Optical Coherence Tomography Changes in High Myopia

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ABSTRACT

BACKGROUND

Myopia affects a significant proportion of population, particularly in the Asian countries. When the dioptric power of the eye is more than -6 diopters it is known as high myopia or pathological myopia. Only few studies have evaluated possible structural changes in the retina in individuals with high myopia without clinically overt retinal disease. With the new modalities like optical coherence tomography it is possible now to study the microscopic anatomy in detail. Moreover, it is an outdoor non-invasive procedure. A basic understanding of colour coding of normative data in programme macular cube and disc cube is a must.

METHODS

This study was carried out on 74 patients (148 eyes) with high myopia (≥-6.00 D) who had undergone OCT scan during the period from Dec 2017 To Nov 2018 at Baroda Medical College. All the patients were included on the basis of their diopteric power and all the patients having any local or systematic comorbidity were excluded. All the patients having history of any eye surgery or any intervention in the globe e.g. intra vitreal injection or Lasik surgery were excluded.

RESULTS

Out of 148 eyes of all patients all had high myopia in diopters from -6 to <-7 with following data. Total 10 (13.15%) eyes & 28 (36.84%) eyes were detected in yellow zone of ILM RPE thickness average & average RNFL thickness respectively. Out of 148 eyes 30 eyes had high myopia in diopters from -7 to <-8 with following data. Total 10 (33.33%) eyes were detected in yellow zone of average RNFL thickness. Which suggests, with increase in diopters of myopia, macular & RNFL thickness starts to decrease as well. Our study results were consistent with the study from Korea which is considered to be a landmark study.

CONCLUSIONS

With increase in diopters of myopia macular and RNFL thickness starts decreasing. So, in a nutshell, OCT is a very important tool in screening the high myopic patients and seeing the structural changes before their clinical signs appear.

KEYWORDS

Myopia, Optical Coherence Tomography, Retinal Nerve Fibre Layer, Internal Limiting Membrane

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BACKGROUND

Myopia affects a significant proportion of population, particularly in the Asian countries. Few studies have evaluated possible structural changes in the retina in individuals with moderate to high myopia without clinically overt retinal disease.[1] Eyes with refractive error -6D or more are said to be high myopia.[2] The histopathological changes that accompany high myopia are well documented.[3-5] Contrary to histologic findings and clinical observations that retinal thinning or chorioretinal atrophy is more common in myopia.[6-7] The correlation between average macular thickness and myopia has been found to be insignificant in previous in vivo imaging (nerve fibre analyser) studies.[8,9] Since its introduction in 1991 by Huang et al[10] the Optical Coherence Tomography (OCT) has become one of the most widely used equipment for assessing the fovea and peripapillary nerve fibre layer. In this study OCT is used to collect the normographic data of high myopes of ≥6D with respect to thickness of macular region & Retinal Nerve Fiber Layer (RNFL), so as to interpret and distinguish the findings of high myopia.

Under ideal conditions, Optical Coherence Tomography (OCT) can quantify the thickness of the retina with a resolution of 8 to 10 µm. OCT uses low coherent interferometry to interpret reflectance data and measure retinal nerve fibre layer thickness and macular thickness. All this emphasizes the need to detect changes in the macula accurately at an early stage. If there is even a glimpse of retinal change because of Myopia, OCT can detect them at very early stage at histopathological level before these changes becomes visible on simple ophthalmoscopy.

Objectives

1. Distribution of eyes according to OCT findings.
2. Interpretation of abnormal OCT findings with degree of myopia.
3. Interpretation of subnormal OCT findings with degree of myopia.

METHODS

This is cross sectional study of 74 patients (148 eyes) with high myopia (≥-6.00 D). This study was carried out at the Department of Ophthalmology, Medical College Baroda & SSG Hospital of Baroda on 74 patients (148 eyes) with high myopia (≥-6.00 D) who had undergone OCT scan at GMERS Medical College Gotri & Hospital of Baroda, during the period from DEC 2017 to NOV 2018. Ethical committee approval was taken before starting the study.

Selection of Cases

Patients from Outpatient department of ophthalmology of SSG Hospital with age from 12-40 years of either sex with High Myopia (≥-6.00 D) were included in the study**.** The patients with a significant systemic or ophthalmic comorbidity like glaucoma, cataract, uveitis, retinal detachment, diabetic retinopathy and age related macular degeneration etc. were excluded. All the patients having history of any eye surgery or any intervention in the globe e.g. intra vitreal injection or Lasik surgery were excluded. All the patients were examined in torch light and slit lamp for anterior segment. Visual acuity was checked on Snellen's chart. Intraocular pressure was checked with applanation tonometer. Fundus was examined both on direct and indirect ophthalmoscope with fully dilated pupil and then OCT was performed.

OCT Scan

- Tropicamide + Phenylephrine combination dilator eye drops were used if high myopic patient were unable to fixate during OCT Examination.
- Both of the eyes were scanned by OCT as in-
  - Scan of Macular Cube 512*128.
  - Scan of Optic Disc Cube 200*200.
- The findings were tabulated as macular thickness & RNFL thickness on a specially prepared proforma and various parameters were studied.
- Normative database uses colour code to indicate normal distribution percentiles.

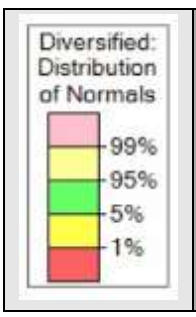

Figure 1. Distribution of Normals in OCT Macular Cube 512*128

Of the Normal Population-

- 1% fall in pink band (outside normal limits towards thickest).
- 4% fall in faded yellow band (within supranormal limits).
- 5 to 95% fall in green band (within normal limits).
- 4% fall in darker yellow band (within subnormal limits).
- 1% fall within red band (outside normal limits towards thinnest).

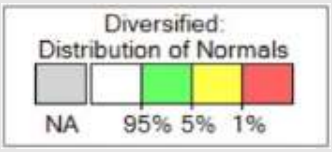

Figure 2. Distribution of Normals in OCT Optic Disc Cube 200*200

Of the Normal Population-

- 5% fall within the white band (thickest than normal limits).
- 5 to 95% fall within the green band (within normal limits).

- 1 to 5% fall within the yellow band (within subnormal limits).
- 1% fall within the red band (outside normal limits towards thinnest).

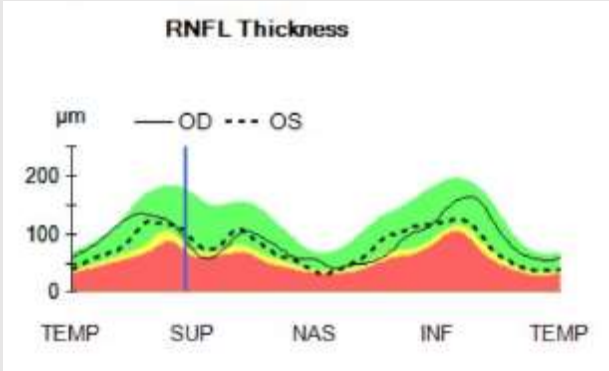

Figure 3. RNFL Thickness

- Separate RNFL-TSNIT normative data graph for right & left eyes.
- The graph is superimposed against the colour codes.
- If the graph dips into red colour in any quadrant, the neuro-retinal rim thickness & RNFL thickness in that quadrant is not normal.

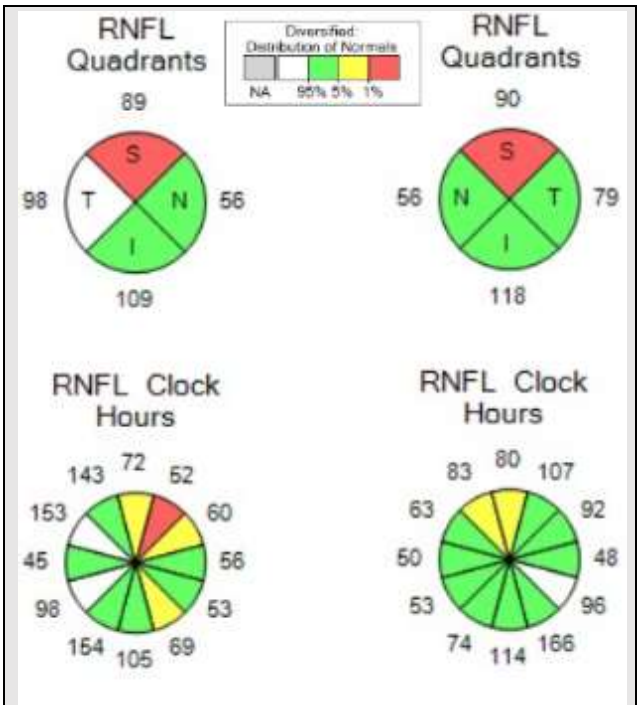

Figure 4

- Displays average RNFL thickness along the whole calculation circle (squares in the print out as well as quadrant & clock hour measurements).
- These measures are represented in pseudo colour coded programs by comparing the measured RNFL thickness to age-matched data in the normative database of the OCT machine.
- Green & white colours indicate normal RNFL Thickness (white colour means thickest).

RESULTS

Present Study included 148 eyes of 74 patients who were examined. All the patients were myopic in both of the eyes.

Age Group (Years)	No. of Cases (%)
11-15	0 (0)
16-20	16 (21.62)
21-25	43 (58.10)
26-30	9 (12.16)
31-35	0 (0)
36-40	6 (8.10)

Table 1. Age Distribution

N=74

The majority of the patients were in the age group 21-25 years (58.10%).

- No cases were in 11-15 years of age group.
- 16 cases were in 16-20 years of age group.
- 43 cases were in 21-25 years of age group.
- 9 cases were in 16-20 years of age group.
- No cases were in 31-35 years of age group.
- 6 cases were in 36-40 years of age group.

Age Group	Male	Female
11-15	0	0
16-20	6	10
21-25	24	19
26-30	6	3
31-35	0	0
36-40	3	3
Total	39	35
Percentage (%)	52.70	47.30

Table 2. Gender Distribution

Out of 74 patients, majority 39 (52.7%) were males and 35 (47.30%) were females.

- In 11-15 years there were no patients.
- In 16-20 years, there were 6 males & 10 females.
- In 21-25 years, there were 24 males & 19 females.
- In 26-30 years, there were 6 males & 3 females.
- In 31-35 years there were no patients.
- In 16-20 years, there were 3 males & 3 females.

Interpretation		OCT Findings		
		ILM RPE Thickness Central	ILM RPE Thickness Avg.	Avg. RNFL Thickness
Red Zone	OD	8	27	17
	OS	6	28	14
Total Eyes (%)		14 (9.45)	55 (37.16)	31 (20.94)
Yellow Zone	OD	2	8	26
	OS	4	8	27
Total Eyes (%)		6 (4.05)	16 (10.81)	53 (35.81)

Table 3. Distribution of No. of Eyes According to OCT Findings

ILM RPE central thickness detected in (red zone) in 14 (9.45%) eyes & in (yellow zone) in 6 (4.05%). That means out of all 148 eyes examined only 9.45+4.05=13.5% were having central foveal thickness in red & yellow zone & the rest of them 86.5% had normal or supra normal central foveal thickness which was detected in green zone.

Out of 148 eyes 128 eyes had high myopia in diaopters from -6 to -8.99 with following data

- Total 10 (7.81%) eyes & 39 (30.46%) eyes & 25 (19.53%) eyes were detected in red zone of ILM RPE

central thickness, average ILM RPE Thickness & average RNFL thickness respectively.

Myopia in Diopters	No. of Eyes in Red Zone ILM RPE Thickness Central	ILM RPE Thickness Avg	Avg. RNFL Thickness
-6 TO -8.99 N=128 (%)	10 (7.81)	39 (30.46)	25 (19.53)
-9 TO -11.99 N=16 (%)	2 (12.5)	13 (81.25)	3 (18.75)
-12 TO -14.99 N=1 (%)	0 (0)	1 (100)	1 (100)
-15 TO -17.99 N=1 (%)	0 (0)	0 (0)	1 (100)
-18 TO -20.99 N=2 (%)	2 100)	2 (100)	1 (50)

Table 4. Interpretation of Abnormal OCT Findings with Degree of Myopia

Out of 148 eyes 16 eyes had high myopia in diaopters from -9 to -11.99 with following data

- Total 13 (81.25%) eyes were detected in red zone of ILM RPE average thickness.

Which suggests, with increase in diopters of myopia, macular & RNFL atrophy dominates.

Myopia in Diopters	No. of Eyes in Yellow Zone ILM RPE Thickness Central	ILM RPE Thickness Avg.	Avg. RNFL Thickness
-6 TO <-7 N=76 (%)	4 (5.26)	10 (13.15)	28 (36.84)
-7 TO <-8 N=30 (%)	(3.33)	2 (6.66)	10 (33.33)
-8 TO <-9 N=22 (%)	(4.54)	3 (13.63)	9 (40.90)
-9 To <-10 N=8 (%)	0(0)	1 (12.5)	6 (75)

Table 5. Interpretation of Subnormal OCT Findings with Degree of Myopia

Out of 148 eyes 76 eyes had high myopia in diaopters from -6 to <-7 with following data

- Total 10 (13.15%) eyes & 28 (36.84%) eyes were detected in yellow zone of ILM RPE thickness average & average RNFL thickness respectively.

Out of 148 eyes 30 eyes had high myopia in diaopters from -7 to <-8 with following data

- Total 10 (33.33%) eyes were detected in yellow zone of average RNFL thickness.

Which suggests, with increase in diopters of myopia, macular & RNFL thickness starts to decrease as well.

DISCUSSION

Degenerative myopia also called pathologic or high myopia is defined as a myopic refractive error of more than -6 diopters (D) associated with degenerative fundus changes. The main feature of degenerative myopia is a congenital scleral weakness leading to progressive globe enlargement, axial lengthening, and finally the formation of posterior staphyloma. Following this scleral stretching, degenerative changes such as progressive atrophy of the choriocapillaris and choroid, linear ruptures of the Bruch membrane (lacquer cracks), and retinal thinning can occur. Other typical features of degenerative myopia are vitreous degeneration and high frequency of peripheral retinal lesions such as lattice degeneration and retinal tears.

Majority of the patients of high myopia in our study were young i.e. in an age group of 21 to 25 years. The males were having a little more prevalence of high myopia as compare to females Optical coherence tomography (OCT) has recently made it possible to explore changes in retinal layers in vivo as axial myopia progresses and the globe is stretched. If there is even a glimpse of retinal change because of Myopia, OCT can detect them at very early stage at histopathological level before these changes becomes visible on simple ophthalmoscopy.

This data correlates with study done on 50 high myopic & 40 emmetropic eyes by Abdul Waris et al.[11] suggested that the central foveal thickness was more in the myopes as in our study 86.5% had normal or supranormal central foveal thickness detected in green zone. ILM RPE average thickness detected in (red zone) in 55 (37.16%) eyes & in (yellow zone) 16 (10.81%) eyes. That means out of all 148 eyes examined 37.16+10.81=47.97% were having average foveal thickness in red & yellow zone & rest of them 52.03% had normal or supranormal average foveal thickness which was detected in green zone. This data correlates with study done on 50 high myopic & 40 emmetropic eyes by Abdul Waris et al.[11] suggested that the parafoveal retinal thickness was significantly thin in myopic eyes as compared to emmetropic eyes.

In spite of the variation in mean thicknesses the conclusion remains same as other study if we neglect numerical mean values Average RNFL thickness detected in (red zone) in 31 (20.94%) eyes & (yellow Zone) in 53 (35.81%) eyes. That means out of all 148 eyes examined 20.94+35.81=56.75% were having average RNFL thickness in red & yellow zone & rest of them 43.25% had normal or supranormal average foveal thickness which was detected in green zone. This data correlates with study done on 269 subjects emmetropic eyes by Shin Hee Kang et al.[12] In korea suggested that high myopia group had significantly lower peak RNLF thicknesses.

Study done by Abdul Waris et al. (2015) the macular thickness of 50 highly myopic eyes and 40 control (emmetropic) eyes from a north Indian patients were measured using the OCT. All highly myopic patients selected for the study had a spherical equivalent of > -6.0 D. None of the patients included in the study had evidence of concomitant ophthalmic disease and none had undergone refractive surgery. The overall mean macular thickness in the myopic groups and control were 262.98 (±24.98) µm and 290.92 (±11.54) respectively. The total macular thickness was less in myopic eyes as compared to emmetropic eyes. But in contrast, the central foveal thickness was 265.43 (±32.69) µm in myopes and 235.95 (±21.91) µm in emmetropes. The parafoveal retinal thickness was significantly thin in myopic eyes as compared to emmetropic eyes. Whereas central foveal thickness more in the myopes. Total macular thickness was significantly decreased in myopic eyes as compared to emmetropic eyes. However central (foveal) thickness was significantly high in high myopes as compared to emmetropes. Central foveal

thickness increase in high myopes may be confused with retinoschisis / retinal edema.

There are many studies in the literature which has emphasized the role of oct in the early diagnosis of vitreo retinal interphase, thickness of macula and retinoschisis associated with high myopia. Though oct is an expensive instrument but it is a very useful tool in ophthalmology specially in diagnosis of a lots of anterior and posterior segment diseases including high myopia.

CONCLUSIONS

With increase in diopters of myopia, macular and RNFL thickness starts decreasing. So, in a nutshell, OCT is a very important tool in screening the high myopic patients, and seeing the structural changes before their clinical signs appear. However, larger studies are required to establish a perfect correlation between the two.

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