Lamellar Macular Hole: Two Distinct Clinical Entities?

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• PURPOSE: **To investigate whether lamellar macular holes can be divided into different subgroups.**

• DESIGN: **Retrospective observational case series.**

• METHODS: **In this institutional study, clinical charts and spectral-domain optical coherence tomography (OCT) images of 102 eyes of 90 consecutive patients diagnosed with lamellar macular hole were reviewed. In OCT imaging, the presence of lamellar macular hole was defined according to the following findings: presence of irregular foveal contour, separation of the layers of the neurosensory retina, and the absence of full-thickness macular defect. Mean outcome was the morphologic and functional characterization of different subtypes of macular hole.**

• RESULTS: **Two different subtypes of lamellar macular hole were identified: tractional and degenerative. The first type, tractional, was diagnosed in 43 eyes, and was characterized by the schitic separation of neurosensory retina between outer plexiform and outer nuclear layers. It often presented with an intact ellipsoid layer and was associated with tractional epiretinal membranes and/or vitreomacular traction. The second type, degenerative, was diagnosed in 48 eyes, and its distinctive traits included the presence of intraretinal cavitation that could affect all retinal layers. It was often associated with nontractional epiretinal proliferation and a retinal "bump." Moreover, it often presented with early ellipsoidal zone defect and its pathogenesis, although chronic and progressive, remains poorly understood. Eleven eyes shared common features with both tractional and degenerative lamellar macular holes and were classified as mixed lesions.**

• CONCLUSIONS: **Degenerative and tractional lamellar macular holes may be 2 distinct clinical entities. A revision of the current concept of lamellar macular holes is needed. (Am J Ophthalmol 2016;164:99–109. © 2016 by Elsevier Inc. All rights reserved.)**

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THE DIAGNOSIS "LAMELLAR MACULAR HOLE" currently refers to a retinal condition characterized by a partial-thickness defect of the macula with an irregular foveal contour and separation between outer and inner retinal layers.[1] Distinct from other macular entities like macular hole and macular pseudohole, lamellar macular hole is typically thought of as a lesion with a lamellar loss of foveal tissue causing distortion of foveal architecture.[2]

The concept of lamellar macular hole was first conceived by Gass in 1976.[3] With slit-lamp biomicroscopy, he described an oval reddish macular lesion in pseudophakic patients with cystoid macular edema, and presented histologic evidence of foveal tissue loss. Later, the introduction of optical coherence tomography (OCT) created a transformative shift in our understanding of in vivo macular pathology and became the gold standard for the diagnosis of lamellar macular hole.[4–6] Recently, spectral-domain technology has replaced time-domain OCT, resulting in dramatically improved resolution and allowing for more detailed analyses of the morphology and evolution of lamellar macular hole.[1,7–9]

With improved macular imaging, a precise definition of lamellar macular hole and clear distinction between several other macular conditions such as pseudohole and macular retinoschisis have blurred. Although OCT-based diagnostic criteria have been proposed, the precise defining features and pathophysiology of these conditions remain unresolved.[10,11]

We hypothesize that the current definitions and terminology may be too broad and may have unintentionally led to misclassification of the entity currently referred to as lamellar macular hole. As a consequence, high levels of heterogeneity, both functionally and morphologically, can be encountered between lesions currently classified as lamellar macular hole.[12] This heterogeneity may also be reflected in the discordant anatomic and visual results within the natural history or after treatment with pars plana vitrectomy and relief of macular traction.[13–20]

Recently, some have focused attention on the "lamellar hole–associated epiretinal proliferation," an entity considered to be characteristic of lamellar macular hole.[12,21,22] This epiretinal proliferation was initially described as a "thicker" or "dense" epiretinal membrane[23] and was later redefined according to its distinctive properties, like the apparent absence of traction, further suggested by histopathologic analysis.[24]

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Due to the anatomic and functional differences between lesions with and without lamellar hole–associated epiretinal proliferation, some authors have suggested that this entity may define a particular subtype of lamellar macular hole.[12,21,22]

However, in our view the presence or absence of this peculiar epiretinal proliferation alone is insufficient to classify lamellar macular hole. Firstly, this proliferation is not specific to lamellar macular hole, as it is also observed in eyes with full-thickness macular hole and epiretinal membrane.[21] Secondly, we hypothesize that lamellar macular hole, as currently classified, may represent more than 1 condition with potentially different natural histories and surgical outcomes. Therefore, the purpose of this study was to investigate the anatomic and functional features of eyes classified as having a lamellar macular hole.

METHODS

A RETROSPECTIVE, OBSERVATIONAL CHART REVIEW OF consecutive patients diagnosed with lamellar macular hole and seen by 2 retina specialists (J.P.H., S.D.S.) at the Stein Eye Institute, University of California Los Angeles was carried out. After the approval from the University of California Los Angeles office of human research protection, cases were identified by medical billing record search, using the International Statistical Classification of Diseases and Related Health Problems, Ninth Revision (ICD-9) diagnosis code 362.54 for macular cysts, holes, and pseudoholes.

Exclusion criteria were history of advanced age-related macular degeneration, diabetic retinopathy, myopic choroidal neovascularization, central retinal vein occlusion, uveitis, trauma, and previous pars plana vitrectomy.

In all cases, OCT images were obtained with the Spectralis OCT (Heidelberg Engineering GmbH, Heidelberg, Germany) and reviewed with the Heidelberg Eye Explorer (version 1.8.6.0) using the HRA/Spectralis Viewing Module (version 5.8.3.0). Additionally, some patients were also imaged with the RS-3000 Advance OCT (Nidek Co, Gamagori, Japan).

The presence of lamellar macular hole was defined according to the following OCT findings: presence of irregular foveal contour, separation of the layers of the neurosensory retina, and the absence of full-thickness macular defects.

Spectralis OCT scan patterns were used for all measurements. All eyes had at least 2 images per visit: 20 × 15 degrees, with 19 B-scans spaced 242 μm, and a single high-definition horizontal line at 30 degrees. In addition, some eyes had high-density 15 × 10 degrees, with 97 B-scans spaced 30 μm. Additional imaging patterns for the RS-3000 Advance OCT were the high-definition macula radial (12 lines), the macula map 9 mm × 9 mm, and a single high-definition horizontal line.

All OCT images were carefully reviewed by at least 2 independent retina specialists (A.G., E.P., H.H.). Analysis and categorization of the morphologic characteristics of lamellar macular hole included shape, minimum foveal retinal thickness, mean central foveal thickness, presence and thickness of the associated epiretinal proliferation, presence of typical epiretinal membrane, integrity of the ellipsoid layer, and the location and morphology of intraretinal separation. We also measured the maximum diameter of the edge of the hole at the level of the retinal surface (inner diameter) and the maximum intraretinal diameter (outer diameter), as seen in Figure 1 (Top and Bottom).

Diameters and minimum foveal retinal thickness measurements were performed with the "caliper" function of the Heidelberg instrument. In all cases, the images were adjusted at 1:1 μm. Mean central foveal thickness as measured was obtained with the automated "thickness map" function of the Heidelberg Eye Explorer.

The best-corrected visual acuity (BCVA) was recorded at each visit and reported in Snellen fraction, which was converted into logarithm of the minimal angle of resolution (logMAR) values for statistical analysis.

In eyes meeting the criteria for lamellar macular hole, lamellar separation of neurosensory retina demonstrated either a "cavitated" or a "schitic" appearance. The schitic appearance was defined by the presence of multiple, narrow hyperreflective tissue bridges crossing wider hyporeflective spaces, located between the outer plexiform and outer nuclear retinal layers (Figure 2, Top left). The cavitated appearance was defined by the presence of a homogeneous round-edged hyporeflective space in the neurosensory retina (Figure 2, Top right).

OCT imaging was also used to differentiate lamellar hole–associated epiretinal proliferation from classic or typical epiretinal membrane. The classical epiretinal membrane tissue was diagnosed as a thinner, irregular and hyperreflective line on the inner retinal surface, occasionally accompanied by areas of hyporeflective space between the membrane and the inner retina, while the lamellar macular hole–associated proliferation was defined as thicker preretinal material of homogenous medium reflectivity (Figure 2, Middle left and Middle right).

To assess signs of retinal traction, we investigated the presence of retinal folds and wrinkling, retinal thickening, and intraretinal cystic spaces (Figure 2, Bottom left and Bottom right).

The progression of lamellar macular hole was assessed both anatomically and functionally. Anatomic progression of lamellar macular hole was defined as widening by more than 50 μm of the inner diameter or of the outer diameter, and/or the appearance of a full-thickness macular hole. We also included the appearance of new defects at the level of the ellipsoid layer in our definition of anatomic progression. Anatomic regression was defined as the reduction of

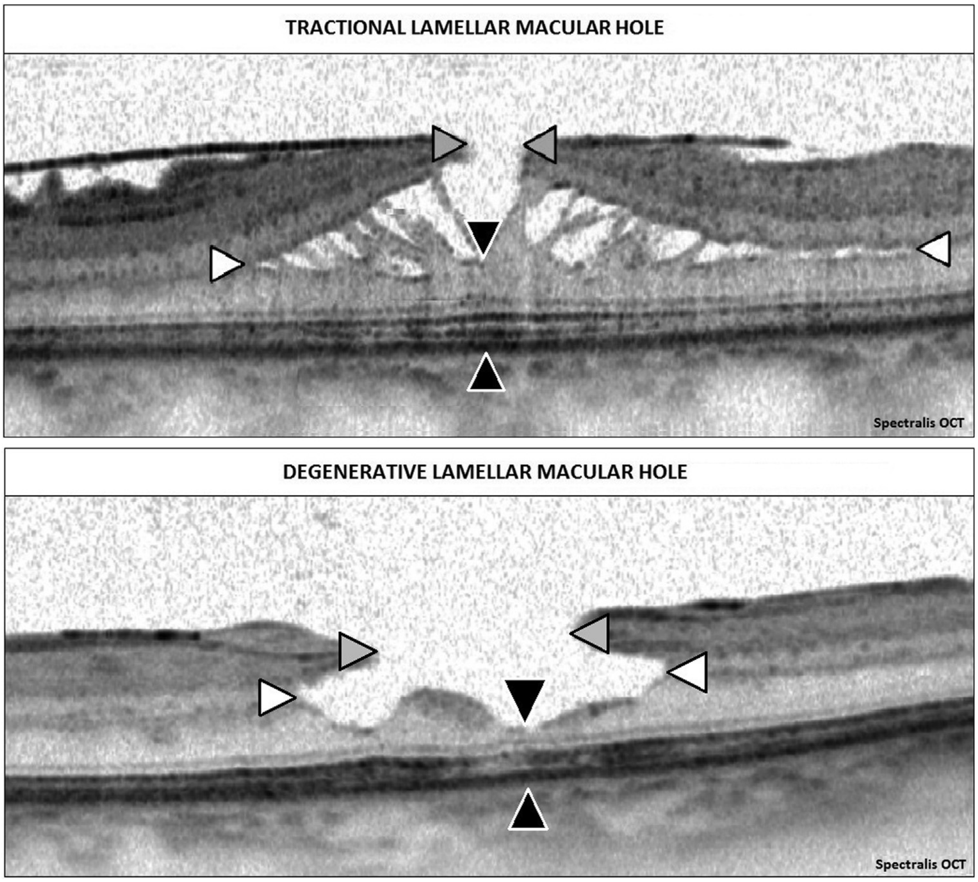

FIGURE 1. Optical coherence tomography measurements of tractional and degenerative lamellar macular hole. (Top) Tractional lamellar macular hole. The widest inner diameter (gray arrows) is the maximum distance between the edges of the hole at the level of the internal limiting membrane. The widest outer diameter (white arrows) is the maximum diameter of the intraretinal schisis. The minimum foveal retinal thickness (black arrows) is the minimum thickness of the retina at the level of the foveal floor. All measurements were made on any cut of a given study. (Bottom) Degenerative lamellar macular hole. The widest inner diameter (gray arrows) is the maximum distance between the edges of the hole at the level of the internal limiting membrane. The widest outer diameter (white arrows) is the maximum diameter of the intraretinal cavitation. The minimum foveal retinal thickness (black arrows) is the minimum thickness of the retina at the level of the foveal floor, typically adjacent to the foveal bump. All measurements were made on any cut of a given study.

the size of either cavitated or schitic lesions, or the resolution of the lamellar macular hole.

Functional progression was defined as any change in BCVA that may reasonably be related to the progression of the lesion itself, and not to cataract formation or other ophthalmic and medical conditions.

Eyes that underwent surgery were excluded from anatomic and functional progression analysis.

All statistical analysis was conducted using SAS software version 9.3 (SAS Institute, Inc, Cary, North Carolina, USA). Descriptive statistics were first calculated for all variables of interest. Mean and standard deviation values were calculated for continuous variables, while frequency and percentage were calculated for categorical variables. Wilcoxon signed rank test was used to determine the statistically significant change between baseline and the end of follow-up in continuous measurements. Kruskal-Wallis test was used to compare the statistically significant difference in continuous measurements among all subgroups. Fisher exact test was used to compare the difference in categorical variables among all subgroups. A *P* value of less than .05 was considered statistically significant.

RESULTS

AFTER A COMPREHENSIVE CHART REVIEW, 102 EYES FROM 90 patients, of which 46 (51.12%) were female and 44 (48.88%) were male, met the inclusion criteria and our definition of lamellar macular hole and were enrolled in the study. Mean age was 73.2 ± 10 years and mean

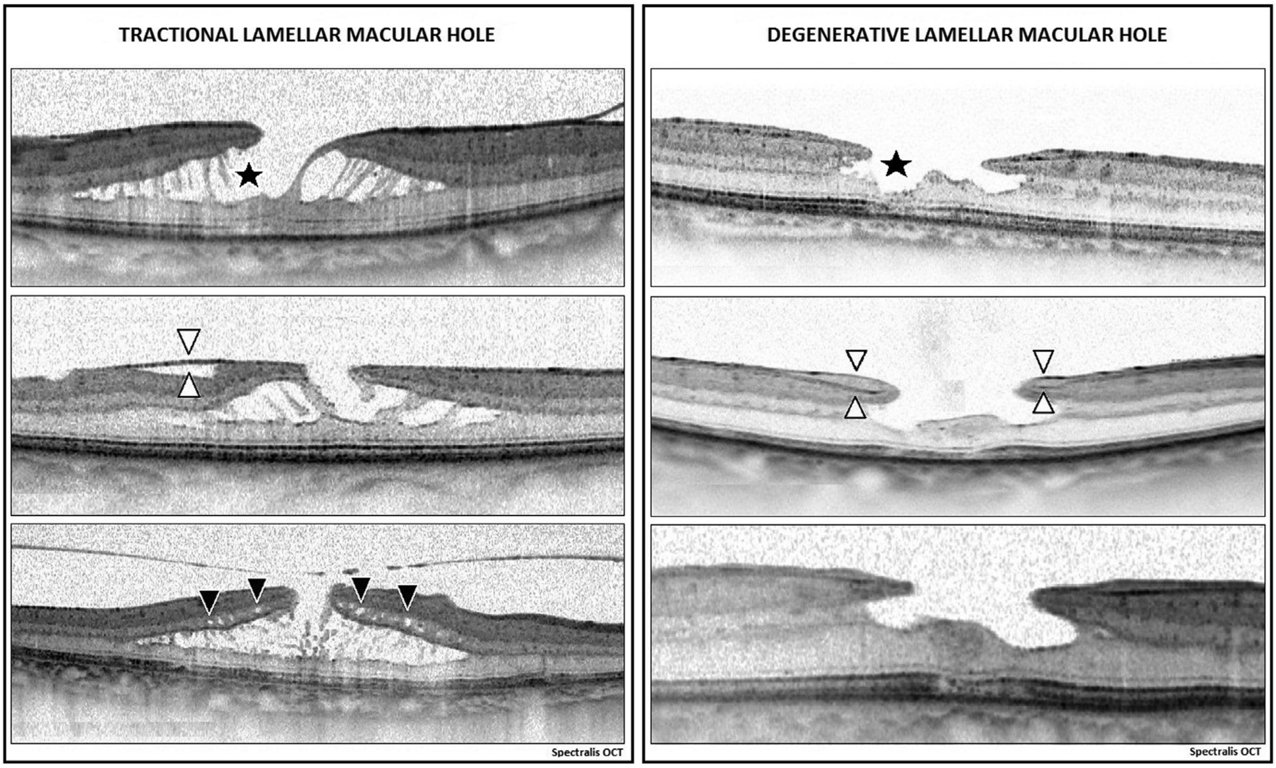

FIGURE 2. Optical coherence tomography features of tractional and degenerative lamellar macular hole. (Left column) Tractional lamellar macular hole. (Top left) The intraretinal schisis is located between outer nuclear and outer plexiform layers (black star) and is characterized by hyperreflective bridges of tissue across wider hyporeflective spaces. (Middle left) Epiretinal membranes are irregular, thin, and hyperreflective lines above the inner retinal surface. Direct and uniform contact with the underlying retina is not always present and is indicative of traction. Note hyporeflective spaces between the epiretinal membrane and the inner retina (white arrows). (Bottom left) Intraretinal cystoid spaces are visible in the inner plexiform layer of tractional lamellar macular holes as small, well delimited hyporeflective areas distinct from schisis, as seen above (black arrows). (Right column) Degenerative lamellar macular hole. (Top right) The intraretinal cavitation is visible as a wide, homogeneous, hyporeflective area involving layers of the neurosensory retina (black star). (Middle right) Lamellar macular hole–associated epiretinal proliferation is visible as homogeneous material with medium reflectivity (white arrows). Note direct, uniform contact between the proliferation and the underlying retina without evidence of traction. (Bottom right) Intraretinal cysts are not typically observed in degenerative lamellar macular hole.

follow-up was 33.6 ± 21.7 months. Of the 102 included eyes, 52 (50.98%) were phakic and 50 (49.02%) pseudophakic at baseline.

Analysis of OCT images suggested 2 distinct subtypes of lamellar macular hole defined by specific morphologic features (Figure 3, Top and Bottom). The first type (Figure 3, Top) was diagnosed in 48 out of 102 eyes (47.06%) and had a "top hat" appearance. Its distinctive characteristics included the presence of a foveal bump, the presence of lamellar hole–associated proliferation, and, in the large majority of the cases, a disrupted ellipsoid zone. Generally, the ratio between inner and outer diameter was more than 1:2 in this group, with a mean value of 0.76 ± 0.38. Furthermore, this subtype was characterized by a round-edged intraretinal cavitation potentially involving outer retinal layers, rather than a "split" between inner and outer retina. We termed this condition "degenerative lamellar macular hole."

The second type observed (Figure 3, Bottom) was diagnosed in 43 out of 102 eyes (42.15%) and had a "moustache" appearance. Its features included the presence of tractional epiretinal membrane. In contrast with degenerative lamellar macular hole, the ratio between inner and outer diameter was generally less than 1:2, with a mean value of 0.31 ± 0.28, and also the ellipsoid layer was intact in almost all cases. Finally, distinct from the degenerative subtype, these lesions were characterized by a sharp-edged schisis-like appearance between outer plexiform and outer nuclear layers, which rarely affected the deeper retinal layers. We termed this subtype "tractional lamellar macular hole." Criteria for the diagnosis of both degenerative and tractional lamellar macular hole are summarized in Table 1.

Eleven out of 102 eyes (10.78%) with lamellar macular hole shared common features of both tractional and degenerative lamellar macular hole and, as a consequence, were classified as "mixed" lesions. Owing to the small number of

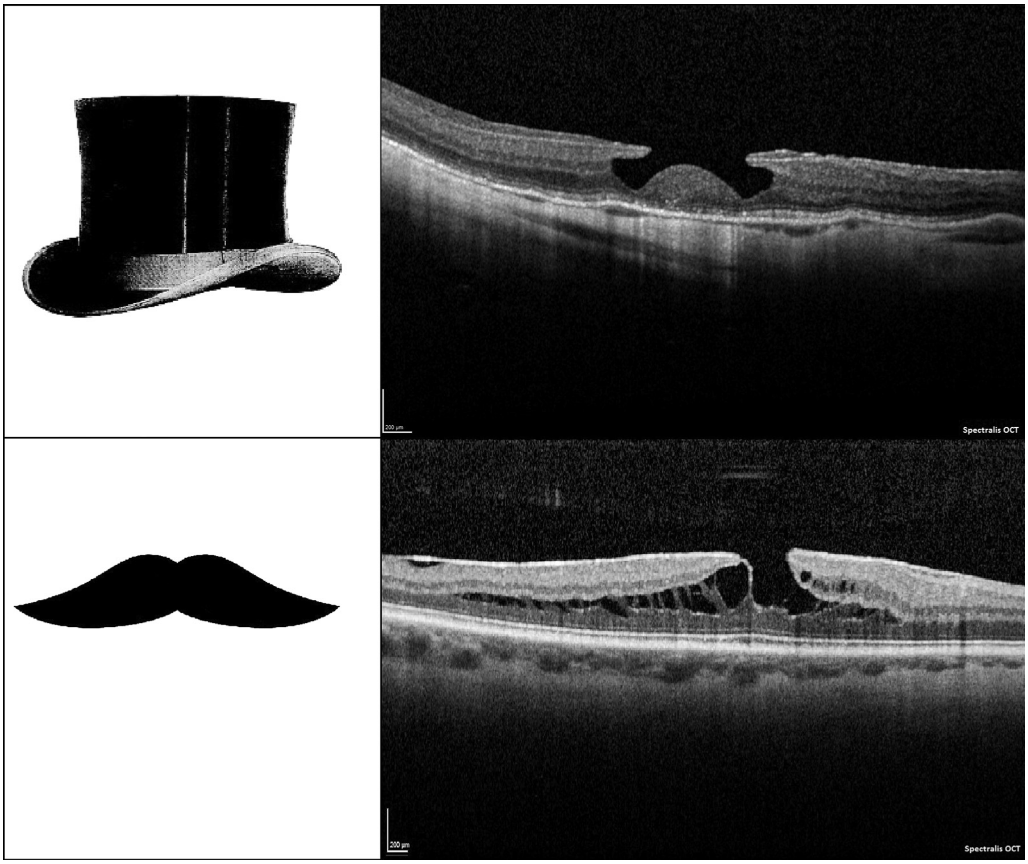

FIGURE 3. Morphology of degenerative and tractional lamellar macular hole. (Top) Degenerative lamellar macular hole, characterized by a "top hat" appearance with round-edged intraretinal cavitation, ellipsoid layer defect, presence of epiretinal proliferation, and a central retinal bump. (Bottom) Tractional lamellar macular hole, characterized by a "moustache" appearance with schitic sharp-edged intraretinal split, intact ellipsoid layer, presence of tractional epiretinal membranes, and intraretinal cystoid spaces.

eyes included in this group, their characteristics are not described in this section.

Bilateral lamellar macular hole was diagnosed in 12 out of 90 (13.3%) of the included patients. Of those, 4 presented with bilateral tractional lamellar macular hole, while 6 were diagnosed with bilateral degenerative subtype. The remaining 2 patients had a degenerative lamellar macular hole in 1 eye and a mixed lesion in the fellow eye.

Mean follow-up for degenerative and tractional lamellar macular hole were similar: 38.2 ± 21 (range 6.1–77.4) months and 29.6 ± 21.8 (range 3.1–76) months, respectively. While there were no significant sex differences between groups ($P = .12$), patients classified with degenerative lamellar macular hole were significantly older (75.8 ± 10 years) compared to those with tractional subtype (69.3 ± 8.9 years), with a P value of .004.

The morphologic differences encountered between groups were reflected in our measurements, and are reported in Table 2.

At presentation, degenerative lamellar macular hole was characterized by mean central foveal thickness of 293 ± 46.8 μm, while in tractional lamellar macular hole this value was significantly thicker (374.1 ± 61.3 μm, $P = .0001$). Mean central foveal thickness did not change significantly over the follow-up period for both degenerative lamellar macular hole (293 ± 46.8 μm at presentation vs 290.3 ± 39.6 μm at the last follow-up visit, $P = .28$) and tractional lamellar macular hole (374.1 ± 61.3 μm at presentation vs 368 ± 67.4 μm at the last follow-up visit, $P = .18$).

Differently, in both subgroups the mean inner and outer diameter increased significantly from baseline to the end of the follow-up period. A slow tendency to anatomic progression was observed in 25 out of 48 eyes (52%) in the degenerative group and in 21 out of 43 eyes (49%) in the tractional group.

In the degenerative lamellar macular hole group, the intraretinal cavitation was associated with significant outer retinal compromise, as demonstrated by the thinner mean minimum retinal thickness and the frequent defects of the ellipsoid layer reported in these lesions (Figure 4, Top).

At baseline, 46 out of 48 eyes (95.8%) classified as degenerative lamellar macular hole demonstrated alterations in

TABLE 1. Diagnostic Criteria for Degenerative and Tractional Lamellar Macular Holes

Diagnostic Criteria[a]			
Degenerative n = 48		Tractional n = 43	
Inner/outer diameter ratio > 1:2	n = 44 (91.67%)	Inner/outer diameter ratio < 1:2	n = 37 (86.05%)
Ellipsoid defect	n = 46 (95.83%)	Intact ellipsoid	n = 42 (97.67%)
Round-edged cavitation	n = 47 (97.92%)	Sharp-edged split	n = 43 (100%)
Foveal bump	n = 42 (87.50%)	Intraretinal cystoid spaces	n = 35 (81.40%)
Epiretinal proliferation	n = 46 (95.83%)	Epiretinal membrane	n = 42 (97.67%)

[a]Diagnosis is made with a minimum of 3 out of 5 criteria. If the lesion does not match with both categories, it is classified as "mixed."

TABLE 2. Anatomic and Functional Characteristics of Degenerative and Tractional Lamellar Macular Holes

	Measurements	Degenerative Group	Tractional Group	
Baseline	Inner diameter	521.7 ± 197.2 μm	365.7 ± 214.8 μm	*P* = .002
End of follow-up		569.8 ± 203.7 μm	456.5 ± 244.1 μm	*P* = .034
		P = .022	*P* = .031	
Baseline	Outer diameter	789.7 ± 387.3 μm	1510.3 ± 649.2 μm	*P* < .0001
End of follow-up		905.9 ± 356.8 μm	1746.3 ± 903.7 μm	*P* < .0001
		P = .001	*P* = .001	
Baseline	Retinal thickness	101.1 ± 34.0 μm	140.2 ± 20.3 μm	*P* < .0001
End of follow-up		95.2 ± 36.4 μm	139.0 ± 21.8 μm	*P* < .0001
		P = .058	*P* = .21	
Baseline	BCVA	0.27 ± 0.20 logMAR	0.13 ± 0.12 logMAR	*P* = .0007
End of follow-up		0.32 ± 0.26 logMAR	0.17 ± 0.19 logMAR	*P* = .006
		P = .42	*P* = .52	

BCVA = best-corrected visual acuity.

the ellipsoid layer. This figure progressed to 100% by the end of the follow-up period. Contrastingly, only 1 out of 43 eyes (2.3%) classified as tractional lamellar macular hole demonstrated disruption of the ellipsoid layer at baseline and this figure progressed to 7 out of 43 eyes (16.3%) at the end of the follow-up period (Figure 4, Bottom).

Interestingly, the majority of lesions classified as degenerative (42 out of 48, 87.5%), were characterized by the presence of a foveal "bump" of presumably spared tissue, located in the base of the lesion, in the foveal region (Figure 4, Top). In contrast, none of the eyes classified as tractional lamellar macular hole presented with this morphologic feature. Furthermore, none developed during the follow-up period (Figure 4, Bottom).

Most eyes classified with degenerative lamellar macular hole (46 out of 48, 95.8%) were characterized by the presence of lamellar hole associated proliferation. Mean thickness of such proliferation increased significantly from baseline (39.7 ± 13 μm) to the last follow-up visit (48.7 ± 14.15 μm, $P < .0001$). In contrast, this type of proliferation was encountered in only 1 out of 43 eyes classified as tractional lamellar macular hole (2.3%). In all cases, in both degenerative and tractional lesions, the proliferation was associated with defects in the ellipsoid layer (Figure 4, Top). The majority of eyes classified with tractional lamellar macular hole, 42 out of 43 (97.7%), demonstrated typical epiretinal membrane. Only 9 out of 48 eyes (18.8%) classified as degenerative macular hole demonstrated typical epiretinal membrane.

Signs of traction such as retinal folds, wrinkling, and intraretinal cystic spaces were seen in 36 out of 43 eyes (83.7%) diagnosed with tractional lamellar macular hole. Contrastingly, signs of traction were only present in 7 out of 48 eyes (14.6%) diagnosed with degenerative lamellar macular hole.

The degenerative lamellar macular hole group demonstrated no significant differences ($P = .42$) between the mean baseline BCVA of 0.27 ± 0.20 logMAR (Snellen equivalent 20/37) and the final mean BCVA of 0.30 ± 0.26 logMAR (Snellen equivalent 20/40).

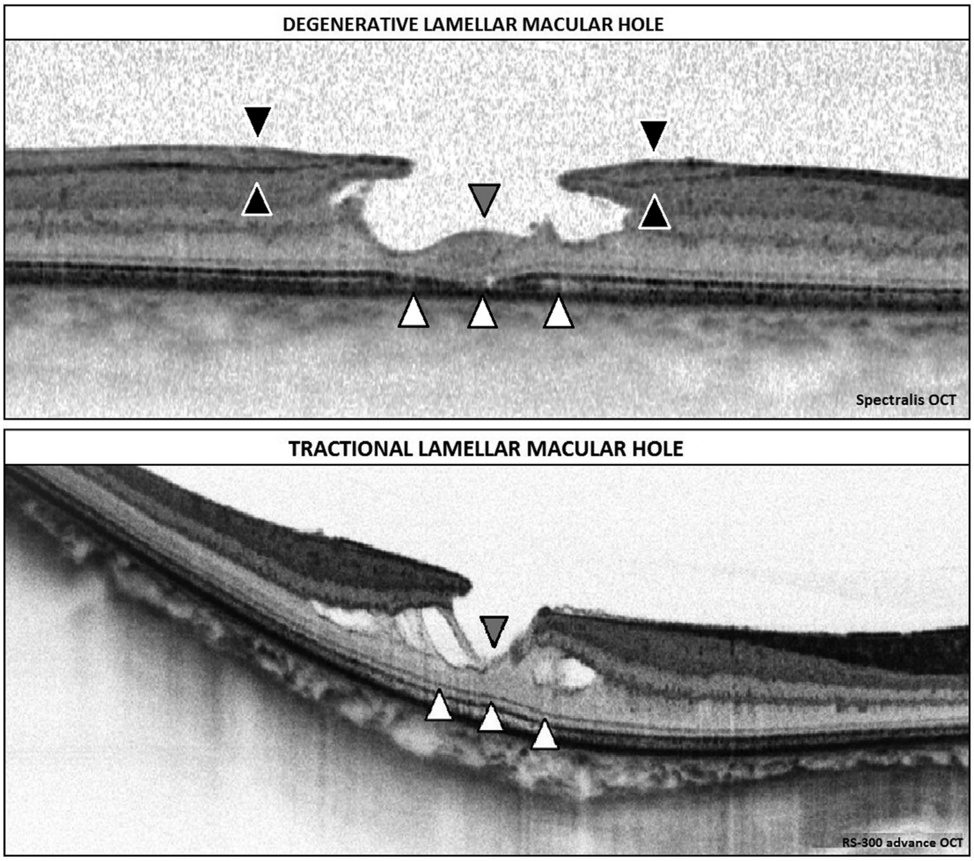

FIGURE 4. Lamellar macular hole and ellipsoid layer status. (Top) Degenerative lamellar macular hole. Disruption of the ellipsoid layer (white arrows) is accompanied by the presence of the lamellar hole–associated epiretinal proliferation (black arrows). A retinal bump of presumably spared tissue is located in the foveal region (gray arrow). (Bottom) Tractional lamellar macular hole. The ellipsoid layer is intact (white arrows) and the schitic separation of the neurosensory retina does not spare the central foveal region (gray arrow).

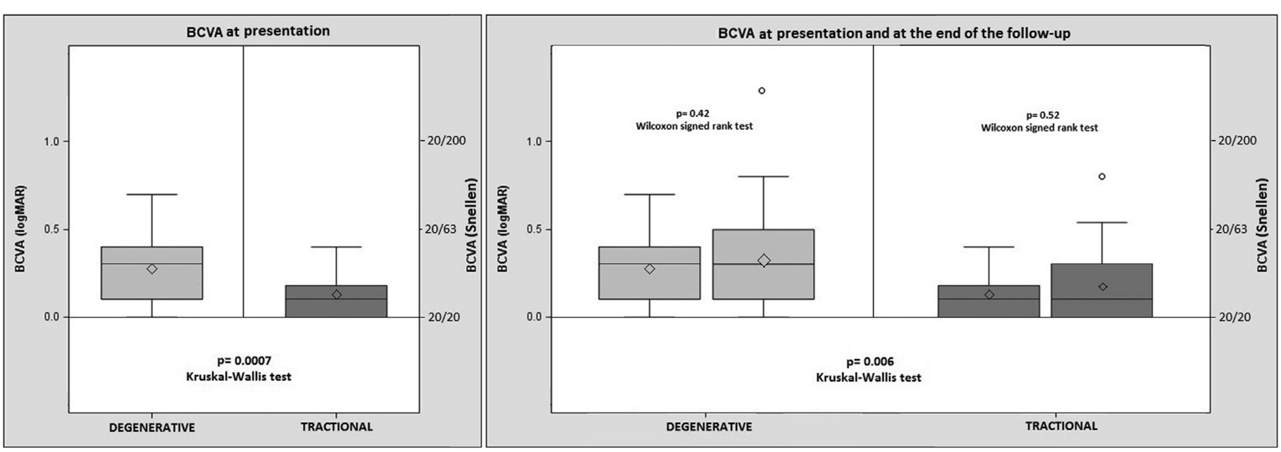

FIGURE 5. Best-corrected visual acuity (BCVA) in tractional and degenerative lamellar macular hole over the follow-up period. In this study, mean BCVA at presentation was significantly lower in degenerative lamellar macular hole when compared to tractional lamellar macular hole (20/37 and 20/27 Snellen equivalent, respectively). BCVA remained stable over the follow-up period in both degenerative and tractional lamellar macular hole (20/40 and 20/29 Snellen equivalent, respectively).

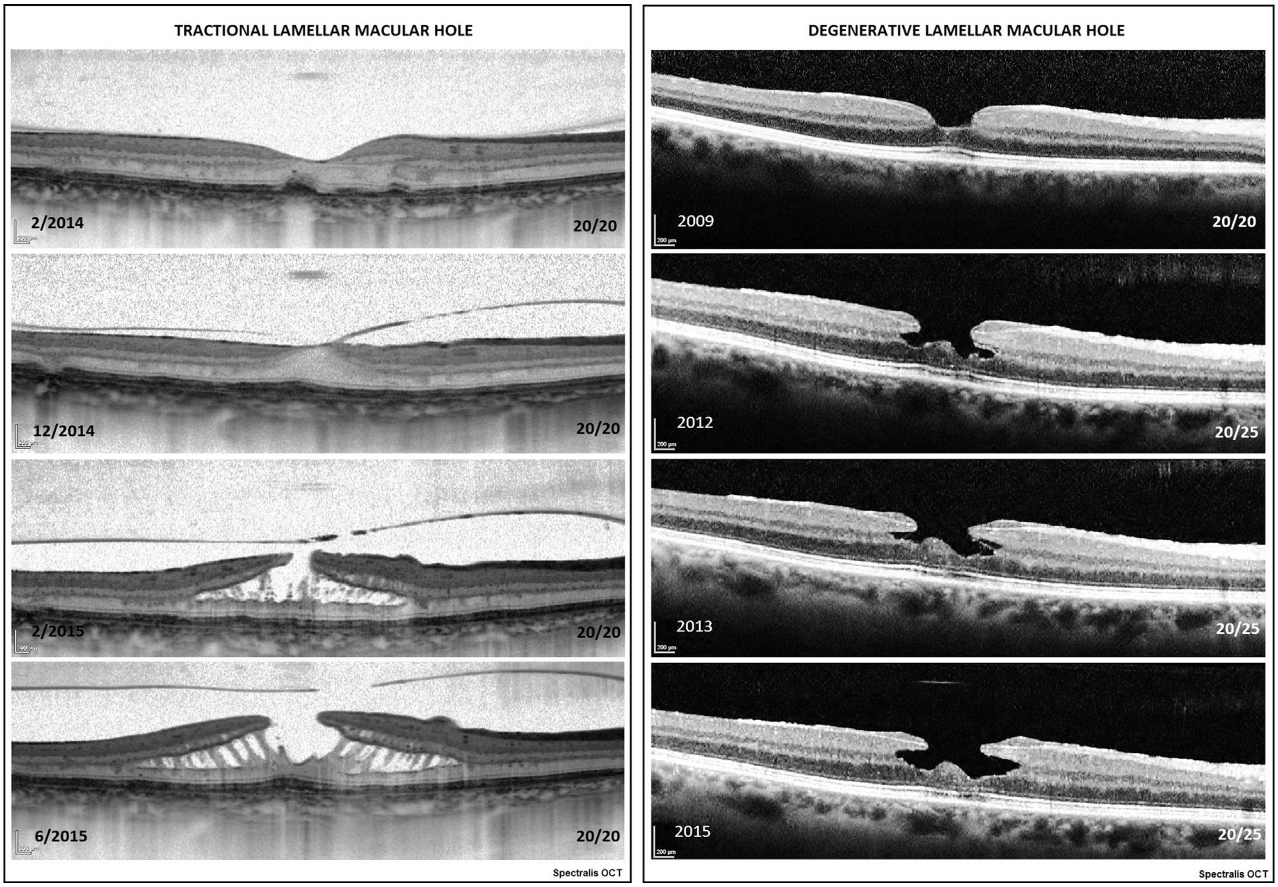

FIGURE 6. Natural history of tractional and degenerative lamellar macular hole. (Left) Tractional lamellar macular hole. Formation of a tractional lamellar macular hole due to vitreomacular traction. At the end of the follow-up period, the lesion has the typical "moustache" morphology. Images are presented in black on white to enhance the visualization of the vitreous. (Right) Degenerative lamellar macular hole. The presence of epiretinal proliferation and ellipsoid defect is noticeable at early stages of degenerative lamellar macular hole formation, without signs of traction. The pathophysiological process seems slow but progressive, and involves all retinal layers. At the end of the follow-up period, the lesion has the typical "top hat" morphology.

Similarly, mean BCVA in the tractional lamellar macular hole group remained relatively stable during follow-up: 0.13 ± 0.12 logMAR (Snellen equivalent 20/27) at baseline and 0.17 ± 0.19 logMAR (Snellen equivalent 20/29) at the last visit ($P = .52$). Differences in mean BCVA between the 2 groups were significant both at baseline ($P = .0007$) and at the last follow-up visit ($P = .006$). Eyes that underwent surgery were excluded from this analysis.

Graphic representation of BCVA in both groups at baseline and at the end of follow-up is presented in Figure 5.

DISCUSSION

THE CONCEPT OF LAMELLAR MACULAR HOLE, DESPITE ITS apparent simplicity, represents a puzzle for clinicians and investigators, as indicated by the large number of studies focused on this issue. Subsequent to the earliest descriptive studies, the diagnosis has been strongly dependent on OCT as the morphologic descriptions, natural history, and prognostic and interventional literature regarding lamellar macular hole evolved concurrently with the improvement of OCT imaging resolution.[1,2,4–9,11]

For instance, Haouchine and associates used time-domain OCT to describe lamellar macular holes as lesions with thin and irregular foveal floor, split foveal edges, and normal perifoveal thickness.[2] Later, Witkin and associates further refined this description, proposing 4 criteria for the diagnosis of lamellar macular hole with spectral-domain OCT: irregular foveal contour, break in inner fovea, intraretinal split located between the outer plexiform and outer nuclear layers, and intact foveal photoreceptors.[1]

A number of theories have been proposed to explain the formation of lamellar macular hole, including the union of intraretinal cysts,[3] aborted formation of full-thickness macular hole,[2,7,8] and centrifugal traction of epiretinal

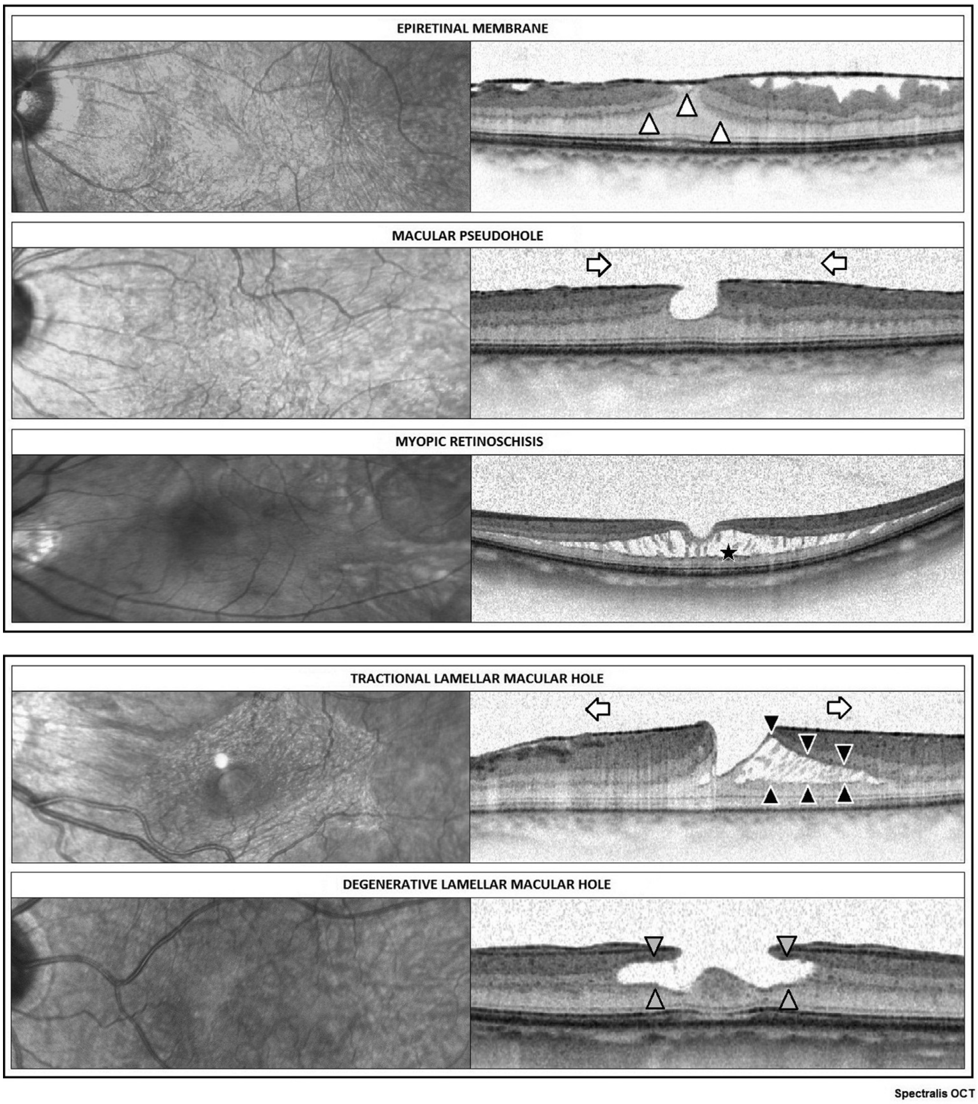

FIGURE 7. Optical coherence tomography findings for similar conditions. Tractional forces caused by epiretinal membranes may produce a distortion of the foveal anatomy (white arrows). Occasionally, tractional forces may contract the epiretinal membrane, resulting in the formation of a macular pseudohole. In myopic retinoschisis, tractional forces of different etiologies may contribute to the separation of the neurosensory retina, typically characterized by bridges of tissue between outer nuclear and outer plexiform layers (black star). In tractional lamellar macular hole, epiretinal membranes generate tractional forces that may cause alterations in the fovea and a definite cleavage plane (black arrows), resulting in a schitic separation similar in morphology and location to myopic retinoschisis. Differently, in degenerative lamellar macular hole no signs of traction are visible and the intraretinal cavitation does not follow a definite cleavage plane (gray arrows).

membranes.[14] However, none of these hypotheses seem to unify the spectrum of findings observed within the current classification of lamellar macular hole. Similarly, prognostic data and interventional data vary from study to study.[13–20]

We hypothesize that current definitions of lamellar macular hole may be artifactually broad and mistakenly inclusive of more than 1 entity, the distinction of which could not be resolved with last-generation OCT technology. In this regard, Gaudric and associates in a recent article[10] seem to agree with us that the entity currently referred to as lamellar macular hole may need to be reclassified. Specifically, the condition herein described as tractional lamellar macular hole seems to resemble the definition by Witkin and associates. On the contrary, the concept of lamellar macular hole proposed by Hauchine and associates may recall that of the degenerative lamellar macular hole.

Fully recognizing that these definitions will continue to evolve with improved imaging, observation, and study, we have proposed the tractional and degenerative subtypes of lamellar macular hole, which may represent different pathologic conditions with equally different clinical implications.

By our definition, the presence of traction may play a pivotal role in the development of tractional lamellar macular hole, as the presence of epiretinal membrane with tractional signs on the underlying retina was observed in the vast majority of lesions of this subtype. Vitreomacular traction may also play a role in these lesions (Figure 6, Left). The characteristic schisis-like separation between the outer plexiform and outer nuclear layers[14] may be a reaction to the apparent traction observed in this study.

The pathophysiology of degenerative lamellar macular hole may represent a distinct pathway to that of the tractional lamellar macular hole, or it may be a different reaction to a similar stimulus. The high frequency of lamellar macular hole–associated proliferation, which is an entity with few apparent contractile properties, may exclude traction as the main driving force in the formation of this subtype of lamellar macular hole. Accordingly, the presence of typical, tractional epiretinal membrane was rarely observed in this subtype of lamellar macular hole.

Interestingly, distinct from the tractional subtype, the degenerative lamellar hole group does not demonstrate splitting of the retina along any definite cleavage plane, and it can affect all retinal layers. Consequently, rather than a definitive separation, the evolution of this type of lamellar macular hole may suggest a slow, chronic, degenerative process causing loss of retinal tissue and the disruption of the ellipsoid layer (Figure 6, Right).

Although the management of lamellar macular hole has traditionally been a matter of contention for surgeons and clinicians, observation may often be preferred to surgery, as these lesions are considered to be relatively stable. Our data generally support observation as best clinical practice despite some anatomic progression in both groups. However, given the retrospective nature of this study and the relatively short follow-up of the lesions, data presented herein are insufficient to warrant any clear and generalizable recommendations. Again, BCVA remained stable in both tractional and degenerative lamellar macular hole groups.

In this study, not all eyes classified as lamellar macular hole stratified into tractional or degenerative subtypes, as some lesions showed features of both. A number of interesting potential explanations exist. First, some lesions may have presented early in the course of the condition prior to developing distinguishing features. This hypothesis would suggest a common early event followed by a divergence into distinct phenotypes. Another potential explanation is that these subtypes actually represent lesions arising from distinct pathogenic mechanisms and thus the current diagnosis of lamellar macular hole actually encompasses more than 1 condition. In this instance, combined lesions observed in this study might have features of both conditions.

Limitations of our study include its retrospective nature and the lack of autofluorescence images, which are useful to assess alteration of the retinal pigment epithelium and its relationship the visual cycle. Moreover, owing to retrospective limitations in OCT imaging, it was not possible to properly assess the condition of the vitreous, which may be significant in the formation of both tractional and degenerative lamellar macular hole. Furthermore, the validity of our statistical analysis is limited, as ours was not a purely descriptive series.

In conclusion, this report attempts to redefine the current concept of lamellar macular hole by describing 2 apparently distinct clinical entities or subtypes currently classified as lamellar macular hole: tractional and degenerative lamellar macular hole. Tractional lamellar macular hole is a partial-thickness macular lesion with a "moustache" appearance on OCT and is characterized by schitic separation of the neurosensory retina between outer plexiform and outer nuclear layers, often with an intact ellipsoid layer and associated with tractional epiretinal membranes and/or vitreomacular traction. This entity may share a common pathophysiological pathway with macular retinoschisis and pseudoholes (Figure 7). Degenerative lamellar macular hole is characterized by a partial-thickness macular lesion with a "top hat" appearance on OCT, and by an intraretinal cavitation that can affect all retinal layers. These degenerative-appearing lesions are also characterized by nontractional epiretinal proliferation and early ellipsoid layer disruption. These lesions may be caused by a chronic, progressive, degenerative mechanism, which remains poorly understood.

Further investigations are needed to better understand the pathophysiology and stages of both tractional and degenerative lamellar macular hole prior to developing rational preventive and interventional strategies.

This study explores morphologic and pathophysiological characteristics of lesions currently classified as lamellar macular hole, with the hope that our results and proposed classification scheme will inform and stimulate future study so as to achieve a broader consensus on the definition and ultimately improve the management of these lesions.

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