

# Relationship between full-thickness macular hole and retinal break/lattice degeneration

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**Background:** The purpose is to investigate the relationship between full-thickness macular hole (MH) and retinal break (RB) and/or lattice degeneration.

**Methods:** Patients diagnosed as full-thickness MH and referred to Dr. Lin Lu from January 2009 to December 2013 were evaluated. All patients underwent general ophthalmologic examinations, fundus examination and optical coherence tomography (OCT). The RB and/or lattice degeneration were recorded.

**Results:** Totally 183 eyes of 167 patients were included. The sex ratio of men to women was 1:2.88. A total of 17 eyes were pseudophakic and 166 eyes were phakic. RB and/or lattice degeneration were found in 62 eyes (33.88%). The prevalence of RB and/or lattice degeneration was similar between men and women ( $P=0.344>0.05$ ). There was no statistical difference between the pseudophakic eyes and phakic eyes ( $P=0.138>0.05$ ). All of the RB and/or lattice degeneration were located near or anterior to the equator. The inferior quadrants and the vertical meridian were affected more often than the superior quadrants and the horizontal meridian.

**Conclusions:** We identified a high incidence of RB/lattice degeneration in cases of full-thickness MH. Carefully examination of the peripheral retina and prophylactic treatment of RB and/or lattice degeneration are critical.

**Keywords:** Macular hole (MH); retinal break (RB); lattice degeneration; optical coherence tomography (OCT); vitreous retinopathy

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## Introduction

The pathogenesis of full-thickness macular hole (MH) is not clearly understood but is believed to involve anteroposterior traction and/or tangential traction exerted by the posterior vitreous cortex at the fovea (1). Retinal break (RB) and lattice degeneration are one of the most important abnormalities of vitreous and vitreoretinal interface. To figure out the relationship between the full-thickness MH and RB/lattice degeneration may contribute

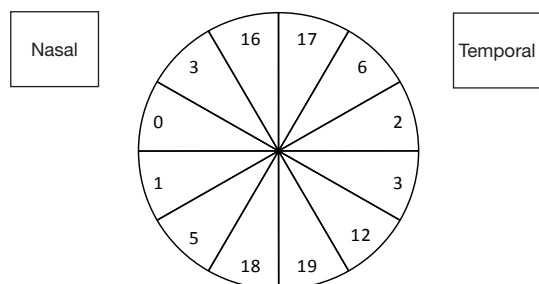
to the understanding of their pathogenesis. We conducted a prospective observational case series to investigate the relationship between full-thickness MH and RB/lattice degeneration.

## Methods

This is a prospective observational case series study conducted according to the tenets of Declaration of Helsinki. All patients gave informed consent to being

**Table 1** Macular hole (MH) staging and anatomic outcome

Characteristics	Eyes
<b>MH stage</b>	
2	23 (12.57%)
3	97 (53.01%)
4	63 (34.43%)
<b>Anatomy outcome</b>	
Retinal breaks	8
Lattice degeneration	41
Lattice degeneration and retinal breaks	13
Retinal breaks in the lattice degeneration lesions	8
Retinal breaks not in the lattice degeneration lesions	5



**Figure 1** Relative distribution of retina break (RB)/lattice degeneration. This figure showed the relative distribution of RB/lattice degeneration. The lesions were somewhat more prevalent in the inferior hemisphere (58/102, 56.87%). The vertical meridian was affected more often than the horizontal meridian (70 vs. 6).

imaged and for the collected data to be used for publication. The Zhongshan Ophthalmic Center Ethics Committee did not require for this study to undergo Internal Review Board (IRB) approval as all the tests carried out were part of the routine care of patients.

This study included patients who were diagnosed as full-thickness MH and referred to Dr. Lin Lu from January 2009 to December 2013 at the Zhongshan Ophthalmic Center. Patients suffering from MH secondary to uveitis, trauma, and high myopia or associated with a simultaneous retinal detachment (RD) were excluded. All the patients received a general ophthalmologic examination. The status of macular was confirmed by optical coherence tomography (OCT). MH were graded using the Gass classification (2). The fundus was carefully inspected by a three-minor

Goldmann lens with a dilated pupil. The RB and/or lattice degeneration were recorded.

Numerical computations were performed using a spreadsheet package (Excel 2010; Microsoft, Redmond, WA, USA). Statistical comparison of categorical findings was performed using the Chi-square test. Statistical significance was set as  $P < 0.05$ .

**Results**

In all, 183 eyes of 167 patients fulfilled the inclusion and exclusion criteria. A total of 124 patients (74.25%) were women. The sex ratio of men to women was 1:2.88. And the 16 bilateral MH cases were all women. The mean age of patients at presentation was  $66.02 \pm 7.30$  (range, 54 to 79) years. The mean duration of patients' symptoms was  $11.46 \pm 6.66$  (range, 1 to 24) months.

Mean spherical equivalent refractive error was  $-1.17 \pm 1.55$  (range,  $-4.00$  to  $1.50$ ) diopters. The mean intraocular pressure was  $15.87 \pm 3.28$  (range, 10 to 24) mmHg. Seventeen eyes (9.29%) were pseudophakic and the remaining 166 eyes (90.71%) were phakic. MH were most commonly graded as stage 3, followed by stage 4 and stage 2 (Table 1).

RB and/or lattice degeneration were detected in 62 eyes (33.88%). Three of them had the history of prophylactic laser photocoagulation. The lattice degeneration seems to be more common than RB (Table 1). Most of the RB were atrophic holes and only one of them was horseshoe-shaped tear. The prevalence of RB and/or lattice degeneration was similar ( $P = 0.344 > 0.05$ ) between men (12/43, 27.91%) and women (50/140, 35.71%). Lattice degenerations were found in three eyes of pseudophakic eyes. There was no statistical difference between the pseudophakic eyes and phakic eyes ( $P = 0.138 > 0.05$ ). All of the RB/lattice degeneration was located near or anterior to the equator. The inferior quadrants and the vertical meridian were affected more often than the superior quadrants and the horizontal meridian (Figure 1).

**Discussion**

No previous study on the relationship between RB/lattice degeneration and MH has been reported. Few studies mentioned it indirectly and had a few limitations. Guillaubey *et al.* (3) retrospectively analyzed 272 idiopathic MH surgery cases. Only the cases of RB were recorded and the lattice degenerations were not included. No RD

occurred in patients presenting with an intraoperative (14 eyes) or preoperative (21 eyes) successfully treated RB. They didn't mention the RB found during the procedure was iatrogenic or not. If the RB found during the procedure were already exist, the RB rate (12.87%) in their cases is similar with ours cases (21/183=11.48%). In another study by Hwang *et al.* (4), 235 MH surgery cases were reviewed. Only eight eyes (3.40%) preexisted RB and/or lattice degeneration before the surgery received intraoperative endolaser photocoagulation. They only concerned about the cases which had been treated during the operation and didn't present the status before the surgery. That's why the RB and/or lattice degeneration rate seems so low in their series.

The prevalence of lattice degeneration of the retina ranges from 6% to 10.7% in the general populations (5-7). In the fellow eye of patients with RD the prevalence is estimated to be 35% (8). This study identified that RB and/or lattice degeneration were involved in almost one third of the full-thickness MH cases. It revealed MH and RB/lattice degeneration might have some pathogenic relationship.

Generally the attachment of the vitreous to the retina is greatest at those sites where the ILM of the retina is the thinnest. These sites include the vitreous base, the major retinal vessels, the optic nerve head, the 1,500- $\mu\text{m}$ -diameter rim surrounding the fovea, and the 500- $\mu\text{m}$ -diameter foveola. Forces generated by movement of the vitreous and the premacular bursa as the eye moves may also play a role in the pathogenesis of posterior vitreous detachment, MH and RB (9). This theory might explain why the RB and/or lattice degenerations found in our cases were located near or anterior to the equator. The RB/lattice degeneration was involved in the inferior temporal quadrant most often in our cases. A total of 68.63% of the lesions were found between the clock hours of 11 to 1 above, or between 5 and 7 below. These findings are similar to previously reported outcomes (5-7). The movement of the eyeball contributes to distribution of the lesions.

Not only the anatomic factors were involved but also the genetic factors may play important roles. Pathogenic features of lattice degeneration of retina include liquefaction of the adjacent vitreous humor, absence of vitreoretinal attachments, absence of the internal limiting membrane (ILM) over the lesions, and vitreous condensation with a firm vitreoretinal attachment at the lesion margins. Pathogenesis may be due to a developmental abnormality involving the ILM of the retina (10). It has been demonstrated the presence of the  $\alpha 3$  (IV) - $\alpha 5$  (IV) collagen

chains in the normal ILM as well as the RPE basement membrane of Bruch's membrane (11). Alport syndrome is an inherited disease and characterized by renal failure, hearing loss, lenticonus, and retinopathy (12). Mutations in the *COL4A3*, -4 and -5 genes in Alport syndrome (13,14) result in the loss of  $\alpha 3$  (IV) - $\alpha 5$  (IV) collagen network from affected basement membranes (15) and the subsequent development of thinning or lamellation (16-18). Vitreoretinal degeneration is complicated by RD in Alport syndrome. Savige *et al.* (11) demonstrated the retinopathy principally affected the ILM/nerve fiber layer (NFL). A thinned ILM may be more susceptible to tractional forces from the vitreous, interfere with the transport of nutrients, or impair the clearance of waste products. Therefore MH associated with Alport syndrome are rare, but they are typically larger than those found in other conditions (19-23). What's more, Smiddy and Flynn demonstrated the importance of the role of degeneration of the inner retinal layers in the formation of MH (24). Meguro *et al.* (25) discovered *COL4A4* on chromosome 2q36.3 was strongly associated with lattice degeneration of the retina susceptibility. The variants in the *COL4A4* gene may contribute to the development of lattice degeneration of the retina. We speculated that aberrations in *COL4A4* may be involved in cases of full-thickness MH.

OCT had disclosed a significant progression of posterior vitreous detachment after phacoemulsification (26). Even so, there is no evidence that RB/lattice degeneration deteriorates after phacoemulsification. In our study, the prevalence of RB/lattice degeneration in the MH cases were similar between the pseudophakic and phakic eyes. Interestingly, most of the full-thickness MH cases were phakic. The onset age of MH is relatively young might be the reason.

In conclusion, the prevalence of RB/lattice degeneration is high in full-thickness MH. Preoperative and intraoperative detection and treatment of RB/lattice degeneration are critical.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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