Original Research Article

Findings of diabetic macular edema on OCT and its correlation with visual acuity

M. Nirmala[1*], Kola Vijaya Sekhar[2], G. S. Ramesh Kumar[3], P.D.S.Keerthi[4], D.Srilakshmi[5]

[1] Assistant Professor, Department of Ophthalmology, Government General Hospital, Guntur, AP, India
[2]Professor, Department of Ophthalmology, Government General Hospital, Guntur, AP, India
[3]Professor and HOD, Department of Ophthalmology, Government General Hospital, Guntur, AP, India
[4,5]Postgraduate, Department of Ophthalmology, Guntur Medical College, Government General Hospital, Guntur, AP, India

Received: 21-06-2021 / Revised: 25-08-2021 / Accepted: 28-09-2021

Abstract

Aim: to describe various findings of Diabetic Macular Edema (DME) demonstrated by OpticalCoherence Tomography (OCT) and correlate them with Visual Acuity. **Methods and materials:** sample of 50 patients with diabetic retinopathy detected to haveclinically significant macular edema, and macular thickening with Optical coherence tomography are included in the study. **Results**: A statistically significant difference was found with P Value <0.05 , indicating thatmorphological subtypes/patterns of DME on OCT varied with the severity of retinopathy .The preponderance of Diabetic Macular Edema is more in the age group of 51-60 years (54%)and in patients with a history of DM for 6-10 years(48%). **Conclusion**: The mean Central Subfield Thickness varied among Various patterns of DME on OCT. Highest mean CST was observed in SRD pattern (497.15µm), and Least mean CST was observed in DRT pattern (332.69µm). Visual acuity varied among various patterns of DMEon OCT. Worst mean Visual Acuity was observed in SRD pattern 1.6 log MAR(Snellen equivalent-6/250)and best mean visual acuity was observed in DRT pattern 0.6 log MAR(Snellen equivalent-6/24).

Keywords: Diabetic retinopathy ,Diabetic macular edema, Optical coherence tomography.

Introduction

Diabetic Retinopathy (DR) is one of the leading causes of blindness in the world. With diabetic macular edema (DME) significantly contributing to visual Impairment.DME can develop at all stages of diabetic retinopathy (DR), but it appears to occur more frequently asthe severity of DR increases. Risk factors that contribute to the progression of DME include increasing levels of hyperglycaemia, diabetes duration, the severity of DR at baseline, diastolic blood Pressure and the presence of gross proteinuria . Although the pathogenesis of DME is still not fully understood ; it is mainly caused by the breakdown of the Inner blood-retinal barrier .Diabetic macular oedema (DME) can cause retinal structural changes severe enough to make it the most common cause of visual loss in patients with diabetes. The prevalence of diabetes mellitus is attaining epidemic proportions worldwide. It is estimated that 382 million people had diabetes Mellitus in 2013. This number is expected to rise to 592 million by 2035. The Wisconsin Epidemiologic Study of Diabetic Retinopathy found the 14-year incidence of DME in people with type I diabetes to be 26% . Similarly the Diabetes Control and Complications Trial (DCCT) reported that 27% of type I diabetic patients Develop DME within nine years of onset. In urban India, the prevalence of DR is 17.6% among the diabetic population and prevalence of DME is 5.0%. An even higher incidence of macular edema has been reported in older patients with type 2 diabetes.Traditional methods of assessing DME include contact and noncontact slit-lamp biomicroscopy, indirect fundoscopy, fluorescein Angiography and fundus stereo- photography. However, given the relative lack of the ability of these methods to detect and to quantify DME, alternative objective have been applied. The introduction of OCT allows an objective evaluation of DME with effectiveness in both qualitative and quantitative Description of this pathology. That is why it becomes a standard tool in the Management of patients with DME. More than ten years after ETDRS, OCT greatly enhanced our ability to detect macular thickening and has brought new insights on the morphology of DME and the presence of vitreoretinal interface Abnormalities. With the precise and useful data given byOCT, we can better diagnose, catalogue and follow DME.

*Correspondence
Dr. M. Nirmala
Assistant professor, Department of Ophthalmology, Government General Hospital, Guntur, Andhra Pradesh, India.
E-mail: dr.nirmala.mande@gmail.com

Aims and objectives

Aim

The main aim of the present study is to describe various findings of Diabetic Macular Edema (DME) demonstrated by Optical Coherence Tomography (OCT) and correlate themwith Visual Acuity.

Objectives

The main objectives of the present study are:

1. To study the various Patterns of Diabetic Macular Edema by Optical CoherenceTomography.
2. To assess the relationship between various patterns of Diabetic Macular Edema onOptical Coherence Tomography and stage of Diabetic Retinopathy
3. To correlate the Optical Coherence Tomography measured Central Subfield Thickness(CST) and Visual Acuity.

Materials and method

Materials

This is a hospital-based cross-sectional observational case study conducted between November 2019- November 2020 in the Retina clinic of the Department of Ophthalmology, Guntur medical college, Guntur, Andhra Pradesh. During the above mentioned period, a sample of 50 patients with diabetic retinopathy detected to have clinically significant macular edema, and macular thickening with Optical coherence tomography are included in the study. While selecting the sample, appropriate inclusion and

exclusion criteria were adopted.

The details of the criteria are:

Inclusion criteria

Patients of age >21 years, with a confirmed diagnosis of Diabetes mellitus and NPDR or PDR with CSME, diagnosed with slit-lamp biomicroscopy with 78D/90D lens and Macular Thickening on Optical Coherence Tomography

Exclusion criteria

i. Eyes with active proliferative retinopathy with vitreous haemorrhage and Dense media haze interfering with acquisition of good OCT image.
ii. Any other ocular pathology which can contribute to reduced visual acuity, macular edema due to associated conditions other than diabetic retinopathy like Central Retinal Vein Occlusion etc.
iii. Recent ocular surgery (3 months)
iv. All other macular pathology
v. Patients diagnosed to have glaucoma
vi. Patients with high refractive errors.

Methods

After obtaining the approval of the Institutional Ethics Committee, a written and informed consent was taken from patients in his/her vernacular language. A detailed history was taken regarding chief complaints, duration of diabetes, treatment taken, and relevant co-morbidities. Clinical examination of the patient included a detailed general physical examination and systematic examination. This was followed by the Ophthalmological examination, which included :

i. Best-corrected visual acuity assessed using illuminated ETDRS Chart and scoredwith log MAR Scale.
ii. Near vision
iii. Colour vision with Ishihara test plates.
iv. Slit-lamp examination for anterior segment especially lenticular opacities
v. Applanation tonometry
vi. Refraction by retinoscopy
vii. Fundus examination with the direct, indirect ophthalmoscope and slit-lamp biomicroscopy 78D/90D lens for macular assessment.
viii. OCT was performed through dilated pupils using Spectral OCT(Primus SD-OCT 200 Model) –Macular cube scan(512×32 feature).
ix. Fundus photography was taken using Zeiss Visucam.
x. Fundus fluorescein angiography (wherever needed).
xi. The patient was subjected to lab investigations Fasting Blood Sugar and Post Prandial Blood Sugar to know whether the Diabetes is controlled or uncontrolled.

OCT was done as follows: Patient was explained about the procedure, and after proper positioning of the patient for each eye, macular scans with fovea centred and more than or equal to 4/10 quality scans were selected for the study.

Macular thickness measurements were obtained in nine regions, which were similar to those in the Early Treatment Diabetic Retinopathy Study. The central circle has a diameter of 1 mm. The inner-circle has a diameter of 3 mm and is divided into four quadrants. The outer circle has a diameter of 6 mm and is also divided into four quadrants. Central subfield thickness was defined as the thickness of the central circle(1mm) in the circular map known as the ETDRS Grid. The central subfield thickness (foveal thickness) is taken for correlation with visual acuity. The Patterns of retinal morphology were assessed using cross-sectional OCT images indicating the reflectivities of retinal structures, and these were classified into four patterns :

i. DRT/SLRT pattern was characterised by a sponge-like retinal swelling of themacula with reduced intraretinal reflectivity.
ii. CME pattern was characterised by intraretinal cystoid spaces of low reflectivity with highly reflective septa separating cystoid-like cavities in the macular area.
iii. SRD pattern was characterised by a shallow elevation of the retina, with an opticallyclear space between the retina and the retinal pigment epithelium (RPE).
iv. PHT pattern was defined using OCT images as vitreomacular traction (VMT). VMTs was taken to be present when a highly reflective band was observed on the surface of the retina at specific sites, and elevated off the surface elsewhere, whether continuous or not with the posterior vitreous surface.
v. In the present study :
vi. Any OCT showing sponge-like thickening was classified as SLRT pattern.
vii. The OCT forms, which include Cystoid like spaces/cystoids cavities were classified as CME and cases where there is a combination of both SLRT and CME are considered under the CME group.
viii. Any pattern either DRT or CME if associated with Serous Retinal Detachment wascategorised under SRD group.
ix. Regardless of pattern combinations, cases with VMT /VMIA were classified as PHT.
x. The software Microsoft Excel was used to store and structure the data for statistical analysis with software R. Mann Whitney U Test, Chi-Square Test, Pearson Correlation Coeffecient, Variance Analysis and Linear Regression were various methods used inthe present study. It was considered a 95% confidence level and statistical significance with $p<0.05$.

Results

Duration of Diabetes Mellitus: According to the history given by the patient, they were divided into various groups ofthe duration of diabetes mellitus in five-year interval . Majority of the sample gave ahistory of diabetes mellitus for 6-10 years (48%)

Table 1: Distribution of patients according to the duration of diabetes

Duration in years	Number ofpatients
0-5 yrs	8
6-10 yrs	24
11-15 yrs	12
16-20 yrs	5
>20 yrs	1
Total	50

Morphological Patterns of DME on OCT

Of the 50 patients in the study, 73 eyes showed Diabetic Macular Edema on OpticalCoherence Tomography. Four different patterns of DME were found on the evaluation of the OCT scans. Cystoid Macular Edema was the most common pattern/ morphological subtype (42.47%), followed by SLRT(31.51%) and SRD(17.81% each). Least common morphological subtype was PHT (8.22%).

Table 2: Morphological patterns of DME on OCT

Morphological pattern	Total no of eyes
SLRT	23 (31.51 %)
CME	31(42.47%)

SRD	12(17.81 %)
PHT	6 (8.22%)
Total	73(100%)

Table 3: Association of Diabetic Retinopathy and various Patterns of DME

STAGE OF DR	DRT	CME	SRD	PHT	
MODERATENPDR	19(41.3%)	22(47.83%)	3(6.52%)	2(4.35%)	46(100%)
SEVERE NPDR	4(21.05%)	7(36.84%)	7(36.84%)	1(5.26%)	19(100%)
VERY SEVERENPDR	-	-	-		-
PDR	-	2(25%)	3(37.5%)	3(37.5%)	8(100%)
	23	31	13	6	73

Statistical analysis of the occurrence of various patterns of DME on OCT and stagesof Diabetic Retinopathy was tried using Chi-Square Test. A statistically significant difference was found with P Value <0.05 , indicating that morphological subtypes/patterns of DME on OCT varied with the severity of retinopathy .

Table 4.Linear Regression Analysis to see the linear relation between CST and visual acuity used to explain the variation in the dependent variable (Central Subfield Thickness (µm)) and to see linear relation between CST & Visual Acuity. On comparison of optical coherence tomography measurements of Central subfield Thickness with Visual Acuity, using Linear Regression Method in 73 eyes with NPDR and PDR there is a significant linear relation between Foveal Thickness and Visual Acuity with R2 =0.52, R-value-0.72and P-Value < 0.001

Table 4: Linear Regression Analysis to see the linear relation between CST and visual acuity

Dependent Variable		N	Multiple R	Squared multiple R	
Visual acuity		73	0.729322	0.525314	
Regression coefficients B =(X'X)-1X'Y					
Effect	Coefficient	S.E.	Std.Coefficient	t	p-value
CONSTANT	-0.78428	0.196405	0.000	-3.99319	0.000157
CST	0.004473	0.000	0.7293	8.98217	<0.001

Table 5: Central subfield thickness in various stages of DR with DME

STAGE OF DR	Number of scans	Mean thickness(microns)	Range (microns)
MODERATE NPDR	46	342.5217	(310-478)
SEVERE NPDR	19	428.3684	(317-634)
VERY SEVERENPDR	-	-	-
PDR	8	493.625	(349-910)

Table 6:Mean Visual Acuity of various patterns of DME

Morphological Sub-types	Number of EyesScanned	Mean Visual Acuity (logMAR) (Snellen equivalent)	Range (microns)
SLRT	**23**	0.5887 (6/24)	0.3010-1 (6/12-6/60)
CME	**31**	0.7942 (6/36)	0.3010-2 (6/12-6/600)
SRD	**13**	1.5581	0.477-3
		(6/250)	(6/18-6/6000)
PHT	**6**	1.4838 (6/200)	0.3010-3 (6/12-6/6000)

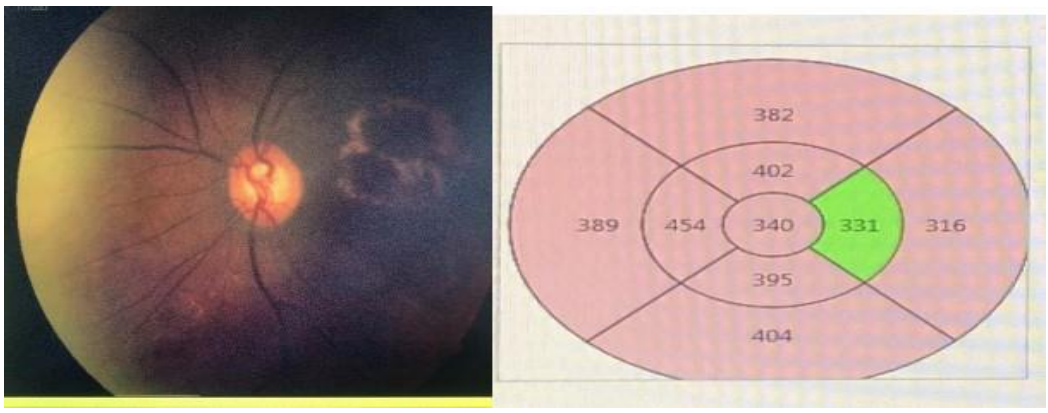

Fig 1: 41 Year Male Patient showing Moderate NPDR LE with CSME with CME Patternon OCT with CST -340µm

Discussion

The present study is a cross-sectional observational case study over a period of twoyears in a sample of 50 patients (73eyes) attending the Retina Clinic of Department of Ophthalmology who satisfied the Morphological Subtype/Pattern of DME was documented and inclusion and exclusion criteria of the study.

The Eyes with clinically significant Macular Edema were analysed using OCT and theeyes showing DME on OCT were evaluated.

evaluated. The data recorded was tabulated and evaluated using R

software and statistical techniques.

Four different patterns of DME were found on the evaluation of the OCT scans.Cystoid Macular Edema was the most common subtype morphology (42.47%), followed by SLRT and SRD (31.51% and 17.81% respectively). Least common morphological subtype was PHT (8.22%).

Patterns were analysed based on the control of Diabetes. 73.91% of the SLRT/DRT pattern was observed in cases whose diabetes was under control. 76.92% of SRD and 83.33 % PHT pattern were observed in cases whose diabetes was not under control. Cystoid Macular Edema pattern was observed both among controlled and uncontrolled diabetes (41.94% and 58.06%) respectively.

Statistical analysis of the occurrence of various patterns with the control of diabetes was done using Pearsons Chisquare test and was found to be statistically significant.SRD and PHT morphological subtypes being predominantly observed in uncontrolled diabetes represent the severe forms of DME on OCT.

Association of Diabetic Retinopathy and various patterns of DME was analysed. Statistical analysis of the prevalence of various patterns of DME on OCT in various stages of Diabetic Retinopathy was tried using Chi-Square Test. A statistically significant difference was found with p-value <0.05,indicating that morphological subtypes /patterns of DME on OCT varied with the severity of retinopathy.DRT Pattern being common in moderate NPDR, CME pattern in moderate NPDR, SRD pattern in Severe NPDR and PHT pattern in PDR group.

The mean Central Subfield Thickness also varied among various stages of Diabetic Retinopathy. The mean CST among various stages of DR with DME were in moderate NPDR-342.52µm, severe NPDR-428.36µm, and 493.62µm in the PDR group. The highest mean CST was observed in the PDR stage of DR and least in the moderate NPDR stage. The significant difference of mean thickness was found in various stages of DR on Statistical Analysis with Analysis of Variance ($p < 0.01$).

The mean Visual Acuity in the study is 0.9 log MAR units(Snellen equivalent-6/48). Worse visual acuity was found among SRD pattern– 1.6 logMAR(snellen equivalent-6/250).Visual acuity was best in DRT-0.6 log MAR(Snellen equivalent-6/24) pattern compared to other patterns.CME pattern was also associated with worse visual acuity than DRT group.

Conclusions

Based on the present study conducted in 73 eyes of 50 patients with CSME withDME on OCT, Following conclusions have emerged.

1. The preponderance of Diabetic Macular Edema is more in the age group of 51-60 years (54%) and in patients with a history of DM for 6-10 years(48%).
2. Though the patients presenting to the hospital showed a Female predominance (Male: Female-0.9:1), gender has no relation with the occurrence of Diabetic MacularEdema.
3. The ratio of Patients suffering from NPDR are more compared to those with PDR(8:1)
4. Four distinct morphological subtypes/patterns of DME are observed on OCT: DRT/SLRT, CME, SRD and PHT. Cystoid Macular Edema (42.47%) is the most common pattern, and Posterior Hyaloid Traction (8.22%) is the least common pattern.
5. The Mean Central Subfield thickness in Diabetic Macular Edema is 381.4µm
6. The Mean BCVA in patients with DME is 0.9 log MAR units which is a Snellenequivalent of 6/48.
7. The mean Central Subfield Thickness varied among Various patterns of DME on OCT. Highest mean CST was observed in SRD pattern (497.15µm), and Least mean CST was observed in DRT pattern (332.69µm).
8. Visual acuity varied among various patterns of DME on OCT. Worst mean Visual Acuity was observed in SRD pattern 1.6 log MAR(Snellen equivalent-6/250)and best mean visual acuity was observed in DRT pattern 0.6 log MAR(Snellen equivalent-6/24).
9. The Mean Central Subfield Thickness also varied with stages of DR. Highest Mean CST was observed in PDR(493.62µm) and least mean CST was observed in ModerateNPDR(342.52µm).
10. Patterns of DME on OCT varied with the severity of retinopathy and the control status of Diabetes. SRD and PHT were the severe forms of DME observed on OCT inuncontrolled Diabetes and in cases with PDR.

Optical coherence tomography (OCT) is a reliable method for high-resolution cross-sectional imaging that directly measures retina thickness. OCT is a novel noninvasive, non-contact, safer imaging technique. The role of OCT in the assessment and management of diabetic retinopathy has become significant in understanding the vitreoretinal relationship and the internal architecture of the retina.

In patients with refractory DME, taut posterior hyaloid membrane(PHT) is readily recognized by OCT scan. Focal vitreoretinal adhesions, subfoveal subretinal fluid, andthe axial distribution of fluid in an edematous macula that cannot be identified on clinical examination can also be evident on OCT. Therefore, OCT is a promising method for screening early development, diagnosis and follow-up of diabetic macularoedema and thereby translates into more timely treatment and targeted prophylaxis for patients with high-risk characteristics.

Acknowledgment

The author is thankful to Department of Ophthalmology for providing all the facilities to carry out this work.

References

1. L.P. Aiello, T.W. Gardner, G.L. King, G. Blankenship, J.D. Cavallerano, F.L.I.I.I. Ferris,R. Klein, Diabetic retinopathy. Technical review. Diabetes Care 1998;21:143–156.
2. Diabetes Control and Complications Trial Research Group. Progression of retinopathy with intensive versus conventional treatment in the Diabetes Control and Complications Trial. Ophthalmology.1995;102:647–61.
3. Rema M, Premkumar S, Anitha B, Deepa R, Pradeepa R, Mohan V. Prevalence of diabetic retinopathy in urban India: the Chennai Urban Rural Epidemiology Study(CURES) eye study, I. Invest Ophthalmol Vis Sci. 2005 Jul; 46(7): 2328-33.92.
4. Bhagat N, Grigorian RA, Tutela A, Zarbin MA. Diabetic macular edema:Pathogenesis and treatment.Surv Ophthalmol. 2009;54:1–32.
5. Massin P, Girach A, Erginay A, Gaudric A. Optical coherence tomography: akey to the future management of patients with diabetic macularedema. Acta Ophthalmol Scand 2006;84:1.
6. Williams R, Airey M, Baxter H, Forrester J, Kennedy-Martin T, Girach A. Epidemiology of diabetic retinopathy and macular oedema: a systematic review. Eye 2004;18(10):963-83.
7. Cunha-Vaz JG, Travassos A. Breakdown of the blood-retinal barriers and cystoid macular edema. Surv Ophthalmol. 1984;28(Suppl):485–92.

Conflict of Interest: Nil Source of support: Nil