Clinical Spectrum of Lamellar Macular Defects Defined by Optical Coherence Tomography

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Abstract :

Introduction : Lamellar macular defects lead to decrease in visual acuity. Optical coherence tomography (OCT) is a non-invasive imaging technology that provides cross-sectional images of the retina with high resolution. **Objectives :** The purpose of this study was to evaluate the varied presentations of lamellar macular defects and their Optical coherence tomography (OCT) features and correlation with visual acuity. **Methods:** This observational, cross sectional and analytical study reviewed OCT scans of 40 eyes with lamellar macular defects. Lamellar macular defects were categorised into different subtypes: macular pseudohole (MPH), lamellar macularhole (LMH) and foveal pseudocyst (FP) according to their OCT appearance. The various parameters of defects in terms of base diameter, depth defect, and central foveal thickness and perifoveal thickness were measured. **Results :** Visual acuity (VA) was significantly correlated with the central foveal thickness and depth of the lamellar defect. MPH was associated with better VA compared with LMH and FP, but there was no statistically significant difference between VA of MPH and FP. FP had a smaller base diameter and had a greater central foveal thickness than that of LMH and MPH. **Conclusion :** Different types of lamellar macular defects were characterised and quantified by OCT. Deeper and wider lamellar defects had poorer visual acuity, suggesting wide intraretinal split probably responsible for the lower visual acuity. **Key words :** Optical Coherence Tomography, Lamellar macular hole, Macular pseudohole and Foveal pseudocyst.

Introduction : Macula is the most sensitive part of the retina for precise central vision. It is a round area at the posterior pole, lying inside the temporal vascular arcades. It measures between 5 mm and 6 mm in diameter, and subserves the central 15–20° of the visual field. Histologically, it shows more than one layer of ganglion cells, in contrast to the single ganglion cell layer of the peripheral retina. The inner layers of the macula contain the yellow xanthophyll carotenoid pigments lutein and zeaxanthin in far higher concentrations than the peripheral retina (hence the full name 'macula lutea' – yellow plaque).[1]

Disorders of macula therefore present with poor visual acuity. Among the various macular disorders, macular defects are described in the form of macular holes. Primary macular holes are full thickness neurosensory retinal defects of the fovea centralis. Most of the macular holes (70%)are idiopathic followed by secondary to trauma and degenerations, encountered in older women.[2]

Lamellar macular hole (LMH) was initially described by Gass and Allen as a partial-thickness foveal defect believed to occur via interruption of the typical macular hole formation process or by the unroofing of the central fovea in chronic cystoid macular edema (CME).[3-5] Since then, there has been much interest in defining the condition from other similar, yet distinct macular disorders, such as full-thickness macular holes, macular pseudo- holes and vitreomacular traction[6-8].

A lamellar macular hole is by definition a partial thickness macular hole where the inner layers of the fovea are involved with traction and detached from the underlying cellular layers of the fovea. Lamellar macular holes typically appear as a round or irregular-shaped, well-circumscribed reddish lesion on biomicropscopy, but clinical detection of lamellar holes at an early stage can be difficult.

Clinical detection of lamellar holes at an early stage is sometimes difficult by slit lamp bio-microscope. OCT examination helps in accurate diagnosis and defining the size of the defect. This would consequently help the clinican to explain patient about the poor visual acuity and need for surgical intervention.[9]

Optical coherence tomography (OCT) is a non-invasive imaging technology that provides cross-sectional images of the retina with high resolution.[10] OCT is based on low-coherence tomography interferometry that uses light in order to measure the difference of reflectivity between the examined tissue and a reference beam.

Nevertheless, direct visualisation of the vitreo-retinal interface has been difficult recently and studies using OCT imaging have significantly enhanced the understanding of the pathophysiology of macular holes, as well as further enabling the classification of stages of macular hole formation. The sequential events leading to a full thickness macular hole, either of idiopathic or traumatic causes, have been well documented by OCT.[11] OCT can be used to detect very early stages of macular hole development (that is, stage 0 and stage 1) and may offer explanations for causes of reduced vision that are not clinically apparent. OCT can also be used to evaluate the risk of progression to a full thickness macular hole or to assess the likelihood of subsequent involvement of the fellow eye, in cases of unilateral macular holes.[11,12,13]

Aim and Objective : The purpose of the study was to examine the varied presentations of macular defects, OCT features and their correlation with visual prognosis in patients presenting in Ophthalmology Department of Pravara Rural Hospital, Loni.

Materials and Methods : We examined 40 eyes of patients who visited our center for consultation between January 2016 and August 2017. The study was conducted in after approval of Ethics Committee. All patients presenting with lamellar macular defects of any age and gender were included in the study. Informed consent was obtained from all patients after explanation of the nature of the study. A complete ocular examination was performed including best corrected visual acuity (VA) measurement and slit-lamp biomicroscopy . VA was first measured on a Snellen chart and then converted to the logMAR . All eyes with macular defects were evaluated with OCT. OCT measures the echo delay and intensity of back-reflected or backscattered infrared light(800 nm) to produce high-resolution, cross-sectional tomography of ocular structure.[9]

Subtypes of lamellar macular defects : Lamellar macular defects were grouped into three different subtypes based on their OCT features: macular pseudoholes (MPH), lamellar macular holes (LMH) and foveal pseudocysts(FP). Lamellar macular defects having a sharply punched out, well-delineated, steepened foveal contour were differentiated as MPH. While LMH had a thin and irregular foveal floor overlying the plane of the retinal pigment epithelium. FP appeared on OCT as a cystoid space occupying mostly the inner part of the fovea, with a perifoveal detachment of the posterior hyaloid.[9]

OCT measurements of base diameter, defect depth, central foveal thickness and peri foveal thickness

Measurements of base diameters and depth of lamellar macular defects were calculated using the software calipers.Measurements of base diameters and depths were made to the most lateral extent of the intra retinal split and the thinnest part of the foveal base respectively by using software calipers.FP defects were not open macular defects and had a roof over the cystic area, so the defect depth measured corresponded to cystic space depth.Retinal thickness was measured at the foveal centre (central foveal thickness) and at points situated 750 μm either side of foveal centre.Then the mean of these two measurements from both sides of the foveal centre was taken as the perifoveal retinal thickness.[9]

Statistical analysis : Statistical analysis was done by descriptive statistics namely mean, SD and percentages etc. Comparison in between subgroups was done by applying Student's Unpaired 't' test. The correlation was done by Karl Pearson's correlation coefficient.

Results :

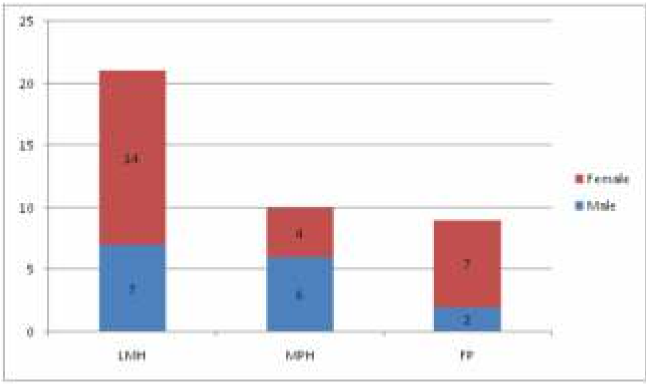

Figure 1: Gender distribution of study population

It was seen from Figure 1 that the OCT scans of the 40 eyes were examined and differentiated into three different subgroups of lamellar macular defects i.e MPH, LMH and FP. OCT scans of 10 eyes corresponded to MPH; 21 scans to the LMH subgroup, and nine scans had the findings corresponding to FP. The visual acuity of 40 eyes ranged from 6/12 to 1/60. The visual acuity differentiated significantly between different subgroups of lamellar macular defects. The VA differed significantly between the three subtypes of lamellar macular defects. The MPH group had the best VA of 0.52(0.23) log MAR compared with that of the LMH group [1.26(0.27) logMAR] and the FP group [0.59(0.41) logMAR]. There is no statistically significant difference between VA of MPH and FP group.

Table 2: Comparison of various parameters in all subgroups under study

Parameters	Subgroups (Type of defect)			P Value (Student's Unpaired 't' test)
	LMH (n=21)	MPH (n=10)	FP (n=9)	
	Mean ± SD	Mean ± SD	Mean ± SD	
Base Diameter	1293.04±423.56	590.0±139.07	477.44±127.22	p<0.05
Defect Depth	388.86±109.47	198.0±46.66	124.55±51.04	p<0.05
Central foveal thickness	134.86±33.03	211.9±39.8	224.22±31.87	p<0.05
Perifoveal Thickness	380.52±96.57	299.95±51.69	272.55±62.04	p<0.05
VA (LogMAR)	1.26±0.27	0.52±0.23	0.59±0.41	p<0.05

It was evident from Table 1 that the difference in central foveal thickness of the three subtypes of lamellar macular defects followed the same patterns the difference observed in VA. FP had the thickest central foveal thickness measurement [224.22(31.87)µm] followed by that of LMH [134.86(33.03)µm] and MPH [211.9(39.8) µm]. There was a statistically significant correlation between VA and central foveal thickness, that is, the central foveal thickness is directly proportional to the visual acuity. There were also significant differences in the base diameter of the lamellar defects of the three groups, LMH had the broadest base diameter [1293.04(423.56) µm], which was significantly greater than that of the MPH [590.0(139.07) µm and the FP subgroup [477.44(127.22) µm].

Table 3: Correlation by Karl Pearson's Correlation coefficient

Correlation between	Subgroups		
	LMH (n=21)	MPH (n=10)	FP (n=9)
	Karl Pearson's Correlation coefficient (r) value		
Base Diameter v/s Visual Acuity	0.545*	0.1114*	0.7256*
Defect Depth v/s Visual Acuity	0.3277*	0.3225*	0.6296*
Central foveal thickness v/s Visual Acuity	0.0571*	0.3099*	0.5389*
Perifoveal Thickness v/s Visual Acuity	0.3451*	0.6245*	0.21*

*** Positive correlation and is significant.(p<0.001)**

As shown in Table 2 that in addition to having defects of larger base diameters, LMH also had deeper defects [388.86(109.47)µm] than that of MPH [198.0(46.66)µm] and FP [124.55(51.04)µm]. The depth of MPH was significantly greater than FP. There was also a statistically significant correlation between VA and depth of the lamellar macular defect, that is, the deeper the lamellar defect, the VA was poor. The perifoveal thickness of FP [272.55(62.04) µm] and MPH [299.95(51.69) µm] were found to be similar while that of LMH [380.52(96.57) µm] was larger.

Discussion : Our study showed the clinical spectrum of lamellar macular defects which may resemble a macular hole on clinical examination. So, by including OCT as a part of routine clinical examination for macular disorder will make the differential diagnosis of various lamellar macular defects easier and it will also simplify the visualisation of the different subtypes of lamellar macular defects.[8]

In our study, an effort has been made to establish a correlation between OCT appearance of lamellar macular defects and visual acuity. Among the different subtypes, it was observed that MPH had the greater visual acuity as compared to that of LMH and FP. On examination of OCT scans, the FP had smallest base diameter while LMH had the largest base diameter and depth of the defect was greatest. However, the findings in this study are different from that of Houchine et al and Chin et al who reported MPH to be having smallest base diameter. The findings in this study correspond to the findings of above mentioned two studies of LMH having deepest defect.

Our study also reported the smallest central foveal thickness in LMH subgroup among the various subtypes of lamellar macular defects which were different from the findings of Houchine et al and Chin et al who had proven otherwise of having central foveal thickness least in FP.[7] In full-thickness macular holes, the associated visual loss is due to the direct loss of foveal tissue, and there is an approach suggesting that the thickness of cellular tissue between the base of the hole and the RPE layer is inversely proportional to the patient's resulting visual acuity[14,15]. There is no statistically significant difference between VA of MPH and FP group.So, a conclusion can be drawn that the higher level of acuity present in MPH and FP sub-groups was due to the smaller base diameter and thicker central foveal tissue, while the poor acuity seen in LMH subgroup was due to the wide intraretinal separation and thin foveal tissue respectively.[9]

In our study,MPH, LMH and FP were classified as subtypes of lamellar macular defects as they are all partial-thickness macular holes with the presevation of some foveal tissue. MPH is said to form when the centripetal contraction of an ERM leads to vertilisation of slope of fovea resulting in formation of defect which is sharply punched out,[16] whereas it has been suggested that LMH results from an abortive process of full thickness macular hole formation, with the peculiar split between the inner and outer retinal layers rather.[7,9] FP is also differentiated as an another separate condition which is predecessor to macular hole or lamellar macular hole formation resulting from direct vitreomacular traction.[7]

While various OCT morphological features corresponding to each lamellar macular defect subtypes have been described in our study, more studies are still required to study the pathogenesis of formation of lamellar macular defects. Measurements of perifoveal thickness of MPH and LMH in our study were both above the normal range of retinal thickness (233–253 µm).

Limitations : A study with a large number of the lamellar macular defects patients will indeed increase our understanding of the etiopathogenesis of each subtype of the lamellar macular defects.

Conclusion : Our study presented the clinical spectrum of macular defects and demonstrated the use of OCT imaging in the classification and differentiation of different types of lamellar macular defects. Classifying lamellar macular defects into subgroups of macular pseudoholes, lamellarmacular holes and foveal pseudocysts based on their OCT parameters like base diameter,defect depth, central foveal thickness and perifoveal thickness gave perceptive insight into their visual prognosis and underlying retinal morphology.Deeper and wider lamellar defects had poorer visual acuity, suggesting wide intraretinal split probably responsible for the lower visual acuity.

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