·Original article·

Inner lamellar macular holes *vs* macular pseudoholes with normal foveal thicknesses

Jose A. Ramirez, MD[1], Avinaom Ophir, MD[1,2]

Abstract **Aim** To compare quantitative data and imaging of inner lamellar macular holes (ILHs) and macular pseudoholes (MPHs) with normal foveal thickness, both associated with epiretinal membranes (ERM). **Methods** In 27 eyes (25 consecutive patients) with ERM at the macula and a clinical appearance of a macular hole or MPH, the foveal thickness and contour were evaluated with optical coherence tomography (OCT). At least two measurements of foveal thickness of ≥135 μm each at two different scans were prerequisites in these eyes for diagnosis of a MPH, and a foveal thickness <135 >0μm was diagnosed as an ILH. Eyes with MPH with foveal thickness >202 μm, eyes with full-thickness macular holes and eyes with vitreo-macular adhesions or other macular abnormalities that could affect the data were excluded from the analysis. **Results** Inner lamellar macular holes were detected in 6 eyes (22.2 %) of 6 patients (mean age, 56 ±18 [s] years), and MPHs with normal foveal thickness (NT-MPHs) were diagnosed in 4 eyes (14.4%) of 4 patients (mean age, 70 ±9 years). The minimal foveal thicknesses at the ILHs and NT-MPHs ranged from 74 to 108μm (mean, 87 ±12.6) and from 135 to 191 μm (mean, 166 ± 27), respectively. At the bases of each NT-MPH and of 4 of the 6 eyes with ILH cystoid changes were detected. All other 17 eyes had a foveal thickness >203 μm in each, associated with more prominent cystoid changes at the fovea **Conclusion** The quantitative findings of the ILHs using OCT could differentiate them from NT-MPHs. The findings suggest that ILHs with cystoid changes may thicken to become MPH. The quantitative data and repeated evaluations during follow-up may prove objective changes that can help in decision-making regarding indication and timing of surgery for ERMs with cystic foveal changes.

Keywords inner lamellar macular holes(ILH); macular pseudoholes(MPH); optical coherence tomography(OCT); foveal thickness

INTRODUCTION

An inner lamellar macular hole (ILH) is a partial thickness hole with absence of an inner portion of macular tissue[1]. Factors encountered that can result in formation of ILHs include cystoid macular edema (CME)[1,2], resolution of stage-I idiopathic macular hole[3], vitreoretinal adhesions[4] and retinoschisis[5]. In contrast, macular pseudoholes (MPH) may appear as well-demarcated, round or oval depressions, usually in an oblique orientation, though without loss of retinal tissue, and are commonly associated with epiretinal membranes (ERM)[1]. Gass suggested that MPH could be caused by centrifugal contraction of a fenestrated ERM, with steepening of the foveal margin that creates the appearance of a hole[6]. Three-dimentional characteristics of the MPH, using confocal laser tomography, frequently reveals irregular rippling undulations around the pseudohole[7].

The best-corrected visual acuity (BCVA) of patients with ILH ranges from 20/20 to 20/80, with or without metamorphopsia[1]. Changes of macular appearance in eyes with ILH have not, to the best of our knowledge, been described, though a case report of progression of ILH to full-thickness was recently described, and has been related to vitreo-macular traction[8]. The ILH has not received therapeutic or surgical focus, probably because the reduction of visual acuity is often mild and considered to be practically non-progressive[1].

The best corrected visual acuity (BCVA) of patients with a MPH is usually good, but can be less than 20/100[7,9]. The thickness of the foveal tissue at the MPH site may vary substantially between eyes[10]. This may be related to the fact that, contradictory to eyes with ILH, definite changes in macular appearance commonly occur in eyes with MPH[11,12].

Vitrectomy surgery to peel the ERM and relieve surface traction in MPH has been reported and was indicated

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From [1]Department of Ophthalmology Hillel-Yaffe Medical Center, Hadera, Israel; [2]The Bruce Rappaport Faculty of Medicine, Haifa, Israel
Correspondence to: A. Ophir, MD, Department of Ophthalmology, Hillel-Yaffe Medical Center Hadera, Israel
Email: ophthalmology@hillel-yaffe.health.gov.il

where functional impairment occurred, e.g., a decrease in BCVA, metamorphopsia, and/or diplopia. Metamorphopsia was the most common complaint (86%; *n* =45) in the series of Massin et al before vitrectomy and ERM peeling[13].

The clinical diagnosis of MPH is based on biomicroscopy and on retinal fluorescein angiography. Although fluorescein angiography may demonstrate hyperfluorescence in the base of the hole[14], usually not as pronounced as that seen in true macular holes, and lamellar macular holes characteristically show no fluorescence in the area of the hole, fluorescein angiography is often not able to differentiate pseudohole from lamellar or full-thickness macular hole. Co-existing conditions, such as cataracts, can directly influence the BCVA in these patients with MPH. Diagnosing the cause of BCVA reduction could thus be misleading, however it is indispensable in order to avoid needless or incorrect surgical intervention in these patients. Fish *et al*[15] reported that initial examining physicians had correctly diagnosed 43% of eyes with MPH. Optical coherence tomography (OCT) imaging has been found to be an objective and reliable diagnostic tool for differentiating ILH, MPH and idiopathic full-thickness macular holes of the various stages [16]. And quantitatively, OCT data on MPH have recently been reported, though differentiation between MPH and ILH was not made[11]. The mean thickness of the normal fovea with OCT was reported to range between 155 ±15μ m[17,18] and 174 ±18μ m[19].

The purpose of this study is to present quantitative data and morphologic abnormalities using OCT in eyes with macular ERMs that are associated with MPH with normal foveal thickness (NT-MPH) or ILH, and evaluate their clinical releavance.

PATIENTS AND METHODS

Patients In a retrospective study, 27 eyes with a diagnosis of ERM at the macular site and a clinical appearance of a macular hole or MPH were evaluated. Ophthalmic examinations, including OCT (Carl Zeiss Meditec, Dublin, CA), took place at the Hillel-Yaffe Medical Center, Hadera, from August 2001 to May 2003. The quantitative data were compared to those of 10 normal eyes of our series. The mean foveolar thickness of these normal eyes was 168±17 (range,141−189) μ m. We therefore have chosen the minimal and maximal thicknesses of 2 standard deviations of this mean to be considered as the limits of normal foveal thickness. These were therefore foveal thicknesses of ⩾135μ m and ⩽ 202 μ m, respectively. Eyes with OCT diagnosis of foveal thickness >202 μ m, of full-thickness macular holes and of vitreomacular adhesions or another macular pathological changes that could affect the findings, such as diabetic macular edema, were excluded from the study analysis.

Methods The OCT examinations initially included 6 radial lines (5.9 mm long each) centered at the macula, followed by multiple scans in various meridians and lengths at and around the macula to detect any associated pathological change. Linear scans between the macula and the optic nerve head were carried out to evaluate the papillo-macular bundle site. At least two measurements of foveal thickness, ⩾135μ m each, but ⩽ 202 μ m, at two different scans at the pseudohole and the typical clinical appearance, were required for a diagnosis of NT-MPH. A foveal thickness <135 >0μ m was diagnosed as ILH. ERM was diagnosed to be non-adherent if it was partially separated from the retinal tissue, with traction focal point(s) of attachment to the macular region; ERM was defined as globally adherent if it was completely adherent to the macular tissue, as previously described[20]. Fluorescein angiography was not routinely done because of the clear OCT diagnoses. Ethical Committee approval was not required for this study.

RESULTS

Inner lamellar holes with ERM were found in 6 eyes (22.2%) of 6 patients and NT-MPH with ERM were detected in 4 eyes (14.4 %) of 4 patients (Table 1, 2). In the eyes with ILH and NT-MPH, BCVA ranged between 20/20 and 20/80 and between 20/30 and 20/80, respectively. Two patients with ILH and one patient with a NT-MPH had opacities of the media due to cataract or secondary cataract.

Small cystoid changes were detected at the bases of 4 of the 6 eyes with ILHs and within their adjacent retinas (Figure 1). The minimal thickness at the base of the fovea in each of these eyes ranged from 74 to 108 μm (mean, 87.0 ± 12.6; Table 1). The ERM was globally adherent in 2 eyes and non-adherent in the other 4 eyes (Figure 1).

Small cystoid changes were also detected at the base of each NT-MPH and within the adjacent retina (Figure 2). These bases were often irregular. The minimal thickness at these bases ranged from 135 to 191 μm (mean, 166± 29; Table 2). In either of two eyes with the NT-MPH, the ERM was globally adherent to the retina throughout its length (Figure 2), whereas in the other two eyes it was non-adherent. The remaining 17 eyes, each with ERM, had foveal thickness that exceeded 202 microns, due to cystoid changes within the foveas and the adjacent retinas. They were diagnosed as thick MPH with ERM.

Table 1 Demographic data and optical coherence tomography findings in eyes with inner lamellar macular holes and epiretinal membrane

Age/gender	BCVA	Cystoid change	Minimal foveal thickness (μm)	epiretinal membrane	Comment
52/M	20/80	yes	74	Adherent	
21/M	20/40	no	81	Adherent	
62/M	20/40	yes	88	Non-adherent	
69/M	20/20	no	94	Non-adherent	
65/F	20/60	yes	77	Non-adherent	Cataract + 1
65/F	20/60	yes	108	Non-adherent	Secondary cataract +2

BCVA = best-corrected visual acuity

Table 2 Demographic data and optical coherence tomography findings in eyes with macular pseudoholes and normal foveal thicknesses

Age/gender	BCVA	Cystoid change	MTFB(μm)	epiretinal membrane	comment
71/F	20/40	yes	191	Adherent ERM	
57/F	20/30	yes	190	Non-adherent ERM	
78/M	20/40	yes	149	Adherent ERM	Posterior sub-capsular cataract +1
72/F	20/30	yes	135	Non-adherent ERM	

BCVA = best-corrected visual acuity; MTFB=minimal thickness at foveal base

DISCUSSION

Quantitative data as provided by the OCT could enable differentiation between NT-MPH and ILH. The morhologic findings indicate that cystoid changes were present at the base of each NT-MPH and its adjacent retinal tissue. These observations may support the notion that part of the thickness at the NT-MPH base is related to the cystoid changes herein. Similar cystoid changes could also be detected at the base of 4 out of 6 eyes with ILH. It may therefore be anticipated that, similar to the worsening and progression of many eyes with MPH due to further cystoid changes, some ILHs with ERM and cystoid changes may gradually progress to what is designated as MPH. This assumption may be further supported by the fact that ERM may cause macular edema. Naturally, the opposite may also occur, namely breaks in cysts of MPH may cause thinning of the tissue with resultant ILH. The study further suggests that OCT quantitative data, supported by the morphological foveal findings, may help in decision-making at diagnosis of MPH or during follow-up, regarding the cause of visual reduction, metamorphopsia and subsequent indication and timing of surgery for MPHs with ERM.

Since changes may be expected with time in many eyes with MPH[11,12], the quantitative OCT data may also provide vital information during follow-up. Using color photographs, Greven *et al* [11] found definite changes in macular appearance in 74% of eyes (n=36) during mean follow-up of 53 months. Thirty of these eyes (84%) had final visual acuity within 2 lines from their initial visual acuity, whereas in 16% it exceeded 2 lines. Fish *et al* [15] reported that a decrease in 1-2 Snellen's lines occurred in 5 eyes (46%) of 11 patients with MPH during 9 to 216 weeks of follow-up. Varano *et al* [12] reported that 44.5% of eyes (n = 27) with MPH showed a decrease of visual acuity after 18-36 months of follow-up. Based on scanning laser ophthalmoscopy (SLO) and SLO microperimetry the authors also found that one third of the patients with MPH progressed into full-thickness macular holes during that period[12].Quantitaive measurements should probably perceive early progression of MPH, and early surgery might avoid further deterioration and needless complications.

Several lesions can mimic MPH or ILH in their clinical appearance, such as full-thickness and impending macular hole, sharply demarcated retinal pigment epithelial atrophy, granular pigmentary changes surrounding the normal foveal depression, and a blunted dilated perifoveal capillary net, as observed in diabetes mellitus and idiopathic perifoveal telangiectasia [1]. The clinical diagnosis of MPH without OCT has been reported to be relatively low, and coexisting conditions could also directly influence the BCVA in these patients, as described above. Correct diagnosis of MPH, ILH and impending or full thickness macular hole might be a challenge or even impossible, based on only a routine examination. Many methods and instruments have been used to improve these diagnoses, *e.g.*, Amsler grid test, Watzke-Allen sign, laser aiming beam test, laser slit lamp, echography, scanning laser ophthalmoscopy and OCT. It is noteworthy that in Greven *et al* [11] series of MPH with ERM, Watzke-Allen test result was abnormal in 7 (23%) of 31 eyes. In the current study one patient with MPH had opaque media at a certain level that could have affected BCVA, but OCT enabled precise and accurate data.

An ERM can result in vascular tortuosity and tethering, irregular vascular dilation, leakage and macular edema, punctate hemorrhages, cotton wool spots, foveal ectopia, sensory retinal detachment, fluffy areas of whitish inner retina (presumably related to axoplasmic stasis), and MPH[21]. The outcome of surgery for ERM with MPH is usually good. The most important preoperative prognostic factors are considered to be the BCVA and duration of symptoms, whereas the prognostic value of preoperative macular edema is still controversial[22]. Massin *et al* [13], presented the outcome of pars plana vitrectomy in 50 patients with MPH. Mean preoperative BCVA was 20/80 and metamorphopsia was present in 86% of the patients. It had improved by 2 or more lines in 31/50 (62%) eyes and was unchanged in 19 eyes (38%). Pseudoholes persisted in 30% after 6 months of follow-up. Based on comparison with surgery for ERM without MPH, in which similar improvement was found in BCVA, the authors conclude that the postoperative persistence of MPH had no adverse prognostic value on final BCVA. However, metamorphopsia disappeared postoperatively in 36 eyes(72%) and decreased in 9(18%) in eyes with MPH and ERM.

Limitations of this study include its retrospective design, a relatively small series of patients, the manual measurements of the foveal thickness with the OCT mires and a lack of standard classification on the OCT differentiation between ILH and NT-MPH. In this regard, a recent study reports OCT observations in eyes with ERM and MPH [10]. The authors found a wide range of thicknesses of the base of the MPH, and classified them into groups. The thinnest group comprised of eyes with MPH and foveal thicknesses <100 microns. This grading is different from ours, as we have graded such as an ILH, based on a partial loss of a retinal tissue.

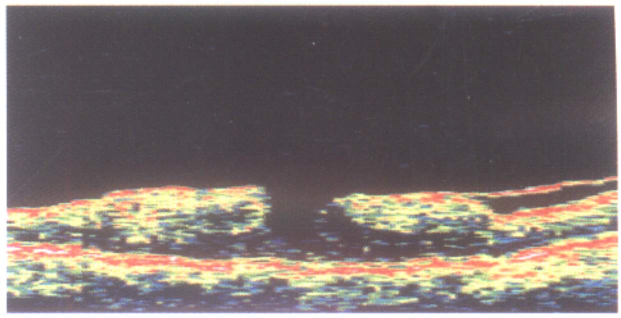

Figure 1 An inner lamellar hole and non-adherent epiretinal membrane. Cystoid changes are evident at the base of the inner lamellar hole and at the retinal tissue surrounding it. The minimal thickness of the base of the inner lamellar hole is 108 μm

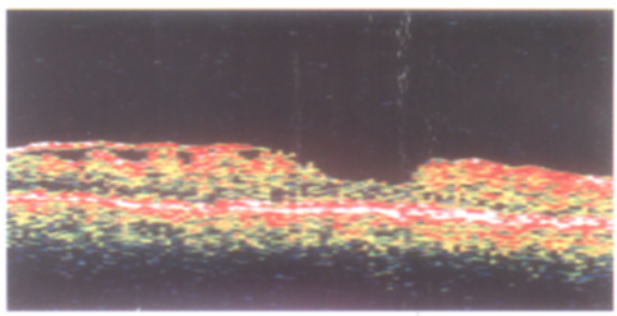

Figure 2 A macular pseudohole and adherent epiretinal membrane. Cystoid changes are present at the base of the macular pseudohole and at the retinal tissue surrounding it. The minimal thickness of the base of the pseudohole is 149μm

In conclusion, OCT provides objective quantitative and morphologic data of the base of each MPH and ILH with normal thickness and on the retinal tissues adjacent to them, and enables their differentiation. The findings suggest that ILH with cystoid changes may thicken to become MPH. Further studies and follow-up are required to validate our observations and conclusions.

(The authors do not have financial interest in any product or company mentioned or related to this study.)

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板层黄斑裂孔与正常中心凹厚度的黄斑假洞的比较

Jose A. Ramirez, MD[1], Avinaom Ophir, MD[1,2]

(以色列海德拉 Hillel-Yaffe 医学中心眼科;[2]以色列海法 Bruce Rappaport 医学院)

摘要 **目的** 比较与视网膜前膜(ERM)相关的黄斑板层裂孔(LH)和具有正常中心凹厚度的黄斑假洞(MPH),在定量和形态学上的差异。**方法** 27眼(25例)具有黄斑洞或黄斑假洞(MPH)的临床形态的黄斑前膜患者,应用视网膜光学相干断层扫描(OCT)评价其中心凹厚度与形态。当每个患者至少两次不同的扫描结果显示中心凹厚度≥135μm时,可诊断为MPH;当厚度介于0与135μm之间时,可诊断为ILH。而能够影响数据的中心凹厚度>202μm的MPH、全层黄斑裂孔及黄斑部玻璃体牵拉及其他黄斑病变的患者,则被排除出本试验。**结果** 6例6眼(22.2%),年龄56±18岁被诊断为ILHs,4例4眼(4.4%),年龄70±9岁被诊断为正常厚度的黄斑假洞。ILH与NT-MPHs的最小中心凹厚度范围分别为74~108(平均87±12.6)μm,135~191(平均166±27)μm。所有NT-MPHs和其中4例ILH患者,被发现具有囊样变。其他17眼,厚度都>203μm,具有更加明显的中心凹囊样变。**结论** OCT的定量检测能够鉴别ILHs与NT-MPHs。囊样变的ILH能够增厚变为MPHs,定量和随访重复测量的结果能够有助于确定囊样变ERMs的手术时机和手术适应症。

关键词 黄斑板层裂孔;黄斑假洞;OCT;中心凹厚度

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