Study of Role of Optical Coherence Tomography in the Interpretation of Common Macular Disorders at a Tertiary Eye Care Centre in Rural Maharashtra

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ABSTRACT

BACKGROUND

Optical Coherence Tomography (OCT) is a commonly used non invasive imaging instrument useful for the diagnosis and follow up of macular disorders, but it has its own share of drawbacks in the presence of media opacities like corneal oedema, dense cataract and vitreous haemorrhage. We wanted to study and interpret the various patterns of common macular diseases on optical coherence tomography.

METHODS

100 patients having macular diseases with no other ocular pathology were selected by simple random sampling. The patients were studied and followed up from day 1 of OPD during the period from January 2019 to December 2019 in rural hospital at Latur. All patients suspected of any macular disorder by slit lamp bio-microscopy with 78D or 90D examination were subjected to OCT evaluation.

RESULTS

On observation, out of 100 cases of macular pathology, 44 % (44 patients) with age related macular degeneration(ARMD), diabetic macular oedema (DME) 36 % (36 patients), central serous retinopathy (CSR) 10 % (10 patients), myopic maculopathy (MM) 7 % (7 patients), macular hole (MH) 3 % (3 patients) were found in our study. In ARMD patients our OCT findings were hard drusens in retinal pigment epithelium (RPE), detachment of neurosensory retina and retinal pigment epithelium whereas in patients of DME our OCT findings were cyst like hyporeflective spaces within the retina, with retinal thinning and loss of foveal depression. In patients of CSR our findings were separation of sensory retina from RP, in myopic maculopathy our OCT findings were presence of macular retinoschisis and in patients of MH our findings were showing attachment of the posterior hyaloids to the fovea, separation of a small portion of the sensory retina from RPE in the foveolar region and intraretinal cystic changes.

CONCLUSIONS

OCT plays a crucial role when added along with the clinical examination in the diagnosis and interpretation of common macular disorders.

KEYWORDS

Optical Coherence Tomography, Age Related Macular Degeneration, Macular Hole, Myopic Maculopathy

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BACKGROUND

The responsibility for a sharp, clear central vision and the ability to perceive colour lies with the macula in retina. The tightly packed arrangement of the photoreceptor cells in the macula control the entire central vision of the eye and are responsible for the ability to read, drive a car, watch television, see faces and distinguish details. There are two types of photoreceptor cells in the retina, rods and cones. The rods provide vision at low light levels, while the cones provide sharp vision and discrimination.[1,2]

OCT is an emerging non-destructive three-dimensional imaging technique that is capable of producing high-resolution cross-sectional images through inhomogeneous samples such as biological tissues.[3]

Basically, OCT is analogous to ultrasound B mode imaging except that it uses light instead of sound.[4] The invention of OCT in the 1990s represents a major milestone in ocular imaging as it is a rapid, non-invasive, radiation-free examination technique which has given the ability to visualize the retinal layers at a microscopic level. OCT brought significant contributions in the field of diagnosis and monitoring a variety of retinal diseases, such as AMD, central serous chorioretinopathy, macular hole, vitreomacular interface syndrome and diabetic maculopathy. Because of its simplicity, non-invasiveness, and richness of information, OCT soon became a crucial investigative tool in most of the retina practices.[5]

Macular degeneration which is more commonly known as age related macular degeneration (AMD or ARMD) is a medical condition which predominantly affects the elderly adults and leads to central visual field loss (the macula) due to damage to the retina. It is a leading cause of blindness and visual impairment in the elderly adult group population (> 50 yrs.). As the age advances, the disease also progresses and it is termed as age related macular degeneration (AMD).

The American Academy of Ophthalmology Preferred Practice Patterns defines Cystoid Macular Edema (CME) as retinal thickening of the macula due to disruption of the normal blood-retinal barrier; this causes leakage from the perifoveal retinal capillaries and accumulation of fluid within the intracellular spaces of the retina, primarily in the outer plexiform layer.[6]

Visual loss occurs from retinal thickening and fluid collection that distorts the architecture of the photoreceptors. CME is a leading cause of central vision loss in the developed world.[7]

Central serous retinopathy (CSR), also known as central serous chorioretinopathy (CSC), is an ocular medical condition which is commonly unilateral and causes visual impairment which is often temporary. It is characterized by sub retinal fluid leakage that has the propensity to accumulate under the central macula.

This results in blurred or distorted vision (metamorphopsia). A blurred or gray spot in the central visual field is common when the retina is detached. Reduced visual acuity may persist after the fluid has disappeared.[8]

The condition is believed to be exacerbated by stress or corticosteroid use.[9,10]

Myopia is a common ocular condition in which the axial length of the eyeball is so long that the parallel rays of light focus ahead of the retina instead of focusing on the retina. High myopic eyes which are characterised by abnormally excessive axial length are at a higher risk of developing degenerative changes in the sclera, choroid, retina and retinal pigment epithelium.

Based on OCT examination, the most common macular change in highly myopic eyes was maculoschisis, followed by incomplete posterior vitreous detachment, disruption of the photoreceptor inner segment / outer segment interface, epiretinal membranes, macular defects in Bruch's membrane, clumping of the retinal pigment epithelium, vitreofoveal adhesion, and macular holes.[11]

Macular hole though it is usually idiopathic, < 10 % have a history of trauma. The most widely accepted theory suggests that age-related focal shrinkage of the prefoveolar vitreous cortex causes traction on the foveal area, leading to foveal detachment and subsequent macular hole formation.[12]

A well-defined punched out area of the macula which is hard to detect needs to be looked for during examination. There may be occasional yellowish – white deposits at the base with a grey margin surrounding it representing oedema. Slit lamp examination shows a round excavation with well-defined borders which usually blocks the beam of slit lamp. A lot of patients also show the presence of a semi translucent tissue over the hole which may often be surrounded by a grey halo caused by detachment of the retina.

Gass Biomicroscopic Classification

- Stage 1a. Seen as a yellow spot. This is not specific for macular hole - can be associated with central serous chorioretinopathy, cystoid macular oedema, and solar maculopathy.
- Stage 1b. Occult hole: doughnut-shaped yellow ring (approximately 200 - 300 µm) centred on the foveola. Approximately 50 % of holes' progress to stage 2.
- Stage 2. Full thickness macular hole (< 400 µm). Prefoveolar cortex usually separates eccentrically creating a semi-transparent opacity, often larger than the hole, and the yellow ring disappears. These generally progress to stage 3.
- Stage 3. Holes > 400 µm associated with partial vitreomacular separation.
- Stage 4. Complete vitreous separation from the entire macula and optic disc.[13]

Here in this study, we wanted to interpret the various patterns of common macular disorders on optical coherence tomography.

METHODS

A prospective study was done on 100 patients having macular disease with no other ocular pathology which were selected by simple random sampling.

The study was approved by the Institutional Ethics Committee Board (Letter Vide No MIMSR / YCRH / Ophthalm / 11 / 2020) and informed consent was obtained from all patients participating in the study. Demographic profile of the patients viz., age, sex, detailed history was obtained by interviewing the participants and detailed ocular examination on slit lamp biomicroscope under full pupillary dilation was performed and necessary investigations were conducted on predesigned and pretested proforma. After taking informed consent of all the eligible patients they were subjected to detailed examination like history, general physical examination and systemic examination.

The patients were studied and followed up from first day of OPD during the period from January 2019 to November 2019 in a tertiary eye care centre at Latur. The patients included those coming on regular OPD basis and also those who were brought by screening camps arranged by ophthalmic assistants in periphery.

All patients suspected of any macular disorder by slit lamp bio-microscopy with 78D or 90D examination were selected. Each case coming to OPD was first subjected to visual acuity testing and refraction by an optometrist. Patient was then examined by a surgeon. After verification of the acuity, detailed history of complaints and also past, personal and family histories were taken. Patients were examined by torch light and findings were noted. Then detailed check up was done on slit lamp.

All patients having macular pathology had their:

- Intraocular pressure measured by Schiotz tonometer, Goldman Applanation Tonometry.
- OCT done.
- B-scan done.

All patients after dilation were subjected for OCT examination.

Statistical Analysis

Data entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA. Qualitative data was expressed in terms of percentages and quantitative data was expressed in terms of mean and standard deviation.

RESULTS

Type of Disorders	Age Group in Years						Total
	< 50	51-60	61-70	71-80	81-90	91-100	
ARMD	5	15	10	5	5	4	**44**
DME	5	13	12	2	2	2	**36**
CSR	2	3	2	1	1	1	**10**
Myopic Maculopathy	4	1	1	1	0	0	**7**
Macular Hole	1	1	1	0	0	0	**3**

Table 1. Distribution of Patients According to the Type of Disorders and Age Group of Patients

On observation of 100 cases of macular pathology it was found that patients with ARMD belonged to an age group of < 50, 51 - 60, 61 - 70, 71 - 80, 81 - 90, 91 – 100 yrs., constituting 11.37 %, 34.09 %, 22.73 %, 11.36 %, 11.36 %, 9.09 % respectively. Patients with DME belonged to an age group of < 50, 51 - 60, 61 - 70, 71 - 80, 81 - 90, 91 – 100 yrs. constituting 13.88 %, 36.11 %, 33.33 %, 5.55 %, 5.56 %, 5.57 % respectively. Patients with CSR belonged to an age group of < 50, 51 - 60, 61 - 70, 71 - 80, 81 - 90, 91 – 100 yrs. constituting 20 %, 30 %, 20 %, 10 %, 10 %, 10 % respectively. Patients with MM belonged to an age group of < 50, 51 - 60, 61 - 70, 71 – 80 yrs. constituting 57.14 %, 14.28 %, 14.29 %, 14.29 %, 0 %, 0 % respectively. Patients with MH belonged to an age group of < 50, 51 - 60, 61 – 70 yrs. constituting 33.33 %, 33.33 %, 33.34 % respectively.

Age Related Macular Degeneration (ARMD)

On observation out of 100 cases of macular pathology, 44 patients i.e. 44 % of the patients had ARMD.

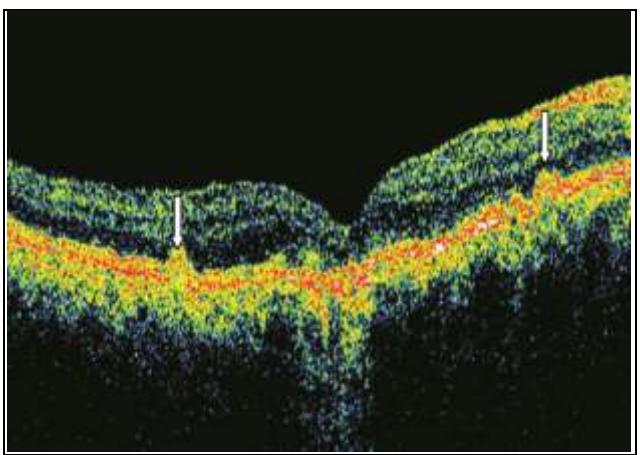

Figure 1. OCT Line Scan Inferior to the Fovea Passing through the Area of the RPE Atrophy and Calcified Drusen Shows Hard Drusen as Small Disruptions In the RPE Projecting into the Over Lying Photoreceptor Layer (Arrows). The Area of RPE Atrophy Shows Hyper-Reflectivity from Underlying Choroid

On OCT our findings were hard drusens in RPE, detachment of neurosensory retina and retinal pigment epithelium.

Diabetic Macular Edema (DME)

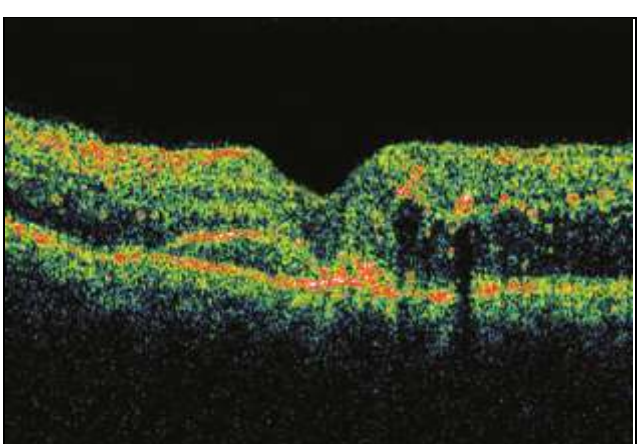

Figure 2 Vertical OCT Line Scan Showing Macular Thickening with Reduced Optical Backscatter Due to Accumulation of Fluid in the Outer Retinal Layers Resembling the Water Logging in a Sponge. The Circinate Rings of Hard Exudates are Seen as Hyper-Reflective Lesions within the Retinal Layers with Shadowing Effect

Males constituted 44.44 % (16 patients) of the patients in the study, while females constituted 55.55 % (20 patients) of the patients.

On OCT our findings were cyst like hyporeflective spaces within the retina, with retinal thinning and loss of foveal depression which is documented in the following table.

Central Serous Retinopathy (CSR)

On observation out of 100 cases of macular pathology 10 patients i.e. 10 % of the patients had CSR and belonged to an age group of < 50, 51 - 60, 61 - 70, 71 - 80, 81 - 90, 91 – 100 yrs. constituting 20 %, 30 %, 20 %, 10 %, 10 %, 10 % respectively.

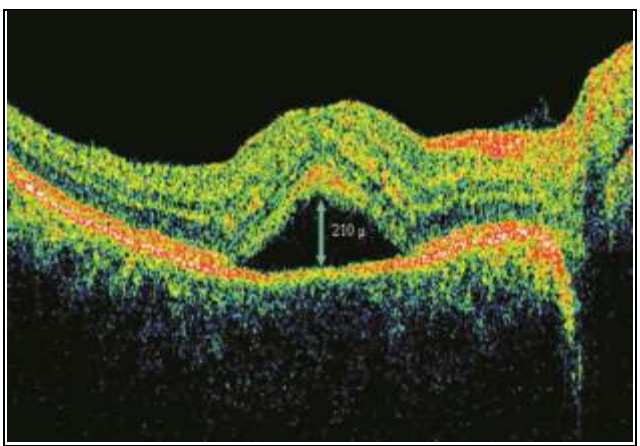

Figure 3. Horizontal Line Scan on OCT through the Fovea Showed Elevation of Neurosensory Retina with an Optically Clear Space Underneath That Corresponded to the Presence of Serous Fluid under the Fovea.

On OCT our findings were separation of neurosensory retina from RPE as depicted in the following table.

Myopic Maculopathy (MM)

The male constituted 43 % (3 patients) of the patients in the study, while females constituted 57 % (4 patients) of the patients.

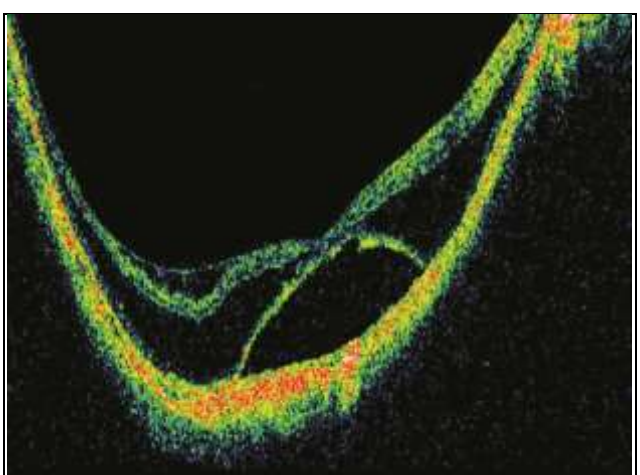

Figure 4 OCT Line Scan Through the Foveal Center Shows Splitting of Neurosensory Retina Indicating the Presence of Macular Retinoschisis as the Cause of Macular Detachment.

On OCT our findings were presence of macular retinoschisis as depicted in the following table.

Macular Hole (MH)

On observation out of 100 cases of macular pathology 3 patients i.e. 3 % of the patients had MH and belonged to an age group of < 50, 51 - 60, 61 – 70 yrs., constituting 33.33 %, 33.33 %, 33.34 % respectively.

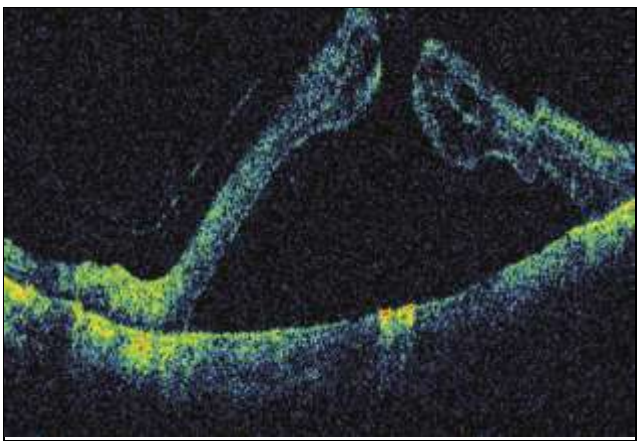

Figure 5. Horizontal OCT Line Scan through the Foveal Center Shows Full Thickness Macular Hole with Underlying Retinal Detachment

Our Findings on OCT Show

a. Occult macular hole - shows attachment of the posterior hyaloids to the fovea, separation of a small portion of the sensory retina from RPE in the foveolar region and intraretinal cystic changes.
b. Small full thickness hole – shows attachment of the vitreous to the lid of the hole and cystic changes.
c. Full size macular hole - shows full thickness macular hole with intraretinal cystic spaces and an overlying pseudo-operculum.
d. Full size macular hole with complete PVD - The posterior vitreous is completely detached often suggested by the presence of a Weiss ring.

OCT Findings in Macular Disorders	ARMD	DME	CSR	MM	MH
Hard Drusens	44	-	-	-	-
RPE Atrophy	44	-	-	-	-
Cyst like Hypo Reflective spaces	-	36	-	-	-
Retinal Thinning	-	36	-	-	-
Loss of Foveal Depression	-	36	-	-	-
Separation of sensory Retina From RPE	-	-	10	-	-
Hyper Reflective area with retinal thinning	-	-	-	-	-
Macular retinoschisis	-	-	-	7	-
Loss of foveal contour	-	-	-	-	-
Thinning of overlying retina	-	-	-	-	-
Presence of cystic spaces in inner retinal layer	-	-	-	-	-
Occult MH - Separation of small portion of sensory retina from RPE in Foveolar region and intra retina cystic changes	-	-	-	-	3
SFT MH - attachment of the vitreous to the lid of the hole and cystic changes.	-	-	-	-	3
FTMH - Shows full thickness MH with intra retinal cystic spaces and an overline pseudo-operculum	-	-	-	-	3
FTMH with complete PVD - posterior vitreous completely detached	-	-	-	-	3

Table 2. OCT Findings of Macular Disorders

DISCUSSION

Vision loss due to macular pathology is one of the commonest problems worldwide. Regular check-up and routine fundus examination is essential. OCT is non-invasive, important diagnostic tool, gives layer wise information and hence there is a need for OCT study. 44 out of 100 patients i.e., 44 % of the patients had ARMD and on OCT our findings were hard drusens in RPE, detachment of neurosensory retina and retinal pigment epithelium. Similar findings were noted in a study conducted by Hee MR1, Baumal CR, Puliafito CA, Duker JS, Reichel E, Wilkins JR et al. in 1996 on 391 patients with the clinical diagnosis of AMD. On OCT examination, it shows pigmentary changes, soft drusen, and detachments of the neurosensory retina and retinal pigment epithelium.[14]

36 out of 100 patients i.e., 36 % of the patients had DME and on OCT our findings were cyst like hyporeflective spaces within the retina, with retinal thinning and loss of foveal depression, which is comparable to the study conducted by Otani T1, Kishi S, Maruyama Y on optical coherence tomography that was performed in 59 eyes of 42 patients with diabetic macular oedema and in 10 eyes of 10 normal control subjects and OCT showed three patterns of structural changes in diabetic macular oedema: sponge-like retinal swelling [52 (88 %) of 59 eyes], cystoid macular oedema [28 (47 %) of 59 eyes], and serous retinal detachment [9 (15 %) of 59 eyes].[15]

10 out of 100 patients i.e. 10 % of the patients had CSR and on OCT our findings were separation of sensory retina from RPE, which is comparable to the following study conducted by Hisataka Fujimoto, Fumi Gomi, Taku Wakabayashi, Miki Sawa, Motokazu Tsujikawa, Yasuo Tano et al. on OCT that was performed in 21 eyes with acute CSR. On OCT, changes in the retinal pigment epithelium (RPE), detached retina, and subretinal space around the leakage sites were evaluated repeatedly during follow-up.[16]

7 out of 100 patients i.e., 7 % of the patients had myopic maculopathy and on OCT our findings were presence of macular retinoschisis. Similar findings were noted in a study conducted by You QS, Peng XY, Xu L, Chen CX, Wang YX, Jonas JB et al. the Beijing Eye Study in 2011 included 3468 subjects with an age of 50 years or more who underwent OCT with enhanced depth imaging of the macula. Based on OCT examination, the most common macular change in highly myopic eyes was maculoschisis, followed by incomplete posterior vitreous detachment, disruption of the photoreceptor inner segment / outer segment interface, epiretinal membranes, macular defects in Bruch's membrane, clumping of the retinal pigment epithelium, vitreofoveal adhesion, and macular holes.

These findings were comparable to a study conducted by Lynn L. Huang, David H. Levinson, Jonathan P. Levine, Umar Mian, and Irena Tsui et al. done among 15,600 patients visiting the clinic database over a three-year time period. Macular holes associated with trauma, retinal detachment, diabetic retinopathy, or myopia were excluded. Macular Pseudoholes (MPH) associated with an epiretinal membrane by clinical diagnosis were also excluded. On OCT data provided additional information such as the presence of vitreomacular traction (VMT), intraretinal cysts and SRF. VMT occurred at about the same rate (14 - 15 %) in both lamellar macular hole (LMH) and full thickness macular hole (FTMH). On optical coherence tomography of full-thickness macular holes shows that (a) with separation of the posterior vitreous from the fovea and (b) with vitreomacular traction.[17]

Similar findings were also found in a study conducted by V Tanner, D S Chauhan, T L Jackson, T H Williamson Mr V Tanner, Royal et al. on 80 eyes of 41 consecutive patients referred with idiopathic full thickness macular hole (FTMH). Both eyes of each patient underwent optical coherence tomography. A total of 30 eyes had stage 2 or 3 FTMHs and of these, 21 had persistent vitreofoveal attachment and associated prefoveal opacities. 18 prefoveal opacities were identified by Goldmann contact lens examination and confirmed on OCT examination. 10 eyes had stage 4 FTMHs and four cases were identified in whom the OCT appearance was consistent with impending, aborted or lamellar macular holes.[18]

CONCLUSIONS

OCT is the fast, simple, non-invasive, radiation free examination technique, gives colour print, richness of information and able to visualize the retinal layers at microscopic level. The information offered by OCT is detailed, and easily interpretable. OCT has brought significant contributions in the field of diagnosis and monitoring a variety of retinal diseases, such as ARMD, CSR, Macular hole, Diabetic maculopathy, solar maculopathy, myopic maculopathy, Epimacular membrane. OCT offers enormous advantages in terms of diagnosis, response to treatment and monitoring of retinal diseases. OCT is the crucial investigative tool in most of retinal practices.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
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