1% over a period of 10 years for macular edema in the younger age group [2]. The reported prevalence of diabetic retinopathy varies substantially between studies, even amongst contemporary diabetic populations in the same country, but is probably upto 40%. It is more common in type 1 diabetes than type 2. Sight threatening disease is present in upto 10% [3].

Histologically, diabetic macular edema is associated with a thickening of the layers of the macula due to abnormal accumulation of fluid. This occurs due to a disruption in the balance between capillary hydrostatic forces and the plasma oncotic pressure gradient. Several biochemical pathways have been proposed to link hyperglycemia and microvascular complications. These include polyol accumulation, formation of advanced glycation end products, oxidative stress and activation of protein kinase.

Risk factors associated with the development of diabetic macular edema are the duration of diabetes, type of diabetes, glycaemic control, hypertension, renal disease, elevated serum lipids, alcoholism, pregnancy, smoking, obesity and anemia.

Macula being the functionally and metabolically most important part of the retina, patients with diabetic macular edema present with a drop in the visual acuity or a central scotoma. There are studies which show that colour vision [4,5] and contrast sensitivity [6,7] are also affected. Colour vision, contrast sensitivity and visual acuity; all the three are important components of functional vision. Keeping this in mind, this study was undertaken to find out the deterioration of these three parameters in patients with diabetic macular edema. These tests can 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.

Material and Methods

A cross sectional randomized study involving sixty patients: thirty diabetic (type 2) presenting with diabetic macular edema (mean age = 56.83 ± 7.47 years) and thirty non diabetic (mean age : 55.7 ± 7.39 years) was undertaken at Shri C.H. Nagri Eye Hospital, Ahmedabad; within a period of two years from January 2010 to December 2011. 42 patients were males and 18 were females. 20 of the 30 diabetic patients (67%) were under insulin therapy and the rest 10 (33%) were on oral hypoglycaemic medication. The glycaemic control was good in 18 (60%) of the diabetics.

All the diabetic patients were known diabetics (Mean diabetic age = 8.7 years) and presented to our retina department for the first time with diabetic macular edema. They had not received any treatment for their retinopathy elsewhere.

Subjects were enrolled after obtaining informed consent. All diabetic patients diagnosed with diabetic macular edema and having a visual acuity of atleast three metres were included in the study. The exclusion criteria were (a) Patients with any other systemic disease. (b) Patients with a refractive error of myopia or hyperopia of more than 6.00 Diopters and an astigmatism of greater than 4.00 Diopters. (c) Patients of diabetic retinopathy having macular ischemia, vitreous hemorrhage, subhyaloid hemorrhage and retinal detachment. (d) Patients of diabetic retinopathy who had received prior treatment in the form of intravitreal steroids/ anti-vascular endothelial growth factors, argon laser photo-coagulation (which can cause a tritan defect in colour vision) or intraocular surgery. (e) Patients with any lens opacities as colour vision gets affected in nuclear sclerosis type of cataract. (f) Patients with congenital colour vision defects and other ocular diseases like glaucoma, optic neuritis, macular diseases, uveitis and amblyopia which could affect visual acuity and contrast sensitivity.

All the patients underwent a complete ophthalmological examination which included the following:

- (1) Present history, medical history and family history.
- (2) Visual acuity of both eyes using the log MAR visual acuity chart.
- (3) A detailed slit lamp examination of the anterior segment of the eye.
- (4) Measurement of intra ocular pressure using Goldmann Applanation Tonometer.
- (5) Fundus examination by indirect ophthalmoscopy (+20 diopter Volk lens) and slit lamp biomicroscopy (+90 diopter Volk lens).
- (6) Objective Refraction of the eye using a retinoscope.
- (7) Subjective Refraction of the eye.

Special ocular investigations included (a) Optical Coherence Tomography (OCT) using the stratus version of optical coherence tomogram for the quantitative and qualitative measurement of retinal thickness. This was complementary to the information obtained by us by fundus fluorescein angiography. We opted for this technique as it was a noninvasive, non contact and a quick screening tool. We used the macular thickness map protocol (MTP) and the fast macular thickness map protocol (FMTM). Since the macular thickness measurement for diagnostic function differs with the population used as a database, we considered the measurements derived from the normative population which were as close as possible to the population for which this technique was used. (b) Farnsworth colour vision D-15 panel to assess the colour vision (c) Pelli Robson contrast sensitivity chart (Right and Left) to assess the contrast sensitivity. (d) The log MAR Chart was used to measure the visual acuity.

All patients underwent a complete haematological check up including fasting and post prandial blood sugar levels, glycosylated haemoglobin, complete blood indices, serum lipid profile and renal function tests.

RESULTS

1. Mean Visual acuity of (BE) in Diabetic patient was $[0.6693 \pm 0.2473]$ and P value was $[3.06248E-14 \text{ or } <0.01]$ and Correlation R= 0.8779
2. Mean Visual acuity of (BE) in Non-Diabetic patient was $[0.1 \pm 4.23451E-17]$ and P value was $[3.06248E-14 \text{ or } <0.01]$ and Correlation R= 0.8779
3. Mean Visual acuity of (RE) in Diabetic patient was $[0.6566 \pm 0.2266]$ and P value was $[4.65858E-13 \text{ or } <0.01]$ and Correlation R= 0.8718
4. Mean Visual acuity of (RE) in Non-Diabetic patient was $[0.1 \pm 4.23451E-17]$ and P value was $[4.65858E-13 \text{ or } <0.01]$ and Correlation R= 0.8718
5. Mean Visual acuity of (LE) in Diabetic patient was $[0.7393 \pm 0.2198]$ and P value was $[7.0899E-16 \text{ or } <0.01]$ and Correlation R= 0.867
6. Mean Visual acuity of (LE) in Non-Diabetic patient was $[0.1 \pm 4.23451E-17]$ and P value was $[4.65858E-13 \text{ or } <0.01]$ and Correlation R= 0.8718
7. Mean Contrast Sensitivity of (BE) in Diabetic patient in Right Chart $[0.86 \pm 0.2838]$ and P value was $[1.6287E-17 \text{ or } <0.01]$ and Correlation R= 0.902 and R=0.944
8. Mean Contrast Sensitivity of (BE) in Non-Diabetic patient in Right Chart $[1.531 \pm 0.1262]$ and P value was $[1.6287E-17 \text{ or } <0.01]$ and Correlation R= 0.902 and R=0.944
9. Mean Contrast Sensitivity of (BE) in Diabetic patient in Left Chart $[0.905 \pm 0.2798]$ and P value was $[8.10295E-17 \text{ or } <0.01]$ and Correlation R= 0.891 and R=0.956
10. Mean Contrast Sensitivity of (BE) in Non-Diabetic patient in Left Chart $[1.533 \pm 0.1169]$ and P value was $[8.10295E-17 \text{ or } <0.01]$ and Correlation R= 0.891 and R=0.956
11. Mean Contrast Sensitivity of (RE) in Diabetic patient in Right Chart $[0.88 \pm 0.3382]$ and P value was $[4.21482E-14 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.908
12. Mean Contrast Sensitivity of (RE) in Non-Diabetic patient in Right Chart $[1.53 \pm 0.1262]$ and P value was $[4.21482E-14 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.908
13. Mean Contrast Sensitivity of (RE) in Diabetic patient in Left Chart $[0.94 \pm 0.3222]$ and P value was $[5.082E-14 \text{ or } <0.01]$ and Correlation R= 0.902 and R=0.922
14. Mean Contrast Sensitivity of (RE) in Non-Diabetic patient in Left Chart $[1.53 \pm 0.126]$ and P value was $[5.082E-14 \text{ or } <0.01]$ and Correlation R= 0.902 and R=0.922
15. Mean Contrast Sensitivity of (LE) in Diabetic patient in Right Chart $[0.833 \pm 0.325]$ and P value was $[2.19E-15 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.906
16. Mean Contrast Sensitivity of (LE) in Non-Diabetic patient in Right Chart $[1.53 \pm 0.126]$ and P value was $[2.19E-15 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.906
17. Mean Contrast Sensitivity of (LE) in Diabetic patient in Left Chart $[0.898 \pm 0.299]$ and P value was $[3.9897E-16 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.931
18. Mean Contrast Sensitivity of (LE) in Non-Diabetic patient in Left Chart $[1.53 \pm 0.126]$ and P value was $[3.9897E-16 \text{ or } <0.01]$ and Correlation R= 0.901 and R=0.931
19. The color vision defect Tritanopia was found in all Diabetic Patients which was proved to be statistically significant P value <0.001

DISCUSSION

Our study aimed to investigate the correlation of the colour vision, contrast sensitivity and visual acuity between patients with diabetic macular edema and non diabetic patients. We found out that all the three parameters were significantly deteriorated in cases with diabetic macular edema.

Visual acuity is a measure of the spatial resolution of eye. The measurement of visual acuity alone does not account for complete assessment of the visual status^[8]. The mean visual acuity of both eyes in diabetic patients was $[0.6693 \pm 0.2473]$ and P value was $[3.06248E-14 \text{ or } <0.01]$ and correlation R=0.8779. A study done by Ismail GM et al also showed that visual acuity and vision were sensitivity to more substantial retinal changes [4]. An improvement in visual acuity was found along with reduction in foveal thickness after a single intravitreal injection of 4 mg triamcinolone acetonide^[9]; necessitating early treatment of

patients with diabetic macular edema.

Contrast sensitivity is a measure of the smallest distinguishable contrast and indirectly assesses the quality of vision. Visual acuity is routinely tested under the best possible conditions and does not reflect the visual problems present when driving at night or on a cloudy day.

In our study, the mean contrast sensitivity of both eyes in diabetic patients was 0.86 ± 0.2838 in the right chart with a P value of $1.6287E-17$ and correlation R=0.902 and R=0.944. For the left chart, the mean contrast sensitivity of both eyes was 0.905 ± 0.2798 with a P value of $8.10295E-17$ and correlation R=0.891 and R=0.956.

Hyvarinen L et al stated that contrast sensitivity at intermediate and low spatial frequencies may decrease without corresponding loss of visual acuity; but in advanced cases contrast sensitivity was better than expected on the basis of visual acuity^[6].

An early non selective neuronal damage of the visual pathways can occur even before the onset of clinically detectable retinopathy, affecting the contrast sensitivity^[7]. Letter contrast sensitivity has been found to be decreased even in diabetics without macular edema^[10]. Both metabolic and vascular changes may be involved in patients with reduced contrast at the level of the retina (ganglion cells) or post retinal neuronal pathways secondary to impaired carbohydrate metabolism which can cause a loss in contrast sensitivity^[8]. Thus, contrast sensitivity can be used as an early index of retinal changes not demonstrated by measurements of visual acuity.

All our 30 diabetic patients with macular edema had defective colour vision in the form of tritanopia. 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^[5]. Peter A. Aspinall et al have also found out that the best single predictor of retinopathy is a colour vision test of yellow blue discrimination^[11]. We had used the Farnsworth colour vision D-15 panel for testing the colour vision; but according to Marr N et al, the D-15 test was not significant ($P=0.345$) and showed low sensitivity for the presence of macular edema^[5]. They suggested the Mollon-Reffin "Minimalist" test version 6.0 as the best colour discrimination test for detecting macular edema.

Several studies have reported reduced colour discrimination in patients with diabetic retinopathy of all degrees of severity but there has been no analysis of the influence of macular edema^[5]. A study which investigated colour vision in patients with diabetic macular edema using the Farnsworth Munsell 100 hue test or the D-15 test also found out a pronounced tritan defect in the affected eyes^[5].

It was found by Bresnick et al that by using the FM-100 test, there was a correlation between macular edema, capillary loss and leakage^[12]. ETDRS (Early treatment diabetic retinopathy study) report also has stated that the tritan axis is affected more severely than the proton and deuteron axes^[5]. Impaired colour vision in patients with diabetic macular edema should be considered particularly in those occupations where colour vision defects can pose a danger at the place of work. It should be considered in the counselling of the patients with diabetic retinopathy.

CONCLUSION

As per the WHO statistics, the number of adults with diabetics in the world is estimated to increase by 122% from 135 million in 1995 to 300 million in 2025^[8]. With increase in the average life span, more and more diabetics will be suffering from its complications. Macular edema being an important cause for visual loss in the early stages of retinopathy, its early diagnosis is essential for optimal prevention of functional loss. Macular

edema is difficult to detect by routine ophthalmological examination and bio microscopy alone. Fluorescein angiography carries a risk of an allergic reaction and the required setup may not always be available.

Timely treatment of diabetic macular edema can decrease the risk of visual impairment. Colour vision, contrast sensitivity and visual testing are cheap, quick, non invasive, portable and bias free methods which can be used as effective tools for screening and follow up examination of cases with diabetic macular edema.

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