IMAGING THE VITREOUS AND VITREOMACULAR INTERFACE

Case presentations demonstrate the utility of 3-D SD-OCT in examining in vivo details of the vitreous structure.

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Detailed biomicroscopic examination of the posterior vitreous gel can be severely compromised by bright, diffuse light reflected from the fundus and the low optical density of vitreous structures. Even the renowned biomicroscopist Vogt stated that, in his view, clinical observations in the posterior part of the vitreous are “illusory rather than real.”

As we age, biochemical and structural changes occur in the corpus vitreous, leading to posterior vitreous detachment (PVD). Although generally benign, PVD can contribute to significant retinal morbidities, such as vitreomacular traction (VMT) syndrome, macular hole, epiretinal membrane (ERM), and retinal tears. Furthermore, the status of the vitreous plays a crucial role in the natural course of preexisting local and systemic conditions (eg, uveitis and diabetes), significantly affecting their prognosis and management.

Although ultrasound has been considered the standard imaging technique to detect and document vitreous detachment, the higher resolution of optical coherence tomography (OCT) offers advantages when studying any intermediate step of this process. Time-domain OCT (TD-OCT) studies have illustrated the posterior hyaloid and its adhesions to the retinal surface in VMT syndrome and related diseases.

Spectral-domain OCT (SD-OCT) technology allows better visualization of the hyaloid and a more detailed image of its structure than TD-OCT. SD-OCT provides a dramatic increase of imaging speed, 50 times faster than standard-resolution OCT. A dense raster pattern with multiple consecutive B scans taken at high speed allows comprehensive retinal coverage. It is possible to acquire complete 3-D data in a time comparable with that of standard OCT protocols that acquire only several individual images. The coupling of SD-OCT technology with 3-D imaging allows precise focusing from deep retinal planes to the mid-vitreous cavity. A 3-D volume of data can be viewed and rotated about three axes. Wanting to capitalize on these advantages, we explored the use of 3-D imaging in SD-OCT to image the vitreous architecture and the vitreomacular interface.

3-D VIEWING IN PRACTICE

Following is an observational case series of patients who presented at our practice. All patients were scanned using the RS-3000 Advance (Nidek). Our goal was to visualize in vivo details of the vitreous structure during the aging process, including various vitreous and vitreomacular interface pathologies.

Case No. 1

A 55-year-old known diabetic and hypertensive woman presented with decreased visual acuity in her right eye (OD) lasting 6 months. Her BCVA was 6/36 OD with early
cataractous changes. Fundus examination revealed asteroid hyalosis with proliferative diabetic retinopathy (PDR) and clinically significant macular edema (CSME) OD (Figure 1). Examination with SD-OCT showed asteroid hyalosis, altered foveal contour with ERM, cystoid spaces, and hard exudates OD.

Case No. 2
A 71-year-old diabetic man, pseudophakic in each eye (OU), presented with diminished visual acuity in his left eye (OS) lasting 2 to 3 years. His BCVA was 6/9 OS. Fundus examination OS showed an ERM, and SD-OCT...
examination OS showed lost foveal contour with VMT and ERM. Vitrectomy was advised for treatment of VMT and ERM removal with dexamethasone intravitreal implant 0.7 mg (Ozurdex, Allergan), but the patient declined treatment. He presented 19 months later with a BCVA of 6/12 OS. Fundus examination OS showed altered foveal reflex OS and a yellow dot with ERM.

SD-OCT examination OS showed lost foveal contour, focal attachments of taut posterior hyaloid over the macula, ERM, corrugations of inner retinal layers, and subfoveal scarring (Figure 2).

Case No. 3
A 70-year-old woman with pseudophakia OS presented with reduced visual acuity OS lasting 3 months. Fundus examination showed altered foveal reflex with VMT, ERM, and optic atrophy OS. SD-OCT examination OS revealed altered foveal contour with a thickened hyaloid causing traction on the macula (VMT syndrome; Figure 3).

Case No. 4
A 19-year-old man with chronic pars planitis OU presented with complaints of floaters OD. Fundus

Figure 3. Fundus photograph OS shows altered foveal reflex with VMT and ERM and optic atrophy (A). Altered foveal contour with VMT syndrome is seen on SD-OCT (B). Pseudocolor (C) and grayscale (D) 3-D reconstructions of SD-OCT scans show the configuration of VMT caused by traction at fovea by the posterior hyaloid, leading to an impending operculum formation from the inner retinal layers at fovea.

Figure 4. Fundus photograph OD shows snowballs and areas of exudation (A, B). SD-OCT scan shows punctate hyperreflective spots in the vitreous suggestive of vitreous cells and the presence of active pars planitis (C). Pseudocolor (D) and grayscale (E) 3-D reconstructions of SD-OCT scans show multiple punctate hyperreflective spots in the vitreous cavity suggestive of vitreous cells.
examination indicated vitritis OD, and SD-OCT examination revealed punctate hyperreflective spots in the vitreous suggestive of vitreous cells, which would indicate active pars planitis (Figure 4). Because the patient was a known steroid responder, he was started on an oral steroid on a tapering course, immunosuppressive therapy with azathioprine, and anti-Koch treatment. The oral steroid was gradually tapered, but the azathioprine was continued. When the patient returned 5 months later, SD-OCT showed a normal foveal contour with disappearance of vitreous cells (Figure 5).

Case No. 5
A 69-year-old man, pseudophakic OU, complained of metamorphopsia OD lasting 7 to 8 days. His BCVA was 6/12 OD. Fundus examination showed a macular hole OD. SD-OCT examination showed a full thickness macular hole with an operculum OD (Figure 6). The patient underwent 25-gauge vitrectomy with intravitreal gas injection OD. At follow-up 1 month later, his BCVA was 6/12 OD. SD-OCT at this visit showed normalization of the foveal contour (Figure 7). Additionally, the macular hole had closed.

DISCUSSION
To date, in vivo imaging of the vitreous body has been difficult because of its transparency and movement, but the assessment of vitreoretinal separation is important in many diseases. Tractional forces play major roles in the development of retinal tears and detachments, and it is likely that a complete PVD reduces the risk of retinal detachment in patients with symptomatic floaters after the acute onset of symptoms.17

Some studies also suggest that knowledge of vitreous anatomic features may influence surgical approach and outcome in diseases such as macular hole.18,19 The identification of vitreomacular adhesions in partial vitreous detachment can be useful in the management of diabetic macular edema and VMT.20-22 Unfortunately, vitreous status can be difficult to determine clinically. Although the detection of Weiss ring on biomicroscopy is believed to indicate a complete PVD, it may be difficult to precisely determine the completeness of vitreoretinal detachment or attachment using clinical observation alone.
Ultrasound is the traditional imaging technique for dynamic study of the posterior hyaloid, and it has been used in clinical trials to monitor PVD induced by pharmacologic agents.\textsuperscript{23} It has a lower depth and horizontal resolution than SD-OCT.\textsuperscript{24} We used 3-D imaging with SD-OCT in the patient case series described above to image the vitreous architecture and the vitreomacular interface. This modality enabled visualization of details of the vitreoretinal interface and vitreous body not discernible clinically or on B-scan OCT images. On the retinal surface, these details included areas of incomplete PVD, focal vitreoretinal adhesion and traction, vitreous remnants on the foveal surface of eyes with complete PVD, and attachment of posterior hyaloid to opercula of full thickness macular holes. In the vitreous cavity, these details included distinction between vitreous opacities such as asteroid hyalosis, vitreous cells, vitreous degeneration, and vitreous hemorrhage. Use of 3-D imaging in SD-OCT can help to objectively assess the reduction of vitritis following treatment in inflammatory pathologies involving the vitreous. Other SD-OCT studies have also used 3-D reconstruction of the retina to analyze the vitreoretinal interface.\textsuperscript{25,26}

CONCLUSION

Reconstruction of 3-D volumes using SD-OCT imaging allows systematic study of the vitreous and vitreoretinal interface and can help clinicians to detect partial and total PVDs. It can also enable the visualization of fine details that show how the retinal surface interacts with and is affected by the vitreous body. Furthermore, information regarding hyaloid cleavage planes can be obtained from this imaging modality in pathologies of the vitreomacular interface, facilitating clinical and surgical decisions. Objective assessment of different causes of vitreous opacities is also possible using 3-D imaging in SD-OCT.


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