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Original Research Article

Detection of macular findings in highly myopic eyes with OCT and to correlate it to various visual parameters

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ABSTRACT

Background: High myopia is when axial length is more than >26 mm and refractive error of atleast 6.00 diopters (D). The definition of pathologic myopia in early studies was not consistent. It revolved around a combination of refractive error and axial length, which simply suggests high myopia.
Aim: To study the pathological findings in subjects with high axial myopia and their relationship with other visual parameters.
Materials and Methods: In this crosssectional analytical study, 200 eyes from 100 patients were studied. Fundus was evaluated with indirect ophthalmoscope. After pupillary dilatation, multiple OCT scans were performed across the macula area centering the fovea with the help of SD-OCT
Results: SD OCT revealed that 46% had normal appearance. Among pathological findings, most common was CNV (10%). Other findings were lamellar macular hole (7%), full thickness macu lar hole (7%), retinal detachment (3%), epiretinal membrane (3%), traction maculopathy (4%), PVD (8%), dome shaped macula (8%)and posterior staphyloma (4%).
Fifty four percent eyes had one or more fundus changes observed by bio-microscopy. Most common findings were lattice degeneration (33.33%) and WWP & WWOP (25%). Other findings were posterior staphyloma (7.41%), retinal detachment (5.51%), Chorioretinal degeneration (11.11%), macular hole (8.3%), PVD (3.70%), Retinal hole (0.92%), maculopathy (0.97%) and CNV (3.70%).
Conclusion: OCT can be done in a healthy high myopic population and in symptomatic myopic population who complains of worsening of visual function to look for epiretinal and/or vitreoretinal traction and related macular damage.

1. Introduction

Myopia is an important and usually underestimated eye disease. Although impaired vision caused by myopia can be corrected with visual aids, such as glasses, contact lenses, or refractive surgery, it is still the major cause of visual impairment globally.

Myopia is classified into two groups: non-pathologic and pathologic myopia. These groups have different disease processes, clinical features, and prognosis. Non-pathological myopia is also termed as physiological, simple or school myopia. In non-pathologic myopia development of the refractive structures is within normal limits, but the refractive power of the eye does not correlate with the axial length.

High myopia is when axial length is more than >26 mm and refractive error of at least 6.00 diopters (D). The definition of pathologic myopia in early studies was not consistent. It revolved around a combination of refractive error and axial length, which simply suggests high myopia.

Features of Pathological Myopia are

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Myopic conus/crescent - Peripapillary scleral expansion leads to a sharply defined concentric area of depigmentation adjacent to the optic disc where the inner surface of sclera is visible. Based on the extent, it can be a temporal conus, nasal conus, inferior conus, or annular conus.

Super traction - It occurs due to dragging of retinochoroidal tissue over the nasal edge of optic disc with expansion of posterior pole.

Tessellation - Generalized depigmentation due to RPE atrophy leads to a tigroid appearance of the fundus.

Posterior Staphyloma (Scarpa's Staphyloma) - It is an outward protrusion of all coats of the posterior pole and is considered pathognomonic of PM. In pathological myopia, the sclera becomes abnormal. In Histopathological study, the collagen bundles in the sclera seems to be thinner, with only few striations of collagen present.

Macular Chorioretinal Atrophy - Chorioretinal atrophy occurs as a result of progressive thinning of the choroid, disappearance of choroidal vessels, and loss of RPE and photoreceptors.[1]

Lacquer Cracks - Lacquer cracks are formed as a result of linear breaks in the Bruch's membrane. The breaks occur usually at the posterior pole. The overlying neuroretina seems to be normal.

Forster-Fuchs' Spot - Forster-Fuchs' spot appears as elevated, round or elliptical area which is pigmented.

Myopic Choroidal Neovascular Membrane - It is a major cause of vision loss subsequent to PM. Myopic CNV tends to be small and thus about 20% of them was extrafoveal.[2] Most of them are type II CNV, above the RPE. Myopic CNV progresses through three phases in natural course as well as after treatment; active phase, scar phase, and atrophic phase (also known as myopic CNV-related macular atrophy).

Retinal and Macular Hole/Schisis/ Detachment: Changes occurs at the vitreoretinal interface on posterior pole may appear as macular hole. This can result in retinal detachment in patients with high myopia Vector forces resulting from axial elongation or staphyloma formation increases liquefaction of vitreous with atrophy of the chorioretinal complex which can result in the formation of a macular hole.

Dome-shaped Macula - it is the covex protrusion of eyeball towards vitreous seen at macular area.

Optical coherence tomography (OCT) has become a prominent biomedical tissue-imaging technique due to micrometer resolution and cross-sectional imaging capabilities; it is particularly suited to ophthalmic applications and other tissue imaging requiring micrometer resolution and millimeter penetration depth. OCT has advantages over the other medical imaging systems. Medical ultrasonography and magnetic resonance imaging (MRI) have poor resolution, and confocal microscopy lacks millimeter penetration depth. So these three are not suited to morphological tissue imaging.

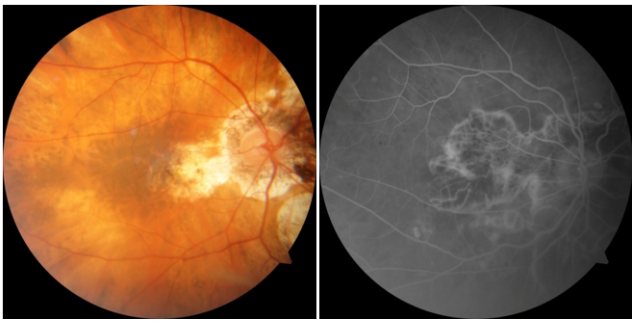

Fig. 1: Fundus photograph and FFA image of 49 year male with CNVM

2. Materials and Methods

This cross-sectional analytical study was done in the Department of Ophthalmology, J.L.N. Medical College, Ajmer, Rajasthan. One hundred consecutive eligible subjects were recruited from the OPD from November 2019 to November 2021.

2.1. Inclusion criteria

1. Bilateral patients
2. Eyes having refractive error of atleast -6 diopter.
3. Axial length atleast 26 mm.

2.2. Exclusion criteria

1. Age less than 10 year.
2. Opaque media.
3. Pseudophakic eyes with/without Yag laser capsulotomy.
4. Eyes that had undergone peripheral laser or cryopexy treatment.

All the patients attending the OPD during study period were screened for eligibility by the investigator. After obtaining written informed consent from the eligible subjects, data collected using pre-tested, interviewer administered Proforma. All participants underwent complete ophthalmic examinations.

The examination includes-

1. Visual acuity measurement (uncorrected & best corrected visual acuity) using Snellen's Chart.
2. Refraction by retinoscopy and auto-refractometer.
3. Intraocular pressure measurement by schiotz tonometer and Goldmann's Applanation Tonometer.
4. Slit Lamp bio-microscopy with help 90 D lens
5. Dilated fundus examination by indirect ophthalmoscope with 20 D lens and direct ophthalmoscope.
6. Measurement of the axial length by A-scan ultrasound biometry and b scan.

All patients were dilated with tropicamide 1% eye drops. After dilatation, multiple OCT scans were done across the macula area centering fovea with the help of SD-OCT. All scans were done by one person.

3. Result

A total of 200 eyes of 100 patients were studied. In my study there were 53 males and 47 females. The patients mean age (SD) was 34.09 (18.21) years, ranging from 11 to 74 years. Nearly one fifth had history of high myopia. Presenting distant visual acuity ranges from more than 6/60 to PR inaccurate with PL positive. Most of the patients had visual acuity of 6/60 to 5/60.

Fifty four percent eyes had one or more fundus changes observed by bio-microscopy. Most common findings were lattice degeneration (33.33%) and WWP & WWOP (25%). Other findings were posterior staphyloma (7.41%), retinal detachment (5.51%), Chorioretinal degeneration (11.11%), macular hole (8.3%), PVD (3.70%), Retinal hole (0.92%), maculopathy (0.97%) and CNV (3.70%).

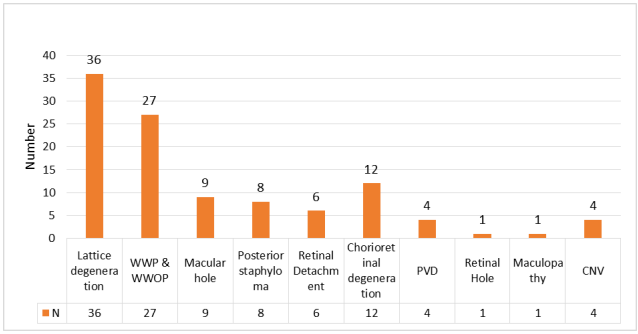

Fig. 2: Distribution of fundus findings among high myopic eyes (n=108)

SD-OCT revealed that 46% had normal appearance. Among pathological findings, most common was CNV (10%). Other findings were lamellar macular hole (7%), full thickness macular hole (7%), retinal detachment (3%), epiretinal membrane (3%), macular traction maculopathy (4%), PVD (8%), dome shaped macula (8%) and posterior staphyloma (4%).

It shows mean (SD) macular thickness was 213.86 (35.28) μ, whereas mean (SD) foveal thickness was 174.71 (19.39) μ. On one-way ANOVA analysis, it shows difference in mean macular thickness across the refractive error categories was statistically significant.

It shows both mean macular thickness and mean foveal thickness were not statistically significant with visual acuity categories on one- way ANOVA analysis.

4. Discussion

Optical coherence tomography (OCT) has become a prominent biomedical tissue-imaging technique due

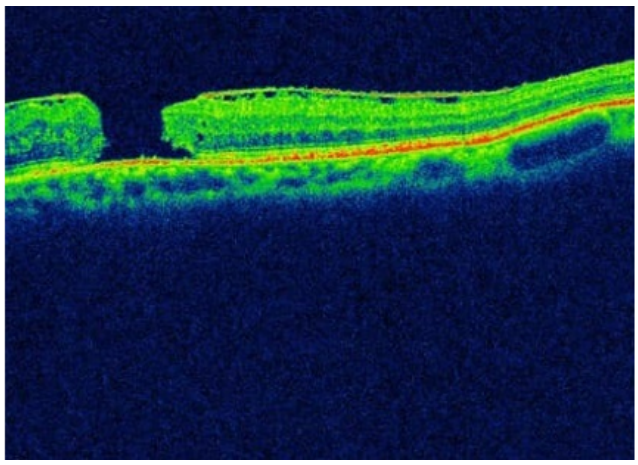

Fig. 3: OCT image showing: Epiretinal membrane with macular hole in left eye of 65 year highly myopic female

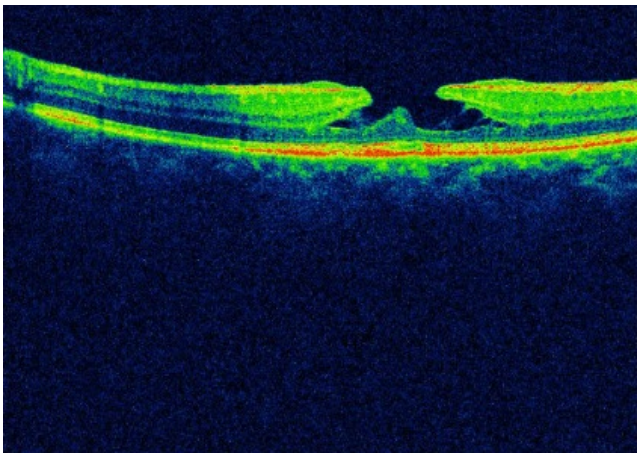

Fig. 4: OCT image showing lamellar macular hole in left eye of 60 year old highly myopic male patient

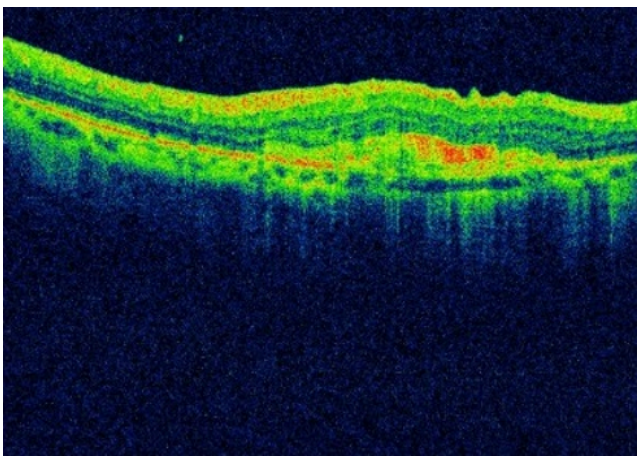

Fig. 5: OCT image showing CNVM in highly myopic left eye of 65 year old female patient

Table 1: Macular and foveal thickness across the refractive error categories

Refractive error	Number of eyes	Macular thicknessMean (SD) μ	Foveal thicknessMean (SD) μ
All	200	213.86 (35.28)	174.71 (19.39)
6-12 D	117	222.21 (30.84)	172.21 (17.21)
12.5- 18 D	64	192.97 (36.56	177.92 (23.09)
>18 D	19	232.78 (23.72)	179.31 (16.87)
F- statistics		20.64	2.42
P- value		<0.01*	0.091

Table 2: Relationship between visual acuity and macular & foveal thickness by OCT

Refractive error	Number of eyes	Macular thicknessMean (SD) μ	Foveal thicknessMean (SD) *M*
All	200	213.86 (35.28)	174.71 (19.39)
>6/60	16	234.38 (14.91)	184.13 (8.84)
6/60 to 4/60	122	218.02 (29.41)	171.34 (20.80)
3/60 to 1/60	48	208.08 (34.13)	175.58 (25.52)
HM to PL positive	14	210.00 (21.89)	184.43 (16.76)
F- statistics		1.81	1.52
P- value		0.151	0.212

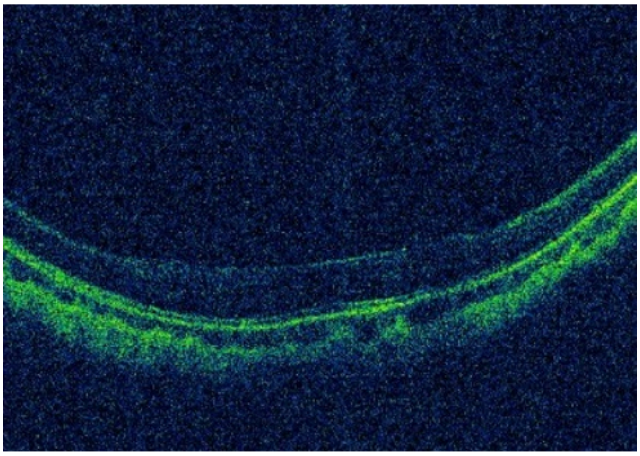

Fig. 6: Posterior staphyloma in right eye of 29 year highly myopic female patien

to micrometer resolution and cross-sectional imaging capabilities; it is particularly suited to ophthalmic applications and other tissue imaging requiring micrometer resolution and millimeter penetration depth. OCT has advantages over the other medical imaging systems. Medical ultrasonography and magnetic resonance imaging (MRI) have poor resolution, and 8 confocal microscopy lacks millimeter penetration depth. So these three are not suited to morphological tissue imaging.

In this study fifty-four percent eyes had one or more fundus changes observed by bio-microscopy. Most common findings in current study were lattice degeneration (33.33%) and WWP & WWOP (25%). Other findings were posterior staphyloma (7.41%), retinal detachment (5.51%), Chorioretinal degeneration (11.11%), macular hole (8.33%), PVD (3.70%), retinal hole (0.92%), maculopathy (0.92%) and CNV (3.70%). Whereas, Gomma et al found that all eyes had one or more chorioretinal features typical of degenerative myopia (tigroid fundus, stretched vascular arcades, peripapillary atrophy, chorioretinal atrophy, and lacquer cracks). On biomicroscopy, they observed complete posterior vitreous detachment with a Weiss ring which was mobile in the vitreous cavity was obvious in 15 eyes. Posterior staphyloma was detected in 75 eyes.[3]

Optical coherence tomography macular findings were recorded. We found that 46% eyes had normal appearance. Among pathological findings, most common was CNV (10%). Other findings were lamellar macular hole (7%), full thickness macular hole (7%), retinal detachment (3%), epiretinal membrane (3%), macular traction maculopathy (4%), PVD (8%), dome shaped macula (8%), posterior staphyloma (4%). Gomma et al found that ERM was present in 65 eyes in a study conducted with 100 eyes. Ten eyes had Vitreomacular traction. Macular retinoschisis was present in 33 eyes. Retinoschisis had multiple columnar structures as long straight highly reflective lines at the fovea. About ten eyes had lamellar macular hole and four eyes had full-thickness macular hole. Two eyes had posterior sensory retinal detachment. ILM detachment was present in seven eyes. Five eyes had dome shaped macula. Myopic CNV was present in 15 eyes. Atrophy of retinal layers was detected in 10 eyes.[3]

Viola et al (2016) reported that foveal subretinal detachment was the most common macular abnormality found in 17 eyes (32.7%) followed by CNV in 13 eyes (25.0%) then extrafoveal schisis in 5 eyes (9.6%) and finally foveoschisis in 2 eyes (3.8%).[4] Lichtwitz et al (2014) who reported that 39 out of 87 eyes (44.8%) had normal

macular appearance.[5] The difference between our study and these studies may be attributed to different population and difference in sample size. We didn't include psedophakic eyes, this might attribute to different findings in our study from these studies.

In a retrospective study by Panozzo G et al found epiretinal traction in 46.4% eyes and retinal damage in 34.4%, of which 87.7% had epiretinal traction. These authors used the term "MTM" to refer to these pathologies, such as macular retinoschisis, shallow retinal detachment without retinal holes, lamellar macular holes, and macular holes with or without retinal detachment.[6] Pannazo G et al, in 2007 reported that retinal damage due to high myopia is not a schisis, but rather due to retinal swelling with the accumulation of fluid.[7] In our study we found 4% cases of myopic traction maculopathy. Optical coherence tomography has shown that myopic maculopathy is not uncommon in highly myopic eyes in different studies.[8–10] Retinoschisis was detected in 9-34% of highly myopic eyes with a posterior staphyloma. Several OCT based studies revealed that strong traction on the retina exerted by residual posterior vitreous cortex, an ILM, retinal vessels, or a combination of these was attributed to myopic macular retinoschisis.[11–13]

Four percent eyes had posterior staphyloma in our study. It might be generated by axial length elongation and/or formation of posterior staphyloma in highly myopic eyes. This is also evident in 60 the remission of the retinoschisis after vitrectomy and ILM peeling, which releases the tractional forces caused by the posterior vitreous cortex and the ILM and partly by the retinal vessels.[14]

Several other studies had also attempted to determine the prevalence of macular changes in high myopia by OCT. Baba T et al studied 134 eyes of 78 consecutive patients with high myopia, with and without visual symptoms, attending a high myopia clinic in Tokyo. They found the prevalence for foveal retinal detachment of 9%. All eyes with foveal retinal detachment also showed severe myopic fundus changes (focal chorioretinal atrophy or bare sclera), with vision ranging from better than 20/50 to below 20/200. It also suggests that in eyes with shallow retinal detachments, oxygen and nutrient diffusion from the choriocapillaris to the photoreceptors might be sufficient, allowing the photoreceptors to survive to some extent.[15]

Takano et al reported a much higher prevalence of retinal detachment, with 34% of highly myopic eyes with posterior staphyloma showing foveal retinal detachment.[16] However, the study group was much smaller. They included only 32 eyes. They also included pseudophakic patients, who are at a greater risk of retinal detachment following cataract surgery. In our study, we didn't include pseudophakic cases.

In current study dome shaped macula was found in 8% eyes. Based on OCT, a dome-shaped macula was first described by Gaucher D et al. as an unexpected finding in myopic staphyloma. Authors characterized it as an inward convexity of the macula in highly myopic eyes within the concavity of a posterior staphyloma. They suggested that the dome-shaped macula may be the result of changes in choroidal thickness or to changes in scleral shape in highly myopic eyes.[17]

5. Conclusion

In this study about fifty percent eyes were found with myopic changes in fundus. These changes were lattice degeneration and WWP & WWOP, macular hole, posterior staphyloma, retinal detachment, chorioretinal degeneration, PVD, retinal hole, maculopathy and CNV. SD-OCT revealed that 46% had normal appearance. Among pathological findings, most common was CNV. Other findings were lamellar macular hole, full thickness macular hole, retinal detachment, epiretinal membrane, macular traction maculopathy, PVD, dome shaped macula, posterior staphyloma.

In current study, retinal thickness increases in the foveal region and decreases in the macular region which correlates with the increase in the refractive error. OCT with cross-sectional images of retinal structures facilitates the study of posterior vitreoretinal anatomy in eyes with high myopia to allow detection of subtle macular changes that are otherwise undetectable in routine biomicroscopy. So, OCT can be done in a healthy high myopic population and in symptomatic myopic population who complains of worsening of visual function to look for epiretinal and/or vitreoretinal traction and related macular damage.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

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