

## RETINA/VITREOUS SESSION - IV

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### Estimation of the Sensitivity and Specificity of Software Based Tritan Contrast Threshold Scoring System in Detection of Sight Threatening Diabetic Retinopathy

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**D**iabetic retinopathy can cause visual loss which may not be detected by standard reading tests such as Snellen.<sup>4</sup> Studies show that in diabetic retinopathy there is a selective loss of S cones which contributes to the tritan defect.<sup>5</sup> It has been proved that there is a decrease in the tritan contrast sensitivity in diabetic patients.<sup>6</sup> The detection of presymptomatic sight threatening diabetic retinopathy (STDR) remains difficult. Early treatment of proliferative diabetic retinopathy and diabetic maculopathy improves visual outcome. However, STDR should be detected before visual damage has taken place as only minorities of patients have improvement in vision following laser treatment. The retinal thickness analyzer (RTA) have demonstrated considerable thickening of the retina before the onset of diabetic retinopathy. However, the high cost of these instruments has made them prohibitively expensive for screening. Colour vision provides a sensitive, non-invasive method to access macular damage. Detoriation in colour vision often precedes changes in other procedures

like visual acuity and morphological changes.<sup>7</sup> However no traditional colour vision test have demonstrated adequate efficacy to warrant indisposed use of screening. Cathode Ray Tube based colour vision test have been shown to have significant advantage over traditional test for colour vision.<sup>8</sup>

### Materials and Methods

In this study a total of 35 consenting diabetic patients (70 eyes with diabetics of the age group<sup>3</sup> 40 yrs) and 40 normal subjects (80 normal eyes without diabetes in the same age group) were prospectively recruited. Medical details of each patient were recorded including duration of diabetes, age, type of treatment, and history of eye treatment. Best-corrected visual acuity (BCVA) was measured using the logMAR chart. Colour vision defects were found using Ishihara pseudoisochromatic plates. The patients underwent a Tritan Contrast Threshold test after a short demonstration. The TCT test was carried out on both eyes monocularly. Pupillary dilatation was done with tropicamide

1%. The colour of the lens was found with the slit lamp using LOCS III classification system. It is graded by comparing the colour of the lens to be graded with that in NC standards 1 through 6. The fundus examination for the subjects was then done by one of the experienced ophthalmologists using a slit lamp biomicroscope with a 78 dioptre Volk lens to provide a gold standard. The results of the TCT test and retinopathy status for each patient were obtained in a masked and independent manner.

Tritan Contrast Threshold (TCT) procedure: The TCT was measured using a program from Visual Basic. The software program generate a series of vertical, sinusoidal, low spatial frequency (0.66 cycle per degree) and standardised equiluminant chromatic gratings on the display monitor, which has a uniform background luminance of 20 cd/m<sup>2</sup>. The chromaticity of the gratings was changed under computer control along a tritan confusion axis. The chromatic contrast of the grating at which the subject could just distinguish the gratings from the background (TCT) was determined using a modified double staircase reversal algorithm as described by Cornsweet. Standardized scores were based on data obtained from a eyes of each of the 40 control subjects. The data for these normal subjects were stratified by decade and the means and standard deviations for each decade age group were determined. The TCT from each diabetic eye was compared to the appropriate normal decade-age group matched according to the lens-equated grade of that eye. We used analysis of variances (ANOVA) to find any significant difference for age, duration, BWA and mean TCT values across all lens grades. We used T test to find any significant difference in age, duration, BCVA and mean TCT between patients with and without diabetic retinopathy, and also between sight threatening and non sight threatening diabetic retinopathy. A Pearson correlation analysis was done for significance of correlation between age and

mean TCT among diabetic and non diabetic groups and also between mean TCT and duration of diabetic. Non-parametric test like Mann-Whitney U test and Kendall's tau B test to analyze the difference between diabetics and lens equated controls and also to find for significant difference in mean TCT values and nuclear colour wave used. An ROC curve was plotted to find the cutoff for mean TCT values in all lens grades for the optimum sensitivity and specificity.

## Results

Of the 150 eyes, 70 eyes were with diabetics of the age group greater than or equal to 40 years and 80 normal eyes without diabetics in the same age group. The mean age among the diabetics group was 51.5 years (range 40 to 70 yrs). The mean duration of diabetes was 25.3 months among those with non-sight threatening retinopathy and 95.7 months among those with sight threatening retinopathy.

**Table1: Clinical details diabetic eyes**

	Dr	No Dr	P Value
No	24	56	
Age (Years)	51.0(6.8)	51.5(7.1)	0.746
Duration Of Dm (Months)	95.7(65.5)	25.3(38.7)	<0.000
BCVA (In Log Units)	0.15(0.07)	0.13(0.05)	0.209
Mean Tct	1.4(0.7)	0.8(0.3)	<0.000

Data are presented as mean (SD). The biomicroscopic assessments showed that out of the 70 eyes 24 had diabetic retinopathy. Out of this, 21 eyes were catagorised as non sight threatening diabetic retinopathy (NSTDR) (6-mild NPDR, 15 -moderate NPDR). The remaining 3 were catagorised as Sight Threatening (STDR) (2 -severe NPDR, 1 -PDR). The mean and standard deviation of the TCT according to grade of retinopathy are summarised in Table 2.

Statistically significant difference existed in duration and mean TCT values between those

**Table 2: Summary of different levels of retinopathy**

	No Dr	Mild Dr	Mod Dr	Severe Dr	Pdr
No	56	6	15	2	1
Age (Years)	51.5 (7.1)	52.7 (8.07)	50.9 (6.9)	47.5 (3.5)	50
Duration (Months)	25.3 (38.7)	75.3(57.5)	102.9(73.8)	90 (42.4)	120
BCVA (In Log Units)	0.13(0.05)	0.12 (0.04)	0.14 (0.06)	0.25 (0.07)	0.03
Mean Tct	0.81 (0.27)	1.23 (0.36)	1.51 (0.95)	1.54 (0.38)	1.28

with and without diabetic retinopathy (Mann Whitney U test,  $p < 0.001$ ). However no significant difference was found in the age ( $p = 0.746$ ) and BWA ( $p = 0.209$ ) in the same group. Similarly there was no difference in the BCVA between the sight threatening and non-sight threatening group (Mann Whitney U test,  $p < 0.001$ ), where as there was no significant difference in age ( $p = 0.97$ ), duration (0.42) and mean TCT ( $p = 0.97$ ). A Pearson correlation analysis between mean TCT, age and duration of diabetes was also carried out. Significant positive correlation was found between age and mean TCT ( $r = 0.383$ ,  $p < 0.055$ ), as well as duration of diabetes and mean TCT ( $r = 0.464$ ,  $p < 0.001$ ). KW test established that statistically significant difference existed in age ( $p < 0.0001$ ), BCVA ( $p < 0.002$ ) and mean TCT ( $p < 0.0001$ ) across all grades of nucleus colour.

The Kendall's tau B test showed that there was significant positive correlation between mean TCT and nuclear colour ( $r = 0.59$ ,  $p < 0.001$ ). Using the Mann-Whitney U test we found that patients with Diabetic retinopathy had significantly abnormal mean TCT when compared to lens equated controls ( $p < 0.05$ ). Using the ROC analysis we found the cut off value for mean TCT across all lens grades. Table 3 summarises the cut off value for mean TCT and their respective sensitivity and specificity in all lens grades. The overall ideal cut off value for mean TCT was found to be 0.86 with a sensitivity and specificity of 87.5% and 61.11% respectively. The positive predictive value was found to be 95.30% and the negative predictive value was found to be 35.20%.

**Table 3: Age, duration, BCVA and mean TCT across lens grades**

	P Value
Age (Years)	<0.001
Duration (Months)	0.1
BCVA (In Log Units)	0.001
Mean Tct	<0.001

## Discussion

Diabetes and related blindness is reaching an alarming proportion in India. Diabetes related blindness is now the sixth important cause of blindness in India as compared to 17<sup>th</sup> cause, about 20 years ago. WHO data shows that in India, the number of adult onset diabetes would grow to nearly 80 million in 2030 from 18 million in 1995.<sup>8,9</sup>

It is believed that people with diabetes are 25 times more likely to become blind, than the general population. Therefore, taking into account this emerging epidemic of diabetes and its associated blindness, we must develop diabetic screening model to address these issue in both rural and urban population.

Ideally, all diabetic population should have their eyes examined annually by ophthalmologists. Early referral to an ophthalmologist is preferably important for patients with severe non-proliferative retinopathy, proliferative retinopathy and diabetic macular edema. Major treatment at this stage is associated with a 50% reduction in the risk of severe visual loss and vitrectomy. Various colour vision assessments such as FM 100, anomaloscope and others have shown correlation between colour vision deficits and

diabetic retinopathy. However, these tests are inadequate and not sensitive enough for wide spread screening purposes. In this study, using the computer-based technique, we have shown the efficacy of using the TCT test in screening for diabetic retinopathy. Our results also show the performance of the test for patients with various lens grades. For lens grades NC2 and NC3 the sensitivity is 100%. This showed the best performance of the TCT test in detecting diabetic retinopathy. Our study showed that there was a significance difference in mean TCT values ( $p < 0.001$ ) between diabetic retinopathy and no diabetic retinopathy groups. But there was no significant difference in BCVA in the same group ( $p = 0.209$ ). This showed that

the tritan contrast threshold technique is a better predictor in detecting diabetic retinopathy over the visual acuity measurement.

In our study we have used the slit lamp biomicroscope to grade the lens colour which is easily available and easy to use and nowadays computers are being used everywhere, so we have used a simple program in Visual Basic that is feasible by any body and easy to handle. The time taken for a single patient to undergo the test is less than 5 minutes, which is very effective for a screening test to be done. Consistently, with other studies our results showed that patients with diabetic retinopathy have tritan colour dysfunction. ( $p < 0.001$ ).

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