Peripheral Lattice Degeneration Imaging with Ultra-Widefield Swept-Source Optical Coherence Tomography

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ABSTRACT

Purpose: To investigate a series of peripheral lattice degeneration cases using an ultra-widefield (UWF) swept-source optical coherence tomography (SSOCT) system (Silverstone, Nikon Healthcare Japan, Inc, Tokyo, Japan).

Methods: From 1st August, 2022 to 31th July, 2023, nineteen eyes of 16 patients with peripheral lattice degeneration were included. They all underwent a UWF-SSOCT examination. Anatomy of retina, vitreous, and associated pathologic changes were assessed.

Results: UWF-SSOCT showed various anatomical changes of retina and vitreous in patients with lattice degeneration. Of fifteen eyes of 12 patients whose UWF-SSOCT images were clearly obtained, 8 eyes showed regional retinal thinning, 7 eyes showed vitreous traction, 2 eyes showed detached vitreous, 3 eyes showed retinal break.

Conclusions: UWF-SSOCT can be a useful tool to understand anatomical changes and pathophysiology of peripheral lattice degeneration.

Keywords: Lattice degeneration, Vitreous, Ultra-widefield swept-source optical coherence tomography
Introduction

Lattice degeneration is the most common type of retinal degeneration that happens especially in the peripheral retina. Its prevalence is about 6%-8% of the general population. It more frequently happens in myopic eyes [1-3]. There was no sexual or racial difference in its prevalence. And about 50% of those who have lattice degeneration have it bilateral [4]. In fundus examination, lattice degeneration is characterized by sharply demarcated, circumferentially oriented, oval or round areas of retinal thinning with overlying vitreous liquefaction, and exaggerated vitreoretinal attachments along its edges [5]. Lattice degeneration is clinically important because it can lead to retinal break and even detachment. Due to the risk of retinal detachment, prophylactic treatment is usually performed, including barrier laser photocoagulation and cryopexy for lattice degenerations with retinal breaks or myopic, aphakic and pseudophakic eye, and past history of retinal detachment on the other eye. However, indication of prophylactic treatment has been ambiguous [6-9]. Some studies have visualized and analyzed anatomic changes of lattice degeneration and adjacent vitreous using spectral domain optical coherence tomography (SD-OCT) and optical coherence tomography angiography (OCTA). However, these devices can only capture central retina, peripheral lattice degeneration could not be characterized [3,10-13]. UWF-SSOCT system is a novel device that combines UWF-scanning laser ophthalmoscope (SLO) with a navigated SSOCT (Silverstone, Nikon Healthcare Japan, Inc, Tokyo, Japan). It can produce an initial high-resolution UWF-SLO fundus image of up to 200°. It uses navigated SS OCT line or volume scans at any location as mapped by UWF-SLO fundus images, making it possible to show tomographic images in the peripheral retina [14,15]. In this paper, anatomy of peripheral lattice degeneration and changes of retina and vitreous following lattice degeneration using UWF-SSOCT system were analyzed.

Materials and Methods

This is a retrospective study that reviewed medical records of patients diagnosed with peripheral lattice degeneration and underwent UWF-SSOCT in __________ Hospital during the period of August 2022 to July 2023. The study protocol adhered to the tenets of the Declaration of Helsinki. It was approved by the Institutional Board (IRB) of __________ Hospital (IRB No. 2023-04-017).

A total of 97 patients who suffered from floater or had a history of retinal detachment were the subject. Of these 97 patients, 19 eyes of 16 patients who had peripheral lattice degeneration were included regardless of the presence of previous laser scar. Lattice degeneration was diagnosed through UWF-photos and fundus examination by
clinicians under dilation. Of nineteen eyes with lattice degeneration, four eyes were excluded because authors were not able to obtain clear UWF-SOCT images. For two eyes, lattice degenerations were located in far periphery and UWF-SOCT could not capture them in primary gaze. For the other two eyes, UWF-SOCT captured lattice degenerations but the obtained image qualities were too poor to analyze. All subjects underwent comprehensive ophthalmic examinations including best-corrected visual acuity (BCVA), intraocular pressure (IOP), slit-lamp examinations, medically induced mydriasis, fundus examinations, UWF-SOCT for UWF fundus imaging, and OCT imaging. All UWF-SOCT imaging procedures were conducted by trained clinicians using UWF HD 6 mm volume cross-sectional scan mode on the UWF-Fundus photograph obtaining 121 images for each trial. Obtained images were diagnosed and analyzed by two clinicians (____). We defined peripheral lattice degeneration as lattice degenerations located beyond the major vascular arcades. SS-OCT images of peripheral lattice degeneration were analyzed, especially focusing on the anatomical changes of retina, relation between vitreous and lattice degeneration including findings like subretinal fluid (SRF), retinal break, vitreoretinal traction, and detached vitreous.

Results

Fifteen eyes of 12 patients (5 males, 7 females) who had peripheral lattice degeneration and underwent UWF-SOCT imaging were included. Basic demographics of subjects are shown in Table 1. Fifteen OCT images were reviewed thoroughly and classified into five distinct anatomical changes of the lattice degeneration and adjacent vitreous around lattice degeneration. Retinal thinning in 8 eyes, retinal break without vitreous traction in 1 eye, vitreous traction in 7 eyes, retinal break with vitreous traction in 2 eyes, and detached vitreous from underlying lattice degeneration in 2 eyes were observed. The UWF fundus images of lattice degeneration including guideline for UWF-SOCT image and cross-sectional SS-OCT images are demonstrated in Figures 1-5. Various findings are described as follows (Table 2).

Retinal thinning

The most common finding was retinal thinning. Of 8 (53.33%) eyes, retinal thinning was found in lattice degeneration (Figure 1). There was overall thinning of retinal layer having ambiguous border of inner and outer retina. Retinal layer thickness was obviously thinner than surrounding normal tissues.
Retinal break

In 1 (6.67%) eye, retinal break was found in lattice degeneration (Figure 2). Retinal break was not clearly seen in fundus photograph, but obvious in OCT scan images. There was retinal thinning around the retinal break.

Vitreous traction

In 7 (46.67%) eyes, vitreous traction was found in lattice degeneration (Figure 3). In all cases, retinoschisis and focal retinal detachment were found as well. Vitreous strand was obviously attached to the retina and pulled it anteriorly, making different degrees of retinoschisis.

Vitreous traction with retinal break

In 2 (13.33%) of 7 eyes that showed vitreous traction, there were retinal breaks (Figure 4). There was a retinal break with an opeculum connected to the vitreous strand above it.

Detached vitreous membrane

In 2 (13.33%) eyes, detached vitreous membrane above the lattice degeneration was observed (Figure 5). A long strand of vitreous membrane was above the retinal layer, showing obvious gap between the vitreous and lattice degeneration.

Discussion

Since the development of OCT, we can understand the anatomy of retina and pathological changes of retinal layers in various diseases much better than before. OCT gives us high-resolution images of retina, choroid, and vitreous with a non-invasive method. In clinics, OCT examination is one of the most important examinations. Many clinicians make decisions depending on results of OCT examination [11,12,16]. However, traditional OCT could not capture pathologic changes outside of major vascular arcades of fundus. Lattice degeneration is a well-known disease usually found in peripheral retina in fundus examination. The reason why it is important is because lattice degeneration is related to retinal breaks and detachment. Histological findings of lattice degeneration including vitreous is firmly attached to the margin of lattice degeneration and that vitreous is liquified over the lattice degeneration are well-known [2]. However, because it is usually located in peripheral retina, it was hard to perform imaging study with OCT. In the current study, we were able to capture OCT images of lattice degeneration located
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in peripheral retina using UWF-SSOCT. We investigated 15 OCT volume scan images of lattice degeneration. With UWF-SSOCT, we were able to capture peripheral lattice degeneration and the vitreous around it as well as the relation between them with cross sectional images. The most common change of peripheral lattice degeneration was retinal thinning. Compared to adjacent normal peripheral retina, the border of inner and outer retina was ambiguous, showing homogenous reflectivity through all layers. Retinal breaks with and without vitreous traction were found as well. And there was a retinal break in lattice degeneration that was hardly seen in fundus photograph.

In previous study analyzed OCT images of posterior lattice degeneration, 46% of studied eyes showed U-shaped vitreous traction, 23% eyes showed retinal thinning, 15% eyes showed vitreous membrane and retinal break respectively [13]. In this study, vitreous membrane, vitreous traction and retinal break showed similar incidence. But, retinal thinning was found in 53.33% of studied eyes, which is much higher than the previous study. This difference is maybe due to the small number of patients in both studies. Or the fact that this study focused on peripheral lattice degeneration compared to the previous study that conducted in patients with posterior lattice degeneration. Because of the low incidence of retinal detachments due to lattice degenerations shown in many studies, prophylactic treatment of lattice degeneration was controversial [6,7,17]. For many clinicians, lattice degeneration alone was not an indication of barrier laser photocoagulation if there were no retinal breaks, previous history of retinal detachment, or family history of retinal detachment [4]. However, with UWF-SSOCT, we can now detect retinal breaks in lattice degeneration that can hardly be detected in fundus examination. We can also differentiate lattice degenerations with vitreous traction from lattice degenerations without vitreous traction. Those lattice degenerations alone could be the subject of barrier laser photocoagulation.

Limitations of this study include its retrospective design and relatively small number of patients included. UWF-SSOCT can capture OCT images of lattice degeneration only when patients are looking straight ahead, not tilting their eyes. Thus, peripheral lattice degenerations captured in UWF fundus photos by tilting patient’s eyes could not be included. In addition, there were some UWF-SSOCT images that were too poor to analyze even though they were captured in UWF fundus photos in primary gaze.

In conclusion, we could capture OCT images of peripheral lattice degeneration that were impossible with traditional OCT using a UWF-SSOCT system even though there were some limitations. By analyzing OCT images, we could understand the anatomy of peripheral lattice degeneration and the vitreous around it better. We were able to detect retinal breaks in lattice degeneration that was not obvious in fundus photograph alone. We found that if there was vitreous traction above peripheral lattice degenerations, barrier laser photocoagulation should be considered to prevent retinal break and detachment even though there were no retinal breaks.
Declaration of conflicting interests

All authors have no potential conflicts of interest with respect to the research, authorship, and/or publication of this report to disclose.

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References


Table 1. Basic demographics of subjects

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<tbody>
<tr>
<td>No. of eyes (subjects)</td>
<td>15 (12)</td>
</tr>
<tr>
<td>Male (%)</td>
<td>5 (41.67)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>41.08±15.67</td>
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<tr>
<td>BCVA (LogMAR)</td>
<td>0.02±0.04</td>
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<td>IOP (mmHg)</td>
<td>15.83±2.64</td>
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<td>Pseudophakic eye (%)</td>
<td>1 (6.67)</td>
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<tr>
<td>Eyes with previous laser treatment (%)</td>
<td>3 (20)</td>
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<tr>
<td>Past history of retinal detachment (%)</td>
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Table 2. Findings of lattice degeneration

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<thead>
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<tbody>
<tr>
<td>Retinal thinning</td>
<td>8 (53.33)</td>
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<tr>
<td>Retinal break with retinal thinning</td>
<td>1 (6.67)</td>
</tr>
<tr>
<td>Detached vitreous membrane</td>
<td>2 (13.33)</td>
</tr>
<tr>
<td>Vitreous traction</td>
<td>7 (46.67)</td>
</tr>
<tr>
<td>Retinal break with vitreous traction</td>
<td>2 (13.33)</td>
</tr>
<tr>
<td>None of specific change</td>
<td>1</td>
</tr>
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Figure 1. Retinal thinning. (A) An ultra-widefield fundus photograph of lattice degeneration and guideline to swept-source optical coherence tomography. (B) An ultra-widefield swept-source optical coherence tomography (UWF-SSOCT) image corresponding to the line of ultra-widefield fundus photography. UWF-SSOCT image shows generalized thinning and disruption of division of retinal layers (white arrows).

Figure 2. Retinal break. (A) An ultra-widefield fundus photograph of lattice degeneration and guideline to swept-source optical coherence tomography. (B) An ultra-widefield swept-source optical coherence tomography (UWF-SSOCT) image corresponding to the line of ultra-widefield fundus photography. UWF-SSOCT image shows retinal break that’s not obvious in the fundus photography (white arrow) along with retinal thinning (white arrowheads).

Figure 3. Vitreous traction. (A) An ultra-widefield fundus photograph of lattice degeneration and guideline to swept-source optical coherence tomography. (B) An ultra-widefield swept-source optical coherence tomography (UWF-SSOCT) image corresponding to the line of ultra-widefield fundus photography. UWF-SSOCT image shows vitreous traction (white arrows) with localized retinal detachment (white star), retinoschisis (white arrowheads).

Figure 4. Vitreous traction with retinal break. (A) An ultra-widefield fundus photograph of lattice degeneration and guideline to swept-source optical coherence tomography. (B) An ultra-widefield swept-source optical coherence tomography (UWF-SSOCT) image corresponding to the line of ultra-widefield fundus photography. In UWF-SSOCT image, a vitreoretinal traction is observed (white arrows), retinal flap is seen connected to the vitreous (white arrowhead).

Figure 5. Detached vitreous membrane. (A) An ultra-widefield fundus photograph of lattice degeneration and guideline to swept-source optical coherence tomography. (B) An ultra-widefield swept-source optical coherence tomography (UWF-SSOCT) image corresponding to the line of ultra-widefield fundus photography. UWF-SSOCT image shows a detached vitreous membrane (white arrows).