

# Assessment of Macular Thickness and Retinal Nerve Fiber Layer Thickness by Spectral Domain OCT in Patients with Type 2 Diabetes Mellitus Without Clinical Diabetic Retinopathy in Relation to the Glycemic Status and Oxidized Low Density Lipoprotein levels

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## Abstract

Diabetes retinopathy (DR) is a vascular disorder affecting the microvasculature of the retina. It is estimated that diabetes mellitus affects 4% of the world's population, almost half of whom have some degree of DR at any given time. Diabetes mellitus is the leading cause of new cases of blindness among adults aged 20 to 74 years. India has more the 62 million diabetic subjects at present as per WHO estimates (8). Prevalence of DR in Wisconsin epidemiological study of diabetic retinopathy (WESDR) was 99% in Insulin dependent diabetes mellitus (IDDM) & 60% in noninsulin dependent diabetes mellitus (NIDDM) Prevalence of DR was 54.2% in the Diabetes Control and Complication Trial (DCCT) study in IDDM and 35-39% in United Kingdom Prospective Diabetes study in NIIDM (5). In the Andhra Pradesh Eye Disease Study (APEDS) of self-reported diabetics the prevalence of DR was 22.4% in the Chennai Urban Rural Study (CURES), done in 2005 they evaluated the urban sample of diabetic patients and estimate the overall prevalence of DR as 17.6% (9). This study aims to measure retinal nerve fibre layer thickness & macular thickness in diabetic patients without retinopathy, by Spectral Domain Optical Coherence Tomography (SD-OCT) and to find out quadrant has maximum change in thickness. The study aims to find the clinical significance of the correlation for practical use.

**Keywords:** Diabetes retinopathy, WESDR, IDDM, NIIDM etc.

## Introduction

Diabetes mellitus is the leading cause of new cases of blindness among adults aged 20 to 74 years. Diabetes retinopathy (DR) is a vascular disorder affecting the microvasculature of the retina.

It is estimated that diabetes mellitus affects 4% of the world's population, almost half of whom have some degree of DR at any given time. DR occurs both in type 1 & type 2 Diabetes mellitus and has been shown that nearly all type 1 and 75% of type 2 DM will develop DR after 15 years of duration of diabetes (1,2).

Prevalence of DR in Wisconsin epidemiological study of diabetic retinopathy (WESDR) was 99% in Insulin dependent diabetes mellitus (IDDM) & 60% in Non-Insulin dependent diabetes mellitus (NIDDM) Prevalence of DR was 54.2% in the Diabetes Control and Complication Trial (DCCT) study in IDDM and 35-39% in United Kingdom Prospective Diabetes study in NIIDM (5).

Majority of the patients have NIIDM or type 2 diabetes. In two studies from south India, done in 2004 the prevalence rate of DR in NIIDM patients were 34.1% and 37% (6,7). India has more the 62 million diabetic subjects at present as per WHO estimates (8). In the Andhra Pradesh Eye Disease Study (APEDS) of self-reported diabetics the prevalence of DR was 22.4% in the Chennai Urban Rural Study (CURES), done in 2005 they evaluated the urban sample of diabetic patients and estimate the overall prevalence of DR as 17.6% (9).

Particularly vision loss in diabetes mellitus is seen in uncontrolled glycemic levels. Moreover, once set in, requires frequent ophthalmic examination and high-cost drugs (eg. Bevacizumab) for treatment. However, it is preventable by achieving the glycemic control and reducing the disease duration.

HbA1c is glycosylated hemoglobin. It is formed due to non-enzymatic glycation pathway by hemoglobin exposure to plasma glucose and reflects the blood glucose over the last 8 to 12 weeks. In diabetes mellitus, higher amount of glycated hemoglobin, indicating poorer control of blood glucose levels, have been associated with

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cardiovascular disease, nephropathy and retinopathy. Monitoring HbA1c levels may improve outcome (10).

Oxidised low density lipoprotein (LDL) derived from LDL cholesterol under oxidative stress, encompasses many atherogenic properties. Oxidised LDL is an independent predictor of endothelial dysfunction with pro-inflammatory, pro-thrombotic and pro-apoptotic properties in individuals suffering from oxidized stress such as diabetic patients. Guidelines for the management of the lipid profile in diabetic patients are mainly focused on controlling LDL cholesterol, triglycerides, high density lipoprotein-cholesterol and total cholesterol. To date, there is still a lack of data concerning the role of atherogenic lipids such as oxidised LDL among diabetic patients with retinopathy, whether there is a significant correlation between oxidised LDL with the retinal nerve fiber layer. Higher total and LDL cholesterol levels were each associated with severity of hard exudates. In a prospective analysis of ETDRS data (11), the development of hard exudate was 50% faster among subjects with elevated baseline levels of total cholesterol and triglycerides and 36% faster among participants with higher baseline of LDL compared with participants with normal lipid levels at baseline in small study. In another smaller study of type 1 diabetes, those who had higher cholesterol levels had a 46% higher incidence of macular edema.

Hyperglycemia is also associated with dyslipidemia, specifically increased levels of total cholesterol and triglycerides, a slight elevation of LDL, but generally little if any change in HDL, resulting in increased total-to-HDL cholesterol ratio. Consequently, we think that the potential for confounding demands adjusting for HbA1c to assure that any observed association between lipids and retinopathy is not a spurious finding.

Spectral domain OCT allows for non-invasive in vivo cross-sectional image of ocular structure such as retina, RNFL and optic nerve head. Spectral domain OCT applies the principle of interferometry to determine the interface between different ocular tissue. Using automated segmentation algorithms based on reflectivity changes between adjacent retinal layers, the RNFL thickness can be calculated (12,13,14,15),

"Thus the purpose of study is to evaluate if poorly controlled diabetes -as reflected by high recent HbA1c levels causes thinning of the nerve fibres & to asses if there is a significant correlation between atherogenic lipids (oxidised LDL) with the retinal nerve fiber layer and macular thickness."

## Diabetes Mellitus

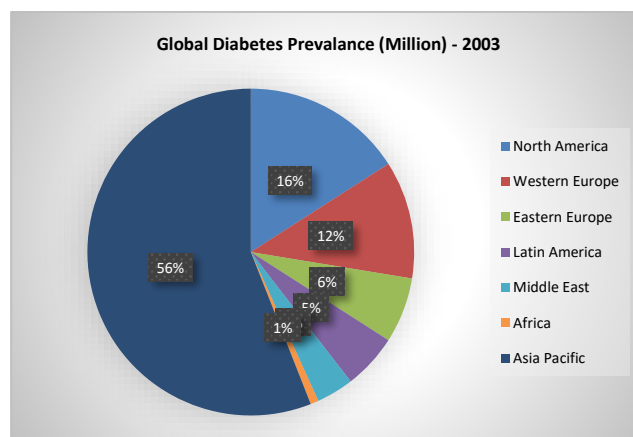
The history of diabetes started in approximately 1550 BC. An Egyptian papyrus mentioned a rare disease that causes the patient to lose weight rapidly and urinate frequently. This is thought to be the first reference of the disease.

Diabetes was given its name by the Greek Physician Aretaeus (30-90 CE). He recorded a disease with symptoms such as constant thirst, excessive urinations loss of weight. He named the condition diabetes, meaning 'a flowing through'.

Later, Galen (131-201CE) noted the rarity of this condition and theorized that it was an affliction of the kidneys. He named the disease "Diarrhea of the urine". After this period, diabetes was rarely mentioned. Indeed, it seemed to have been a mystery or incredibility rare during the Middle Ages. The first clear reference to this disease came from Avicenna., the famous Arabian Physician. He described in detail the complication of the disease and how it happened.

Indian Physician Sushruta and Charaka identified Type 1 and Type 2 diabetes as separate condition for the first time in 400-500 AD: type 1 associated with young and type 2 associated with being overweight. The term "mellitus" or "from honey" was added by Briton John Rolle in the late 1700s to separate the condition from diabetes insipidus, which is also associated with frequent urination. Effective treatment was not developed until the early part of the 20<sup>th</sup> century, when Canadians Frederick Banting and Charles Harbert Best isolated and purified insulin on 1921 and 1922. This was followed by the development of the long-acting insulin NPH in the 1940s. Birth date of Best, 14th November is celebrated as World Diabetes Day.

Globally, as of 2010, an estimated 285 million people had diabetes, with type 2 making up about 90% of the cases (16), In 2013, according to International Diabetes Federation, an estimated 381 million people had diabetes. Its prevalence is increasing rapidly, and by 2030, this number is estimated to almost double (17), Diabetes mellitus occurs throughout the world, but is more common (especially type 2) in the more developed countries. The greatest increase in prevalence is, however, expected to occur in Asia-Pacific, where most patients will probably be found by 2030. The increase in incidence in developing countries follows the trend of urbanization and lifestyle changes, perhaps most importantly a "Western-style" diet.



India has more diabetics than any other country in the world, according to the International Diabetes

Foundation,(18) although more recent data suggest that China has even more. According to the Indian Heart Association, India is the diabetes capital of the world with a projected 109 million individuals with diabetes by 2035 (19). The disease, currently affects more than 62 million Indians, which is more than 7.1% of India's adult population. An estimate shows that nearly 1 million Indians die due to Diabetes every year (20). The average age of onset is 42.5 years (20). The high incidence is attributed to a combination of genetic susceptibility plus adaptation of a high calories, low-activity lifestyle by India's growing middle class (21). Additionally, a study by the American Diabetes Association reports that India will see the greatest increase in the people diagnosed with diabetes by 2030.

Diabetes Mellitus is a chronic disease that occur either when the pancreas does not produce enough insulin or the body cannot effectively use the insulin it produces. Insulin is a hormone that regulate blood sugar (22). Hyperglycemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many body's system, especially the nerves and blood vessels.

**Type 1 diabetes:** Type 1 diabetes (previously known as insulin dependent, juvenile or childhood onset) is characterized by deficient insulin production and requires daily administration of insulin. The cause of this type 1 Diabetes is not known and it is not preventable with current knowledge.

Symptoms include excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision change and fatigue. These symptoms may occur suddenly.

**Type 2 diabetes (formerly called non-insulin-dependent or adult-onset):** results from the body's ineffective use of insulin. Type 2 diabetes comprises 90% of people with diabetes around the world (7), and is largely the result of excess body weight and physical inactivity.

Symptoms may be similar to those of Type 1 diabetes, but are often less marked. As a result, the disease may be diagnosed several years after onset, once complications have already arisen.

The importance of protecting the body from hyperglycemia cannot be overstated; the direct and indirect effects on the human vascular tree are the major source of morbidity and mortality in both type 1 and type 2 diabetes. Generally, the injurious effects of hyperglycemia are separated into macrovascular complications (coronary artery disease, peripheral arterial disease, and stroke) and microvascular complications (diabetic nephropathy, neuropathy, and retinopathy).

Criteria for Diagnosis of Diabetes Mellitus- Symptoms of diabetes plus random blood glucose concentration  $\geq$  11.1 mmol/L(200 mg/dL)

- Fasting plasma glucose  $\geq$  7.0 mmol/L (126mg/dL)
- HbA1c  $>$  6.5 or
- Two hour post prandial plasma glucose  $\geq$  11.1 mmol/L during an oral glucose tolerance test

### Retinal Nerve Fiber Layer Thickness in Diabetes and its Association with Glycemic Status and Lipid Profile

Normal vision depends on the normal function of the retinal neurons to produce a good quality of vision. The quality of vision starts to deteriorate early in diabetes, before the clinical retinopathy becomes evident, probably indicating the early signs of neuronal dysfunction.

RNFL is an important structural neuron in the retina layer which is often shown to affect in the early pathogenesis of diabetic retinopathy. Several studies have reported RNFL thinning or defects in people with diabetes. Histological studies of neural components of the retina have revealed that diabetes induced biochemical mechanism can potentially cause neural cell degeneration, an in-depth understanding of the vascular changes in the retina during diabetes has given cause for the treatment of diabetic retinopathy. Indeed, the only proven treatment for diabetic retinopathy apart from intensive insulin therapy is laser photocoagulation, which involves the destruction of the retinal regions which contains overt vascular abnormalities. Subsequently, early detection of RNFL thinning may help ophthalmologists to provide effective treatment of diabetic retinopathy and with early prevention, thus reducing vision loss.

Nowadays, due to the new introduction of imaging devices such as Heidelberg Retina Tomograph (HRT) and optical coherence tomography (OCT), RNFL thickness can be measured quantitatively and evaluated in vivo. Besides this, we also noticed that the thickest RNFL in nasal quadrant might be due to the lack of micro aneurysm presence in this area and therefore less retinal nerve fiber layer damage occurred in this quadrant.

Studies concerning RNFL thickness in diabetes are very rare from Asia. One landmark study from Japan found significant RNFL thinning in diabetics (Oshitari et al., 2009). In that study, they also found significant differences of RNFL thickness according to gender. However, once proliferative changes developed, there was macular thickening (Oshitari et al., 2009). In another prospective study from Korea, the authors found significant peripapillary thickening in retina, correlating with the severity of diabetic retinopathy (Cho et al, 2010). However, our study was with patients in early stage of retinopathy or no overt retinopathy. Further studies are needed to find the changes in RNFL with time. Extensive literature search could not reveal any Indian study on RNFL thickness in diabetes.

### Review of literature

#### Prevalence of diabetic retinopathy globally

Studies performed across the globe reported varying rates of prevalence such as Lianet al. (39%) in Hong Kong.

Rodriguez-Poncelaset al. (12.3%) in Spain, Dawkins et al. (18.6%) in Timor-Leste, Huang et al. (33.9%) in Singapore, Giloyan et al. (36.2%) in Armenia, Hajar et al. (27.8%) in Saudi Arabia, and Dutra Medeiros et al. (16.3%) in Portugal.

A pooled individual participant meta-analysis involving 35 studies conducted worldwide from 1980 to 2008, estimated global prevalence of any DR and PDR among patients with diabetes to be 35.4 and 7.5 % respectively.

Prevalence of any DR and PDR was higher in those with type 1 diabetes, compared to those with type 2 diabetes (77.3 vs. 25.2 % for any DR, 32.1 vs. 3.0 % for PDR).

In general, patients with type 2 diabetes in Western communities have a higher prevalence of DR than their Asian counterparts. In the USA, studies estimate that 28.5-40.3 % of patients with type 2 diabetes had DR, and 4.1-8.2 % of them had VTDR. In contrast, most Asian countries report DR prevalence to be between 12.1-23.0 %, and VTDR prevalence to be between 4.3-4.6 %.

### Incidence of diabetic retinopathy globally

There are few population-based cohort studies, outside of the USA or UK, which have investigated DR incidence.

In the USA, the Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) found that among patients with insulin-dependent diabetes with onset before the age of 30, who are presumed to have type 1 diabetes, the 4-year cumulative incidence of DR was 59.0%. At 10, 14 and 25 years, cumulative incidence of DR in the same cohort rose to 89.3%, 95.9% (9) and 97 % respectively.

The Blue Mountains Eye Study in Australia reported a cumulative 5-year incidence of DR of 22.2% in those diagnosed with diabetes at baseline, while progression to proliferative DR occurred in 4.1% of those who had DR at baseline.

The DR screening program in the UK has reported the 5-year cumulative incidence of any DR as 36%, proliferative DR as 0.7% and DME as 0.6%, rising to 66%, 1.5% and 1.2% respectively after 10-years follow-up.

### The India scenario of diabetic retinopathy

According to statistics from the International Diabetes Federation (IDF), India has more diabetics than any other nation of the world. Current estimates peg the number of diabetics in the country at about 62 million - an increase of over 10 million from 2011 when estimates suggested that about 50.8 million people in the country were suffering from the disease. If you think the disease has already reached endemic proportions in the country, consider this. By the year 2030, over 100 million people in India are likely to suffer from diabetes.

### The Chennai Urban Rural Epidemiology Study (CURE)

Eye study is a population-based study conducted on a representative population of Chennai (formerly Madras)

city in South India to assess the prevalence of diabetic retinopathy (DR) in type 2 diabetic subjects in urban India using four-field stereo color photography. The overall prevalence of DR in the population was 17.6% (95% CI:15.8-19.5, which included 20.8% (95% CI:18.7-23.1) in known diabetic subjects and 5.1% (95% CI: 3.1-8.0) in subjects with newly detected diabetes. The prevalence of DR was significantly higher in men than in women (21.3% vs. 14.6%;  $P < 0.0001$ ) and among subjects with proteinuria ( $P = 0.002$ ). Logistic regression analysis showed that for every 5-year increase in the duration of diabetes, the risk for DR increased 1.89-fold (95% CI: 1.679-2.135;  $P < 0.0001$ ). For every 2% elevation of glycated hemoglobin (HbA1c), the risk for DR increased by a factor of 1.7 (95% CI: 1.545-1.980;  $P < 0.0001$ ).

### Prevalence of diabetic retinopathy in India: The All-India Ophthalmological Society Diabetic Retinopathy Eye Screening Study 2011

A total of 6218 known diabetes rescreened. Totally, 5130 data entry forms were considered suitable for further evaluation. About 61.2% were males, 88.6% were between 40 and 80 years of age, almost two-thirds of the patients were from the west and south zones, and over half had diabetes more than 5 years. The data set was predominantly urban 84.7% and 46.1% had no family history. DR prevalence in the entire data set was 21.7%. Prevalence was more in males ( $P = 0.007$ ). Diabetics more than 5 years ( $P = 0.001$ ), those above 40 years ( $P = 0.01$ ), insulin users ( $P = 0.001$ ), and history of vascular accidents ( $P = 0.0014$ ). Significantly 22.18% of patients detected with DR had a vision of 6/18 or better in the worse eye. The study reiterated the findings of earlier regional studies on a pan Indian scale and put data in perspective.

### Material & methods

1. **Study area:** Department of Ophthalmology, Drishtideep Eye Institute
2. **Study population:** Patients attending Department of Ophthalmology OPD of Drishtideep Eye Institute
3. **Sample size:** 40 patients- Type 2 Diabetic patients without any evidence of diabetic retinopathy. A total of 80 eyes were observed
4. **Study design:** Cross sectional, hospital-based study

### Explanation of procedure

If you agree to participate in this study, we will collect some relevant information from your hospital records. We would be doing certain tests like Direct Ophthalmoscopy, Visual Acuity, US B Scan etc. and these tests would not be charged. Data from the study will be used for research purpose only. The results of the study will not be made available to you. All the analysis will be made with an intention to treat. This is to inform you that there are some risks involved in the process of study but

the chances of the same are minimal. Serious life-threatening reactions are exceptionally.

### Potential Benefits

Your participation will help us in managing this problem in you and other patients and results of this study will also be beneficial for future generations.

### Assurance Of Confidentiality

The information concerning your participation in the study will be kept confidential to the full extent permitted by law and used only for scientific purpose. No one except members of the research team will have access to test results. Your name will not be used in any report or released in any way.

### Consent

A written consent was taken by the patient mentioning the pros and cons of the research work. The patients were given full opportunity to discuss about the study and had full right to quit anytime from the study when desired.

### Clinical Examination

Data collected from the patients' records included patient's age, gender, duration of diabetes mellitus, age at onset of diabetes mellitus, presence or absence of hypertension use of insulin or oral hypoglycemic agents, presence of other systemic diabetic complications and other general illness. All patients undergone biological workup including:

FBS- fasting blood sugar at first contact with patient  
PPBS- post prandial blood sugar at Erst contact with the patient

HbA1c & oxidized LDL. levels at the first contact with the patient

All the patients underwent the following tests on the first day of visit and then registered for further evaluation-

- Visual acuity using Snellen's chart
- Vision with pin hole\* Refraction by autorefractometer and best corrected visual acuity (BCVA)
- Slit lamp examination & Slit lamp bio-microscopy with +78D or +90D lens.
- Distant direct ophthalmoscopy
- Indirect ophthalmoscopy
- Spectral domain OCT (Cirrus HD-OCT, Carl Zeiss Meditec, Dublin, CA)

### Inclusion criteria

Cases:

- Type 2 Diabetic patients of both sexes without retinopathy receiving treatment at OPD clinic of S. S. Hospital BHU, Varanasi.
- Only adults (>18years of age)

### Exclusion Criteria

Patients having ophthalmoscopic conditions where evaluation of fundus by +90D or +78D Jenses, indirect ophthalmoscopy and spectral domain OCT procedures cannot be possible (like nuclear sclerosis grade 3 & onward cataracts, complicated cataracts, cortical cataracts & dense media opacities which hinders the evaluation)

- Neural ophthalmic conditions
- High myopia
- Glaucoma
- Patients taking retinotoxic drugs like hydrochloroquin
- Hypertensive patients

All patients were refracted, and BCVA was measured using the Smellen's visual acuity chart. In addition to other routine ophthalmic examinations, spectral-domain OCT (Cirrus HD-OCT, Carl Zeiss Meditec, Dublin, CA) was performed in all eyes with à6. mim line scan, which comprises 1,024 axial scans, through the central fovea in Oh the horizontal and vertical directions. We also obtained images using the Currently available Cirrus-OCT software (Carl Zeiss Meditec, Dublin, CA) for a macular cube of 512x128, in which a 6x6-mm area of the macula is scanned with 28 horizontal lines, each consisting of 512 A-scans per line. We defined the central subfield thickness (CST) as the average retinal thickness of the 1-mm central scanned arca and cystic changes as intra-retinal cystoid spaces in the fovea (1.8 mmin diameter).

### Slit Lamp Bi-microscopy

Diabetic macular edema can appear as a localized or diffuse macular thickening depending on the severity of retinopathy. The localization of macular edema can be guided by the presence of characteristic elements such as microaneurysms and hard exudates.

### Optical Coherence Tomography (OCT)

OCT represents an important tool, helpful both in the diagnosis and follow-up procedure. OCT is an optical technique for high resolution, cross-sectional imaging of tissue. It is analogous to computed tomography, which uses X rays; magnetic resonance, which uses spin resonance and ultrasound B scan, which uses sound waves. OCT uses a super-luminescent diode as its light source. It can perform micron resolution up to <10

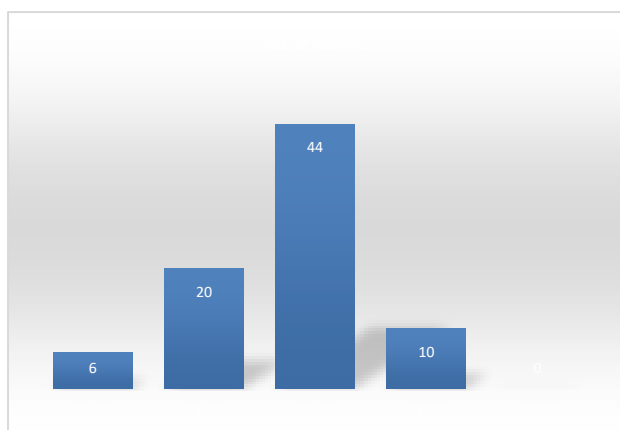
microns on cross-sectional or topographical imaging in biological tissues

**Statistical Analysis**

Statistical analysis was performed using software. Master chart was prepared by Microsoft excel & then loaded onto the SPSS software. Descriptive statistical analysis was performed to prepare different frequency tables and to calculate the means with corresponding standard errors. Pearson Chi Square test was applied as measure of association. P<0.05 was taken to be statistically significant.

**Observation Table**

Total number of patients studied is 40  
 Both eyes of the patient were studied (80 eyes)  
 Minimum age of the subject under study is 35  
 Maximum age of the subject under study is 65  
 Total number of males is 28  
 Total number of females is 12

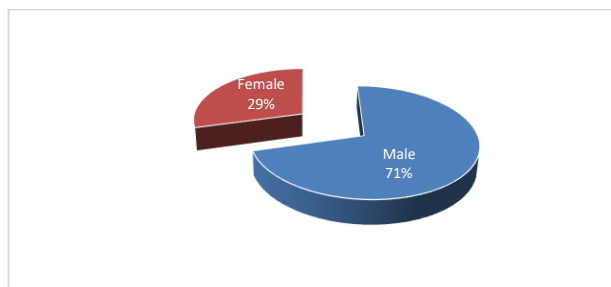


X-axis shows age in years.  
 Y-axis shows number of subjects.  
 Total number of subjects: 40  
 Minimum age of the subject: 35 years  
 Maximum age of the subject: 65 years  
 Range - 30 years (35-65)  
 Mean age of patient: 53.40 years +/-7.28 years.

**Table 1:** Showing age distribution among the study group

Age in Years	Count	Percentage
31-40	6	7.5
41-50	20	25
51-60	44	55
61-70	10	12.5

Maximum number of patient s belongs to the gr group of 51-60 years (55%)



**Table2:** Showing gender distribution among the study group

Gender	Count	Percentage
Male	58	70
Female	24	30

**Table 3:** Showing gender distribution among the various age group

Age in Years	Count	Count of Male	Count of Female
31-40	6	2	4
41-50	20	10	14
51-60	44	36	8
61-70	10	8	2
71-80	0	0	0
Total	80	58	24

**Table 4:** Statistical correlation between fasting blood sugar (FBS) with Retinal Nerve Fiber Layer thickness in all quadrants

FBS (mg/dl)	Mean+/- SD	f-value	p-value
<100	101.00 +/- 12.336	32.827	<0.001
100-126	124.00+/- 13.543		
>126	135.00+/- 11.015		

p-value is <0.001, hence the result is statistically significant.

**Table 5:** Statistical correlation between post prandial blood sugar (PPBS) with Retinal Nerve Fiber Layer thickness in all quadrants

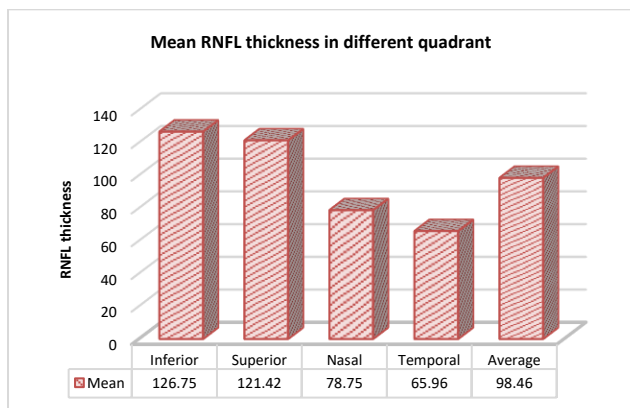
PPBS (mg/dl)	Mean+/- SD	f-value	p-value
<140	154.38 +/- 20.827	21.184	<0.001
140-200	187.11+/- 24.523		
>200	199.00+/- 19.900		

p-value is <0.001, hence the result is statistically significant.

**Retinal Nerve Fiber Layer Thickness**

**Table 6:** Showing the Mean Retinal Nerve Fiber Layer Thickness in all quadrant

Quadrants	Mean	Standard Deviation
Inferior	126.75	14.7863
Superior	121.42	11.7621
Nasal	78.75	18.9890
Temporal	65.96	12.5541
Average	98.46	10.7671



Showing Mean Retinal Nerve Fiber Layer Thickness in all quadrant (in Micro Meter)

**Chi Square Test**

**Table 7:** Statistical correlation between Inferior RNFL thickness with HbA1c

	Value	Df	Asymp. Sig (2-Sided)
Person Chi Square	19.84	4	0.0005
No. of Valid Cases	80		

P value is 0.0005, hence the result is statistically significant.

**Table 8:** Statistical correlation between Superior RNFL thickness with HbA1c

	Value	Df	Asymp. Sig (2-Sided)
Person Chi Square	32.32	4	<0.001
No. of Valid Cases	80		

P value is <0.001, hence the result is statistically significant.

**Table 9:** Statistical correlation between Nasal RNFL thickness with HbA1c

	Value	Df	Asymp. Sig (2-Sided)
Person Chi Square	6.79	4	0.146
No. of Valid Cases	80		

P value is 0.146, hence the result is not statistically significant

**Table 10:** Statistical correlation between Temporal RNFL thickness with HbA1c

	Value	Df	Asymp.Sig (2-Sided)
Person Chi Square	0.629	2	0.7299
No. of Valid Cases	80		

P value is 0.7299, hence the result is not statistically significant

**Table 11:** Statistical correlation between Average RNFL thickness with HbA1c

	Value	Df	Asymp.Sig (2-Sided)
Person Chi Square	35.14	4	<0.001
No. of Valid Cases	80		

P value is <0.001, hence the result is statistically significant.

**Discussion**

Advances in ocular imaging technology have made it possible to evaluate the RNFL thickness in an objective, quantifiable, and reproducible fashion, Optical Coherence Tomography (OCT), which uses short coherence length interferometer, has a fine resolution (up to 2 microns) and reflects the histologic characteristics of the tissue. Because OCT is based on the cross-sectional image of the retina, the instrument measures the nerve fibre layer directly, has no need for a reference plane, and is known to be unaffected by the refractive status, axial length of the subject, sclerosis of the lens, or pupillary dilation. The only limitations of OCT imaging are the uncertainty of the assumed group refractive index of tissue, the effect of eye movements during the B-scan location, and the interface detection artifacts. The Cirrus HD-OCT, Carl Zeiss Meditec, Dublin, CA has eye tracking system and it negate the effect of the eye movements. To avoid any influence of the eye movements, we observed the scanned eye software interface detection artifacts, we inspected every B-scan and repeated the scan if we noticed any eye movements. To avoid software interface detection artifacts, we inspected every B-scan after acquisition and repeated the scan if the software was unable to detect the RNFL borders. Previous studies have shown that in patients with diabetes mellitus, poor glycemic control leads to infarction in the nerve fiber layer leading to axonal degeneration and decrease in inferior, decrease in the number of optic nerve axons and the number of retro-bulbar optic nerve fibers (100-103).

Two studies of the retinal nerve fiber layer have shown both broad and slit like defects, suggesting that retinal nerve fiber loss and optic nerve fiber loss are related to subclinical vision loss in diabetic patients without any clinical retinopathy.

**The Purpose of our study was to measure**

- A. Retinal nerve fiber layer (RNFL) thickness in diabetic patient without retinopathy and find out which quadrant has maximal change in thickness in relation to the glycemic levels. During study period 80 eyes of

40 patients with type 2 diabetes mellitus without any diabetic retinopathy changes were evaluated. Fasting blood sugar (FBS), post prandial blood sugar (PPBS) & HbA1c of each patient were considered as glycemic status markers. All the three parameters were correlated with superior, inferior, nasal, temporal & average RNFL thickness.

Using the spectral domain OCT in this study, we were able to detect significant decrease in inferior, superior and average RNFL thickness measurement in Type 2 diabetes without any clinical evidence of Diabetic retinopathy.

### The Final Result

1. Statistical correlation between FBS and RNFL thickness in different quadrants- P value is  $<0.001$ , hence the result is statistically significant (Table 4).
2. Statistical correlation between PPBS and RNFL thickness in different quadrants- P value is  $<0.001$ , hence the result is statistically significant (Table 5).
3. Statistical correlation between inferior RNFL thickness with HbA1c- P value is 0.0005, hence the result is statistically significant (Table 7).
4. Statistical correlation between superior RNFL thickness with HbA1c- P value is  $<0.001$ , hence the result is statistically significant (Table 8).
5. Statistical correlation between Nasal RNFL thickness with HbA1c- P value is 0.146, hence the result is statistically significant (Table 9).
6. Statistical correlation between Temporal RNFL thickness with HbA1c- P value is 0.7299, hence the result is statistically significant (Table 10).
7. Statistical correlation between Average RNFL thickness with HbA1c- P value is  $<0.001$ , hence the result is statistically significant (Table 11).

Our findings were in parallel to other studies done by Takahashi et al and Tekeli et al. In the study done by Tekeli et al, HRT was used to evaluate the optic nerve head parameter in diabetes mellitus with and without retinoscopy. Whereas Takahashi et al. used the stratus OCT which is different from tool compared with this study. Both studies did not find any significant reduction in RNFL thickness among the subjects of mild to moderate NPDR compared with age-related healthy subjects.

Our results were fairly similar to studies done by Lopes DE Faris et al and Takahashi et al which disclosed that RNFL was thinner in superior quadrant. This finding corroborates with previous study of Kern showing that the early events of Diabetic Retinal Disease (micro aneurysms and acellular capillaries) occur preferentially in the superior temporal quadrant rather than inferior area. Among the other studies Chung et al demonstrated that blood flow in the superior temporal retina increased in response to hypercapnia, but did not decrease in response to hyperoxia. In contrast, hyperoxia led to a decrease in blood flow to the inferior retina, whereas

hypercapnia did not result in an increased blood flow within the area. The lack of normal vasoconstrictor response in this superior quadrant could explain why this region is more susceptible to micro aneurysm acellular capillaries in diabetes mellitus and also why the retinal fiber is preferentially lost in this region even before clinically detectable diabetic retinopathy. Sugimoto postulated that the superior quadrant was more susceptible to under going damage compared with other areas and may have a tendency for higher rates of cell death, which result in RNFL thinning. Besides this it has come see that micro aneurysm present in this area and therefore less retinal nerve fiber layer damage occurred in this quadrant.

HbA1c is known as the index blood glucose in fasting and the postprandial state, and is well established and widely used as clinical measure of chronic glycemia. HbA1c of 6.5% has now been seen as sufficiently sensitive and specific to identify individuals who are the risk of developing diabetic retinopathy. From our study we noted that the majority of our subjects in diabetic patients without retinopathy changes had poor glycemic control. The HbA1c is greater than or equal to 6.5%. The result of mean HbA1c were fairly consistent with others.

### Summary

- This was a cross sectional, hospital-based study to evaluate the Retinal Nerve Fiber Level (RNFL) thickness & Central Macular thickness (CMT) in type 2 diabetic patients without clinical diabetic retinopathy by Spectral Domain Optical Coherence Tomography (SD-OCT).
- 80 eyes of 40 diabetic patients were selected fulfilling inclusion criterion and evaluated at Department of Ophthalmology, Dristideep Eye Hospital.
- RNFL thickness was measured along a 3.4 mm circle entering the optic nerve head and CMT was measured along HD 5-line raster by SD-OCT.
- Significant decrease in inferior, superior and average RNFL thickness measurement in TYPE 2 diabetic patients without any clinical evidence of diabetic retinopathy.
- No significant change in the nasal and temporal RNFL thickness.
- The decrease in the thickness in the superior, inferior and average RNFL thickness is affected by raised HbA1c level, raised fasting blood sugar (FBS) & PPBS level.
- Using the spectral domain OCT in this study, no significant in CMT in relation to oxidized LOW Density Lipoprotein (LDL) levels were observed in Type 2 Diabetes patients without any clinical evidence of Diabetic Retinopathy.



## Conclusion

The Final results are:

- Statistical correlation between FBS and RNFL thickness in different quadrants- P value is <0.001, hence the result is statistically significant.
- Statistical correlation between PPBS and RNFL thickness in different quadrants- P value is <0.001, hence the result is statistically significant.
- Statistical correlation between inferior RNFL thickness with HbA1c- P value is 0.0005, hence the result is statistically significant.
- Statistical correlation between superior RNFL thickness with HbA1c- P value is <0.001, hence the result is statistically significant.
- Statistical correlation between Nasal RNFL thickness with HbA1c- P value is 0.146, hence the result is statistically significant.
- Statistical correlation between Temporal RNFL thickness with HbA1c- P value is 0.7299, hence the result is statistically significant.
- Statistical correlation between Average RNFL thickness with HbA1c- P value is <0.001, hence the result is statistically significant.

## Limitations

There are certain limitations of our study. Main drawback of our study is sample size. The result of the study can be improved by increasing the sample size. Also, the patient are poorly characterized in aspects of several factors such as age, duration of diabetes, types of treatment whether the patient receives no treatment/oral hypoglycemia agents/insulin/lipid lowering agents or coexistent disease. Also, it helps in qualitative assessment of decrease of RNFL, a quantitate result for an age matched population cannot be determined.

The duration of diabetes is also variable and further clarification is needed for the clarification is needed for the relation of outcomes in relation to duration of diabetes.

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