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Indian Journal of Clinical and Experimental Ophthalmology

Journal homepage: www.ijceo.org

Original Research Article

The relationship of central macular thickness with clinical grades of diabetic retinopathy

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ARTICLE INFO

Article history:
Received 08-05-2023
Accepted 24-06-2023
Available online 29-09-2023

Keywords:
Central macular thickness
Diabetic retinopathy
Diabetic macular edema

ABSTRACT

Aim: To assess central macular thickness (CMT) in diabetics with or without diabetic retinopathy (DR) and compare it with various clinical grades of DR.

Materials and Methods: All patients attending the ophthalmic OPD fulfilling the inclusion and met no exclusion criteria were enrolled in this study. All eyes underwent comprehensive and standardized ophthalmic examination. The CMT was measured using spectral domain optical coherence tomography using Cirrus HD OCT Model 500.

Result: The mean CMT in cases is significantly greater than controls. It is also significantly greater in diabetics with DR as compared to diabetics without DR and it significantly varies with various grades of DR. The mean CMT is also increased in patients with diabetic macular edema (DME) and panretinal photocoagulation (PRP) untreated DR as compared to diabetics without DME and PRP treated DR respectively.

Conclusion: Central macular thickness can be used as an indicator to monitor individuals with diabetes as it increased in diabetics and the presence of macular edema decreased in PRP treated eyes. It also varies with various grades of DR.

1. Introduction

Diabetic retinopathy is a common sight threatening retinopathy that occurs due to abnormalities of the retinal blood vessels and capillaries in a person with diabetes. It is a leading cause of vision loss across the world.[1,2] The development of proliferative retinopathy and macular edema among diabetics are the most important causes of impaired vision.

The macula at the center is the most sensitive part of the retina responsible for the changes in vision. In patients with diabetes, breakdown of the inner blood retinal barrier results in outpourings, leakage and accumulation of lipid exudates within the layers of the retina which end up causing macular edema. This certainly is considered the most important contributing factor to reduced visual acuity in diabetic retinopathy (DR). Therefore, it is crucial to assess central macular thickness.[3]

Until recently, slit-lamp bio-microscopy and stereoscopic photography were the available methods to evaluate macular thickness, but these methods did not provide a quantitative assessment of macular thickness. Recently, newer methods like optical coherence tomography (OCT) have emerged for measuring retinal thickness.[4–9] OCT is a diagnostic technique that provides high-resolution cross-sectional imaging of the retina that comes up with consistent and

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https://doi.org/10.18231/j.ijceo.2023.063

quantitative data on retinal thickness. It is being employed for the quantitative determination of macular edema in various diseases.[10] In the given study we employed OCT to measure the central macular thickness (CMT), with the following aims: 1) to compare CMT in diabetics and age matched healthy controls; 2) to compare CMT in diabetics with and without retinopathy; 3) to assess the relationship in diabetic patients between CMT and stage of DR and diabetic macular edema (DME); 4) to compare CMT in treatment naïve DR and PRP treated DR patients who had history of last PRP session of more than 3 months after three months of PRP.

2. Materials and Methods

All patients with diabetes coming to ophthalmic OPD at a tertiary care center in central India from February 2019 to August 2020 who fulfilled the described inclusion criteria as well as met no exclusion criteria were involved in this study.

2.1. Inclusion criteria

1. Age more than or equal to 18 years.
2. Known diabetic with or without diabetic retinopathy(FBS≥120, PPBS≥180).
3. Age matched healthy controls.

2.2. Exclusion criteria

1. History of vitreoretinal surgery
2. Vitreoretinal disorders other than diabetic retinopathy currently or in the past.
3. Cataract surgery in the past 6 months.
4. Spherical equivalent of refractive error more than or equal to +/- 6D.
5. Any media opacity likely to cause attenuation of signal strength in OCT.
6. Signal strength <6/10 in OCT.
7. PRP treated within 3 months
8. History of intravitreal anti-VEGF.

After taking a written informed consent, a comprehensive history was taken which included detailed ocular and systemic (duration of diabetes and antidiabetic medication) history, demography (age, sex) laterality, systemic co-morbidities (hypertension, kidney disease). General examination and systemic examination of associated systemic diseases was done.

All patients underwent recording of BCVA, IOP evaluation by noncontact tonometer, and evaluation of both anterior and posterior segments using slit-lamp bio-microscope with a +90D lens which is being done after dilating the pupil with Tropac-P eye drops. Digital fundus photography, fundus fluorescein angiography, and OCT using cirrus HD OCT Model 500 were done and relevant investigations were advised.

Patients were categorized as per the classification given by ETDRS, categorizing diabetic Retinopathy into mild, moderate and severe non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). Each patient with diabetic retinopathy was also grouped on the basis of whether they have diabetic macular edema (DME) or not. Patients were also divided into PRP untreated DR and PRP treated DR with history of last session of PRP of more than 3 months.

The CMT was measured using the SD-OCT technique. For quantitative estimation, the macula is divided into 9 ETDRS type regions each having a diameter of 500μm with an inner and outer ring, each of which is further partitioned into four quadrants, having outer radii of 1DD and 2DD respectively. The software in OCT identifies the inner and outer boundaries of the retina automatically and generates a pseudo color-scaled topographic map defining regions of increased thickness and decreased thickness in brighter and darker colors respectively. Both horizontal and vertical scans passing through the center of macula were analyzed. (Figure 1)

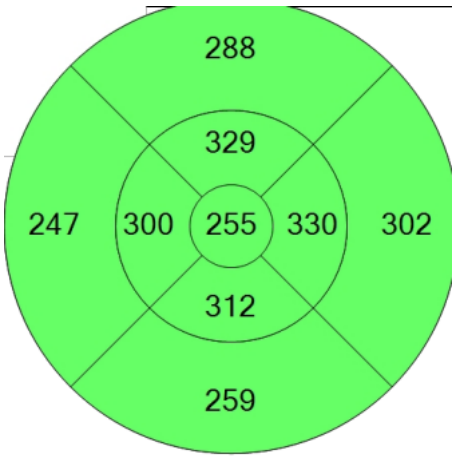


Fig. 1: OCT image of mild NPDR

2.3. Statistical analysis

The confined data was laid in MS Excel on a computer and the analysis was done using SPSS (Statistical Package for the Social Sciences version 20) for statistics. Student t-test and one-way ANOVA were applied to analyze quantitative variables.

3. Result

During the course of the study, a total of 400 eyes of 200 patients were included in the study which was categorized as 320 eyes of patients having diabetes and 80 eyes of age matched healthy controls.

Three twenty eyes were divided on the basis of severity of diabetic retinopathy into diabetics with no diabetic retinopathy (50 eyes), mild NPDR (60 eyes), moderate NPDR (62 eyes), severe NPDR (70 eyes), PDR (48 eyes) and PRP treated DR (30 eyes).

On the basis of the presence of macular edema patients were categorized as 75 eyes with DME and 195 eyes without DME.

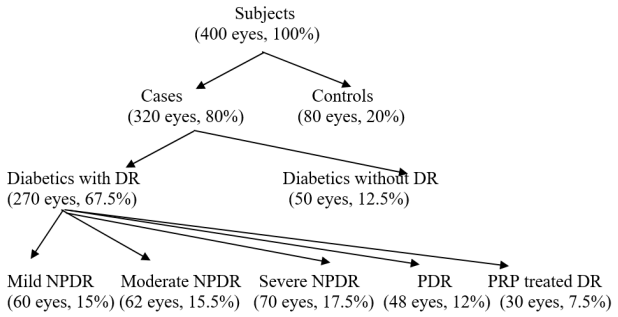
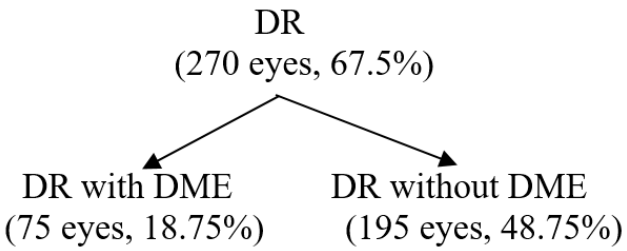


Fig. 2: Shows the distribution of patients



The base line features of cases and controls including mean age, sex, duration of diabetes and mean BCVA were measured.

The mean CMT in patients with a history of diabetes was 291.28 ± 105.98μm and in age matched healthy controls was 231.29 ± 6.40 μm. While comparing both the groups it was significantly greater in patients with diabetes as compared to healthy controls with p value<0.001.(Table 1)

Table 1: Shows central macular thickness according to the presence of diabetes mellitus

Group (n=400)	CMT (Mean ± SD)	p value
Non-diabetic (n=80)	231.29 ± 6.40	<0.001
Diabetic (n=320)	291.28 ± 105.98	

When CMT was compared in diabetics with and without DR, it was found to be significantly greater in eyes with DR (mean CMT=301.6 ± 112.37μm) as compared to eyes with no DR (mean CMT=235.56 ± 7.15μm) with p value <0.001.(Table 2)

Table 2: Shows central macular thickness according to the presence of diabetic retinopathy

Group (n=320)	CMT (Mean ± SD)	p value
DR Absent(n=50)	235.56 ± 7.15	<0.001
DR Present(n=270)	301.60 ± 112.37	

As mentioned above diabetic retinopathy was divided into various grades according to severity of DR. CMT was measured in various grades and the mean CMT values in no DR, mild NPDR, moderate NPDR, severe NPDR and PDR were 235.56 ± 7.15 μm, 297.83 ± 125.47 μm, 288.79 ± 119.98 μm, 339.26 ± 117.98 μm and 307.88 ± 90.88 μm respectively with all were having a p value<0.001 and it was decreased in the order as severe NPDR, PDR, mild NPDR, moderate NPDR and no DR. (Table 3)

Table 3: Shows central macular thickness according to the severity of diabetic retinopathy

Group (n=400)	CMT (Mean ± SD)	
Non-diabetics (n=80)	231.29 ± 6.40	
Diabetics with no DR(n=50)	235.56 ± 7.15	p value <0.001
Mild NPDR (n=60)	297.83 ± 125.47	
Moderate NPDR (n=62)	288.79 ± 119.98	
Severe NPDR (n=70)	339.26 ± 117.98	
PDR(n=48)	307.88 ± 90.88	
PRP treated DR (n=30)	237.70 ± 14.86	

While assessing CMT in diabetic patients with and without DME, it increased significantly in eyes with DME (mean CMT=448.96 ± 121.98μm) as compared to eyes without DME (mean CMT=243.01 ± 13.82 μm) with p value<0.001. (Table 4)

Table 4: Shows central macular thickness according to the presence of diabetic macular edema

Group(n=320)	CMT (Mean ±SD)	p value <0.001
DME Absent(n=195)	243.01 ± 13.82	
DME Present(n=75)	448.96 ± 121.98	

CMT was also assessed in PRP untreated DR and PRP treated DR, the mean CMT values in PRP untreated DR and PRP treated DR were 309.59 ± 116.66μm and 237.70 ± 14.86 μm respectively. It was significantly decreased in PRP treated DR as compared with PRP untreated DR with p value<0.001.(Table 5)

4. Discussion

Diabetic retinopathy is potentially a complication of diabetes mellitus causing blindness. The causes of visual loss are diabetic maculopathy and the complications of

Table 5: Shows central macular thickness in diabetic retinopathy patients with or without intervention (PRP)

Group (n=320)	CMT (Mean ± SD)	p value <0.001
PRP untreated DR (n=240)	309.59 ± 116.66	
PRP treated DR(n=30)	237.70 ± 14.86	

PDR like vitreous hemorrhage, neovascular glaucoma and tractional retinal detachment.[11]

The macula, at the center is the most sensitive part of the retina responsible for changes in vision. In patients with diabetes, the breakdown of inner blood retinal barrier results in outpourings, seepage and accumulation of lipid exudates within the layers of the retina resulting in macular edema. This is certainly considered as the major contributing factor of diminution of vision in diabetic retinopathy. Therefore, it is crucial to assess central macular thickness.[3]

OCT has evolved as a crucial technique that aids in the assessment as well as the management of retinal disease. Its noninvasive character and ability to do in vivo imaging of intraocular structures with a resolution closer to that of histological sections, has made it very useful particularly in detecting and quantifying macular pathologies.

While comparing the CMT in diabetics with age matched healthy controls it was found to be significantly greater in diabetics (mean CMT=291.28 ± 105.98μm) as compared to healthy controls (mean CMT=231.29 ± 6.40 μm) with p value<0.001. Abrar F et al[3] found the results comparable to our study. Demir M et al[12] found no significant difference between the two groups.

In diabetics, the increase in macular thickness in comparison to the healthy control, could be depicted by seeing the pathophysiology of DR. The changes in the glucose metabolism are responsible for the alterations in the capillary walls of retinal blood vessels that sequentially destroy blood retinal barrier that further leads to hemorrhages and leakage of exudates that can be seen by OCT as a detectable thickening of the retina.

While comparing CMT in diabetics with and without DR, it showed significantly greater values in eyes with DR as compared to eyes with no DR.

As mentioned above diabetic retinopathy was divided into various grades according to severity of DR. The mean CMT values significantly decreased in the order as severe NPDR, PDR, mild NPDR, moderate NPDR and no DR. Abrar F et al[3] found that CMT increases with increasing severity of DR.

The exact reason for the differences in findings of our study and previously done study is not known. The maximum CMT in severe NPDR might be due to presence of maximum number of patients having DME in this group in our study because when mean CMT in eyes with severe NPDR without DME compared with PDR without DME, it was found to be significantly greater in eyes with PDR without DME (mean CMT=264 ± 7.07 μm) than in eyes with severe NPDR without DME (mean CMT=255.89 ± 6.97 μm).

When CMT was compared in diabetic patients with and without DME, it was increased significantly in eyes with DME as compared to eyes without DME. Sudhalkar A et al[13] noticed similar findings as found in our study.

While assessing CMT in PRP untreated and PRP treated DR, it was significantly decreased in PRP treated DR as compared with PRP untreated DR. Mukhtar A et al[14] observation was consistent with our study. Lee SB et al[15] showed observation against our study.

5. Limitations

1. Owing to the smaller sample size generalizability of the results is not feasible for the diabetic population.
2. Type 1 or type 2 diabetes were not distinguished, which vary in pathophysiology and treatment that might lead to variation in macular thickness measurements.
3. The duration of diabetes, the type and dosage of systemic treatment and the presence of diabetic nephropathy has not been considered in this study.

6. Conclusion

In conclusion, the central macular thickness can be used as an indicator to monitor diabetic individuals as it is increased in diabetics, and the presence of macular edema is decreased in PRP treated eyes. It also varied with different grades of DR.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Cite this article: Gupta S, Rajpoot MS, Aloney S, Chouhan P, Tyagi M. The relationship of central macular thickness with clinical grades of diabetic retinopathy. *Indian J Clin Exp Ophthalmol* 2023;9(3):334-338.