Brief Report

Lattice Degeneration Imaging with Optical Coherence Tomography Angiography

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Abstract

Purpose: To describe a series of cases of lattice degeneration of the retina imaged with optical coherence tomography angiography (OCTA).

Methods: Four eyes of four patients were included and evaluated with green reflectance using a confocal scanning laser ophthalmoscopy and OCTA. In each case, the microcirculation of the retina and choriocapillaris within the lesion, as well as choroidal thickness beneath the lesion, were assessed.

Results: OCTA showed regional loss of retinal perfusion and rarefication of the choriocapillaris network within the lesion and the presence of venous collectors in the choroid beneath the lesion. The choroid was substantially thinner beneath the lesion compared to the adjacent normal region. Cross-sectional OCT scans showed retinal thinning, vitreal adhesion, atrophic holes, and subretinal fluid within the lesions.

Conclusion: Lattice degeneration is characterized by significant local changes in retinal and choroidal microcirculation which may play an important role in the pathophysiology of lattice degeneration.

Keywords: Choriocapillaris, Choroid, Lattice degeneration, Optical coherence tomography angiography, Retinal perfusion

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Introduction

Lattice degeneration is a clinically significant type of peripheral retinal degeneration and is responsible for the occurrence of retinal breaks and rhegmatogenous retinal detachment.[1] The prevalence of lattice degeneration is about 6%–10% of the general population and is bilateral in one-third to one-half of all affected individuals.[2] Most frequently appearing at the equator or more peripherally, lattice degeneration is characterized as an elongated area of retinal thinning crossed by whitish retinal vessels.[3] Essential signs of lattice degeneration are vitreous liquefaction over a thinned retina and tight vitreoretinal adhesion at the borders of the lesion which contribute to the risk of horseshoe retinal breaks.[1-3] Although lattice degeneration is one of the most frequent findings in otherwise healthy eyes, its cause is not fully understood.

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Optical coherence tomography (OCT) provides an additional insight into retinal and vitreal changes in lattice degeneration. OCT has confirmed all histopathological features of lattice degeneration and has been proposed as an additional instrument in determining the need for prophylactic laser treatment for this condition.[4,5] More importantly, these studies have shown that the evaluation of peripheral retinal lesions is possible with clinical OCT.

Optical coherence tomography angiography (OCTA) has become an essential diagnostic tool in retinal imaging and may improve our understanding of lattice degeneration pathophysiology. However, OCTA is considered an instrument for evaluating the posterior eye pole, and although the OCTA scanning area expands from year to year, it is still limited in

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visualizing the retinal periphery. Consequently, no cases of OCTA imaging of lattice degeneration have been described so far.

In this paper, using the same approach as for the imaging of peripheral retinal lesions with structural OCT,[5] we describe a series of cases where lattice degeneration lesions were examined with OCTA.

Methods

The study was conducted in accordance with the Declaration of Helsinki for research involving human subjects and was approved by the local institutional ethics committee. All participants were informed as to the aim and design of the study and signed informed consent for the use of the data obtained during the ophthalmic examination. This prospective case series included four patients who were diagnosed with lattice degeneration in our department in 2019–2020 and for whom OCTA examination of the lesion was possible. All patients received a comprehensive ophthalmic examination, green reflectance using a confocal scanning laser ophthalmoscopy (F-10, NIDEK, Gamagori, Japan), and OCT/OCTA under medically induced mydriasis. All OCT/OCTA examinations were performed with RTVue-XR Avanti (Optovue, Fremont, CA) running software version 2017.1.0.150. Three-mm OCTA scans (304 2 × B-scans each of 304 A-scans) centered on the lattice degeneration lesion were obtained in each case. To perform OCTA examination, patients were asked to look in the direction of the lesion. Additionally, the head position was adjusted to achieve some head tilt in the direction of the lesion.[5] A series of OCTA scans was obtained, and those with a scan quality of Q5 or higher were chosen for analysis.

In each case, local status of retinal and choriocapillaris microcirculation was evaluated. Retinal microcirculation was assessed using OCTA projection of the full retina slab (between the inner limiting membrane and inner/outer segment junction segmentation lines, with no offset). A standard choriocapillaris slab (between two retinal pigment epithelium [RPE] segmentation lines with –9 μm and 30 μm offset) was used to evaluate choriocapillaris microcirculation. All segmentation lines were inspected and corrected before assessing the resultant *en face* projections. Additionally, minimum choroidal thickness was measured beneath the lesion and at an adjacent normal region of the same scan. All patients provided written consent for ophthalmic examination and use of their medical data in the study.

Results

Case 1: A 37-year-old myopic female was diagnosed with lattice degeneration in her right eye during preoperative examination prior to laser-assisted *in situ* keratomileusis (LASIK). An ovoid lesion was found in the right eye mid-periphery at 7 o'clock [Figure 1a]. The length of the lesion was approximately 3 mm. OCTA showed regional loss of retinal microcirculation occupying all retinal layers [Figure 1b]. Flow signal remained visible in some whitish vessels while absent in others. The choriocapillaris slab showed rarefied choriocapillaris with two venous collectors beneath the lesion [Figure 1c]. Minimum choroidal thickness was 39 μm beneath the lesion and 138 μm at the adjacent unaffected region [Figure 1d]. Cross-sectional OCT scans showed retinal thinning, vitreal adhesion, and atrophic holes within the lesion.

Case 2: A 67-year-old emmetropic female was presented for her annual ophthalmic examination. She reported a history of branch retinal vein occlusion in her right eye which had spontaneously resolved 3 years ago. In her left eye, indirect ophthalmoscopy revealed a lattice degeneration lesion occupying the superior nasal quadrant and showing whitish retinal vessels and pigmentary changes [Figure 2a]. OCTA showed loss of retinal microcirculation [Figure 2b] and rarefication of the choriocapillaris network with three venous collectors visible [Figure 2c]. Choroidal thickness beneath the lesion was 44 μm at the thinnest point and 128 μm at the adjacent unaffected region [Figure 2d]. Structural OCT scan through the lesion showed retinal thinning, vitreous tractions, a retinal hole, and a local retinal detachment.

Case 3: A 27-year-old myopic male was diagnosed with lattice degeneration in his right eye prior to LASIK. An ovoid lesion was found mid-periphery in the right eye at 7 o'clock. The length of the lesion was approximately 3 mm, with subtle whitening of large retinal vessels crossing the lesion [Figure 3a]. Structural OCT showed retinal thinning and some vitreal tractions at the borders of the lesion. OCTA showed loss of retinal microcirculation, except for the large retinal vessels [Figure 3b]. The choriocapillaris slab showed rarefied choriocapillaris with two venous collectors beneath the lesion [Figure 3c]. The minimum choroidal thickness was 60 μm beneath the lesion and 134 μm at the adjacent unaffected region [Figure 3d].

Case 4: A 56-year-old myopic male was diagnosed with a local peripheral rhegmatogenous retinal detachment, an asymptomatic retinal break, a choroidal nevus, lattice degeneration lesions in his left eye, and a cavernous hemangioma in his right orbit. Lattice degeneration lesions were found before the equator at 6 o'clock. The lesion demonstrated some whitish vessels, hyperpigmentation, and RPE atrophy [Figure 4a]. OCTA showed complete loss of retinal microcirculation, except for the large retinal vessels [Figure 4b]. The choriocapillaris slab showed appearance of the choriocapillaris in detail, with a noticeably increased intercapillary distance and multiple venous collectors [Figure 4c]. Choroidal thickness was 59 μm at the thinnest point beneath the lesion and 132 μm at the adjacent unaffected region [Figure 4d]. Cross-sectional OCT showed retinal thinning and vitreous tractions.

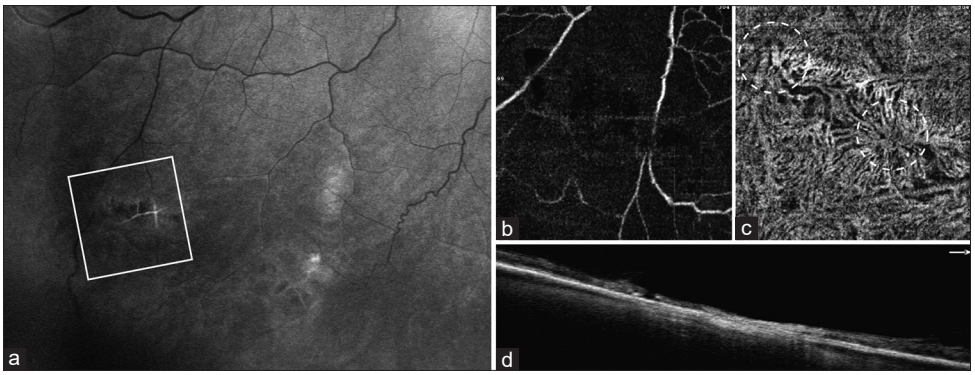

Figure 1: Multimodal imaging in Case 1: (a), Green reflectance using a confocal scanning laser ophthalmoscopy shows lattice retinal degeneration lesions in the right eye. The white box shows the position of optical coherence tomography angiography (OCTA) scan (b), OCTA projection of full retina slab shows retinal capillary nonperfusion within the lesion (c), OCTA projection of choriocapillaris slab shows rarefication of choriocapillaris network and two venous collectors beneath the lesion (dashed circles) (d), Cross-sectional optical coherence tomography scan shows retinal thinning, atrophic hole, and choroidal thinning within the lesion

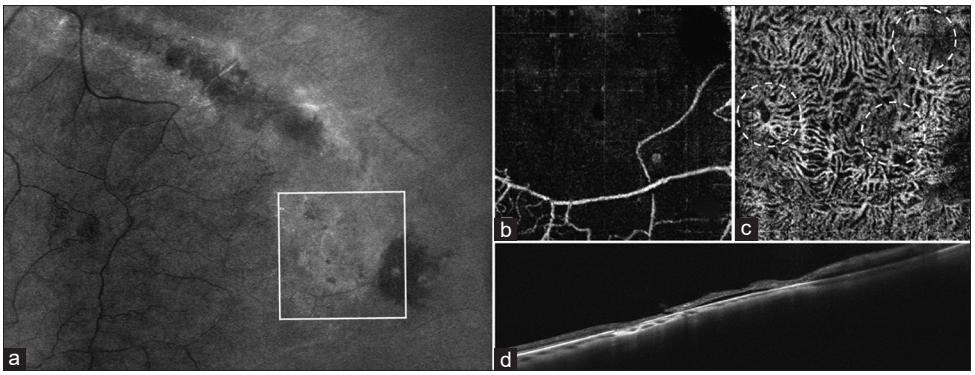

Figure 2: Multimodal imaging in Case 2: (a) Green reflectance using a confocal scanning laser ophthalmoscopy shows lattice retinal degeneration lesions in the left eye. The white box shows the position of optical coherence tomography angiography (OCTA) scan (b), OCTA projection of full retina slab shows retinal capillary nonperfusion within the lesion (c), OCTA projection of choriocapillaris slab shows rarefication of choriocapillaris network and three venous collectors beneath the lesion (dashed circles) (d), Cross-sectional optical coherence tomography scan shows retinal thinning, atrophic hole, subretinal fluid, and choroidal thinning within the lesion

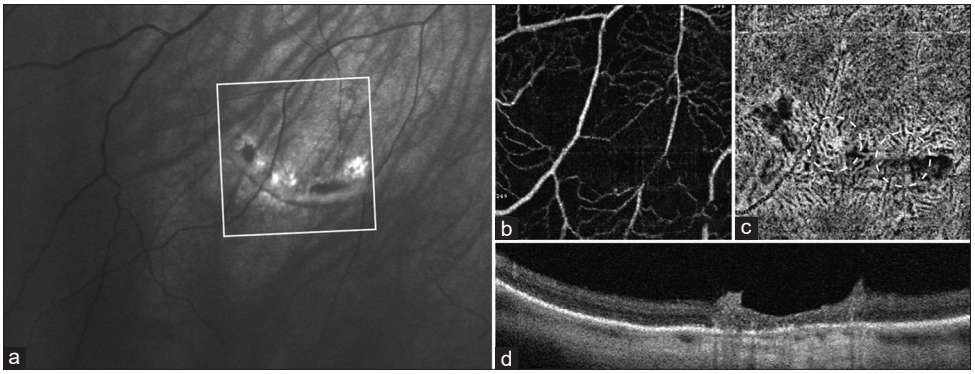

Figure 3: Multimodal imaging in Case 3: (a) Green reflectance using a confocal scanning laser ophthalmoscopy shows lattice retinal degeneration lesions in the right eye. The white box shows the position of optical coherence tomography angiography (OCTA) scan (b), OCTA projection of full retina slab shows retinal capillary nonperfusion within the lesion (c), OCTA projection of choriocapillaris slab shows rarefication of choriocapillaris network and two venous collectors beneath the lesion (dashed circles) (d), Cross-sectional optical coherence tomography scan shows retinal and choroidal thinning within the lesion

Discussion

Beyond histopathological and structural OCT studies, little is known regarding the pathophysiology of lattice degeneration. Moreover, the generally held view of lattice degeneration as one of the complications of myopia is not without controversy. Although myopes are mostly affected, in patients with high myopia the prevalence of lattice degeneration appears to be

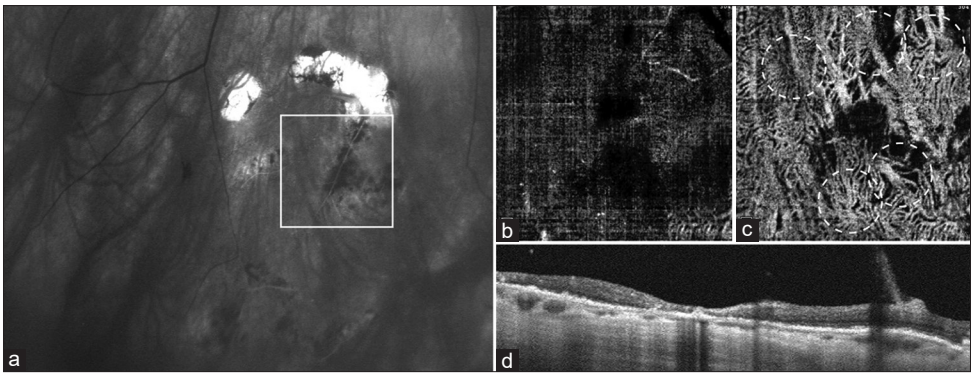

Figure 4: Multimodal imaging in Case 4: (a) Green reflectance using a confocal scanning laser ophthalmoscopy shows lattice retinal degeneration lesions in the left eye. The white box shows the position of optical coherence tomography angiography (OCTA) scan (b), OCTA projection of full retina slab shows retinal capillary nonperfusion within the lesion (c), OCTA projection of choriocapillaris slab shows rarefication of choriocapillaris network and several venous collectors beneath the lesion (dashed circles) (d), Cross-sectional optical coherence tomography scan shows retinal thinning, vitreous tractions, and choroidal thinning within the lesion

not as high as in mild to moderate myopia.[6] Additionally, emmetropes are frequently affected by lattice degeneration.[7] The same is correct when considering axial length as a factor determining the occurrence of lattice degeneration since, in extremely elongated eyes, lattice degeneration is less frequent compared to mildly or moderately elongated eyes.[5] It seems, therefore, that neither refractive error nor axial length are the sole drivers in the pathophysiology of lattice degeneration.

It is known that lattice degeneration frequently occurs in young, generally healthy people. However, the prevalence of this condition seems to increase with age,[3] while refractive error and axial length mostly remain stable after the 3rd decade of life. Some familial cases, as well as syndromic lattice degeneration cases, such as those in Stickler syndrome, suggest some genetic predisposition for this condition.[8] However, sporadic cases of lattice degeneration are most common in the general population. To date there are no comprehensive genetic studies on lattice degeneration, but changes in collagen A expression may contribute to this condition.[9]

The involvement of retinal vessels in lattice degeneration lesions suggests the role of vascular pathology in the pathogenesis of this condition. However, unlike truly vascular lesions, lattice degeneration does not demonstrate a regular pattern or distribution within a region supplied by any particular retinal vessel. Although fluorescein angiography in lattice degeneration showed a decrease or complete loss of retinal perfusion, arterial thinning, and occlusion of retinal venules, it is unlikely that the lesion is caused by the initial alteration of retinal microcirculation.

Autopsy studies have shown a loss of choriocapillaris, endothelial cells, pericytes, and fibrosis of all vessels within the region occupied by lattice degeneration.[3] However, no studies have been able to show with microscopic resolution these changes *in vivo*. In contrast, OCTA can display retinal vascular and choriocapillaris microanatomy *in vivo* with high resolution. Additionally, the high density of B-scans required for vessel reconstruction in OCTA provides high-resolution structural OCT images. All of this allows evaluation of vascular microanatomy of various retinal lesions, but conventionally only within the posterior eye pole. At the same time, lattice degeneration lesions are mostly distributed at the mid or far periphery in superior and inferior quadrants.[3] Some changes of head position and gaze direction allow visualization of peripheral retinal areas, including those areas with lattice degeneration. However, only a few cases with lesions of a relatively central position allowed sufficient imaging with OCTA.

In our study, OCTA confirmed all known pathohistological characteristics of lattice degeneration, including retinal thinning, vitreous adhesion, loss of retinal microcirculation, and choriocapillaris hypoperfusion.[3] Alteration of RPE, one of the histopathological features of lattice degeneration, was also noticeable with OCTA as clear visualization of individual choriocapillaries beneath the lesion since detailed imaging of the choriocapillaris is impossible with normal RPE. Recent findings of Mizuno *et al*. suggest that migration, proliferation, and differentiation of RPE might be involved in the pathophysiology of lattice degeneration.[10] However, it is not clear if RPE plays any specific role in pathogenesis of lattice degeneration or if its injury is a result of another process in the underlying choroid.

With OCTA, lattice degeneration lesions demonstrate not only some rarefication of choriocapillaris, but also collector venules. Therefore, the shape of lattice degeneration lesions may follow the lobular structure of the choriocapillaris. Additionally, structural OCT images reveal local thinning of the choroid beneath lattice degeneration lesions. Based on this data, we can suggest that lattice degeneration may have a choroidal nature with secondary involvement of the retina and RPE. This is compatible with the study of Oztas *et al*. showing an association between peripheral retinal lesions, including lattice degeneration, and central serous chorioretinopathy, which is characterized by changes in choroidal perfusion.[11]

It is known that retinal microcirculation plays only a minor role in the maintenance of the structure of the retina at the

periphery of the ocular fundus. Indeed, neither ischemic retinal vein occlusion nor arterial occlusion results in degenerative changes of the peripheral retina. On the other hand, RPE and neurosensory retina exhibit degenerative changes and thinning over the areas of choroidal ischemia.[12]

The main limitation of this study is the inclusion of quite centrally placed lattice degeneration lesions, since only such lesions are available for OCTA imaging. This can justify the limited number of included cases. We must, therefore, be cautious about extrapolating our findings to lattice degeneration as a general phenomenon, and larger studies are required to evaluate choroidal involvement in lattice degeneration pathophysiology. Additionally, peripheral OCTA provides images of limited quality due to optical aberrations and difficulties in eye tracking.

In conclusion, in this study, we have evaluated lattice degeneration of the retina using OCTA. OCTA revealed retinal capillary nonperfusion, choriocapillaris rarefication within the lesions as well as the presence of venous collectors. Additionally, structural cross-sectional scans showed significant choroidal thinning beneath the lesions. All of this suggests that choroidal circulatory changes may play an important role in the pathophysiology of lattice degeneration.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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