OPEN

# STARDUST SIGN AND RETINAL TEAR DETECTION ON SWEPT SOURCE OPTICAL COHERENCE TOMOGRAPHY

HIROTAKA ITAKURA, MD,* MARIKO ITAKURA, MD,* TAKU SATO, MD†

**Purpose:** The causes of floaters include posterior vitreous detachment and fundus hemorrhage, both of which are risk factors for retinal tears. We observed the vitreous of patients with floaters using swept source optical coherence tomography.

**Methods:** Fundus examination was performed, and the vitreous was observed using swept source optical coherence tomography in 202 eyes of 202 patients with floaters. Patients with uveitis, diabetic retinopathy, and other fundus diseases were excluded.

**Results:** Swept source optical coherence tomography revealed posterior vitreous detachment in 145 of 202 eyes (71.8%) and dot reflex like stardust in the vitreous in 42 of 202 eyes (20.8%). Posterior vitreous detachment occurred in 35 of 42 eyes (83.3%) and 110 of 160 eyes (68.8%) in the stardust (+) and stardust (−) groups, respectively; a significant difference was observed ($P < 0.001$). In the stardust (+) group, 11 of 42 eyes (26.2%) had retinal tears with posterior vitreous detachment and 21 of 42 eyes (50.0%) had fundus hemorrhage. Three of 160 eyes (1.9%) and 4 of 160 eyes (2.5%) in the stardust (−) group had retinal tears with posterior vitreous detachment and fundus hemorrhage, respectively. Both tears and fundus hemorrhage were more frequent in the stardust (+) group than in the stardust (−) group ($P < 0.001$).

**Conclusion:** The stardust sign on swept source optical coherence tomography indicates the risk of retinal tear.

**RETINA** 42:336–339, 2022

The vitreous, which has a gel structure with the entwining of hyaluronic acid with the skeleton of collagen fibers, liquefies with aging resulting in posterior vitreous detachment (PVD).[1] PVD is associated with subjective symptoms such as floater and photopsia in middle-aged and elderly people and may cause vitreous hemorrhage, retinal tears, and retinal detachment.[2] PVD with vitreous hemorrhage has a high risk of retinal detachment development.[3] In myopic eyes, the vitreous liquefies from a younger age and PVD is likely to occur, and the risk of developing retinal detachment associated with PVD is high.[4,5] Recently, advances in optical coherence tomography (OCT) have made possible the observation of the PVD progress, which is difficult to assess by ophthalmoscope.[6–8] Swept source OCT (SS-OCT) can more clearly depict PVD and vitreous structure in detail.[9–11] In this study, we observed the vitreous body of patients with floaters using SS-OCT.

## Patients and Methods

This prospective observational analysis was performed at the Maebashi Minami Eye Clinic. We prospectively examined 202 eyes of 202 patients (63 men and 139 women; mean age ± SD, 58.9 ± 13.3 years [range, 19–88 years]) who complained of floaters, which were observed in one eye within a month using SS-OCT (DRI OCT-1 Atlantis; Topcon, Tokyo, Japan) from July 2020 to May 2021. We performed fundus examination with mydriatic eye drops using slit-lamp microscopy, indirect ophthalmoscopy,

From the *Maebashi Minami Eye Clinic, Maebashi-city, Gunma, Japan; and †Takasaki Sato Eye Clinic, Takasaki, Gunma, Japan.

None of the authors has any financial/conflicting interests to disclose.



Reprint Requests: Hirotaka Itakura, MD, Maebashi Minami Eye Clinic, 146-1 Miyajimachi, Maebashi-city 371-0814, Gunma, Japan; e-mail: itakhiro8@gmail.com

fundus photography, and SS-OCT for both eyes of all cases.

Posterior vitreous detachment and the properties of the vitreous body were observed using SS-OCT. The posterior vitreous cortex separates around the macula and becomes parafoveal PVD with aging, then separates from the central fovea, and finally separates from the optic disc to complete PVD.[8] In this study, complete PVD was defined as no reflection of vitreous gel and cortex from the front of the retina and optic disc by SS-OCT. In all cases, the patient was revisited 1 to 2 weeks after the initial diagnosis, and fundus examination and OCT examination were performed in the same manner.

Patients with uveitis, diabetic retinopathy, asteroid hyalosis, and other cases of fundus disease were excluded from the study because the eyes with these diseases could be accompanied with vitreous opacity owing to inflammation and bleeding (Figure 1).[12]

The differences between the groups were analyzed using the chi-square test. Correlations between the groups were analyzed using Pearson's correlation coefficient test. Statistical significance was set at $P < 0.05$.

The Institutional Review Board approval was obtained from the Institutional Review Board Committee of Tone Central Hospital. Informed consent was obtained from all the patients. This study was conducted in accordance with the tenets of the Declaration of Helsinki.

## Results

Swept source optical coherence tomography revealed complete PVD in 145 of 202 eyes (71.8%) with floaters and dot reflections such as stardust in the vitreous in 42 of 202 eyes (20.8%) with floaters at the first visit (Figure 2). In all cases, the dot reflections decreased at the time of examination, 1 to 2 weeks after the first visit.

Complete PVD occurred in 35 of 42 eyes (83.3%) and 110 of 160 eyes (68.8%) in the stardust (+) and stardust (−) group, respectively; a significant difference was observed (Table 1) ($P < 0.001$).

In the stardust (+) group, 11 of 42 eyes (26.2%) had retinal tears (Figure 3), including two eyes, which had already progressed to rhegmatogenous retinal detachment (Figure 4) and 21 of 42 eyes (50.0%) had fundus hemorrhage, such as retinal, preretinal, and vitreous hemorrhage. The retinal tears in all 11 eyes were horseshoe tears attributed to PVD. In one case of preretinal hemorrhage, the stardust sign decreased when OCT was performed again one week later (Figure 5).

By contrast, 3 of 160 eyes (1.9%) in the stardust (−) group had horseshoe tears associated with PVD, 3 of 160 eyes (1.9%) had atrophic holes in lattice degeneration without PVD, and 4 of 160 eyes (2.5%) had fundus hemorrhage.

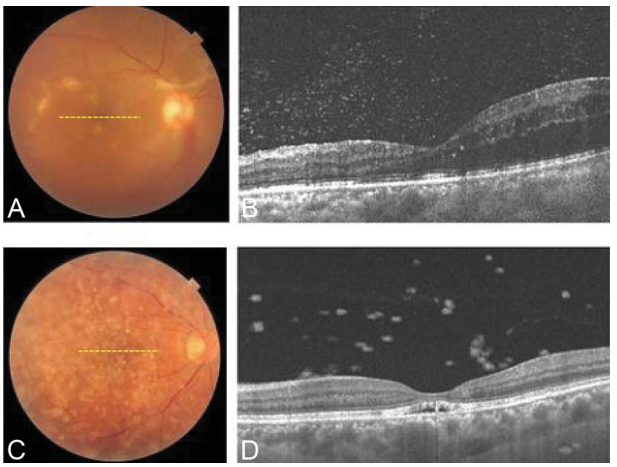


**Fig. 1.** Cases excluded from this study. The right eye of a 46-year-old woman. Proliferative diabetic retinopathy with vitreous hemorrhage (**A**: color fundus photograph). Swept source optical coherence tomography (SS-OCT) shows high-density reflections like a sandstorm (**B**). The right eye of a 65-year-old man. Asteroid hyalosis (**C**: color fundus photograph). SS-OCT shows granular reflections larger than red blood cells (**D**).

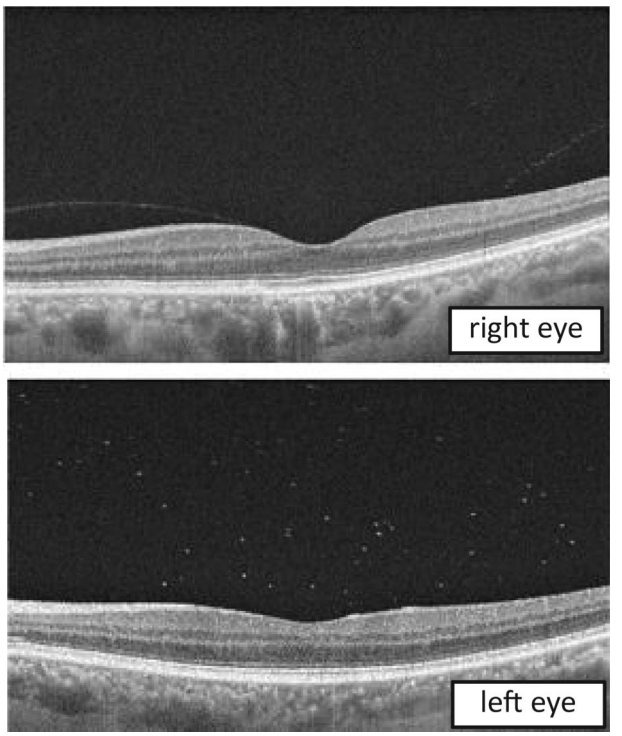


**Fig. 2.** Stardust sign. The left eye of a 65-year-old man. On the day he became aware of the floater, SS-OCT revealed partial PVD and no reflectivity in the vitreous cavity in the right eye. However, SS-OCT showed complete PVD, and many dot reflections in the vitreous cavity appeared similar to stardust in the night sky (stardust sign) in the left eye. There was preretinal hemorrhage associated with PVD in the peripheral retina.

Table 1. Stardust Sign and the Ratio of PVD, Retinal Tear, and Fundus Hemorrhage

| | Complete PVD | Retinal Tears | Fundus Hemorrhage |
|---|---|---|---|
| Stardust sign (+) 42 eyes | 35 (83.3%)* | 11 (26.2%)* | 21(50.0%)* |
| Stardust sign (−) 160 eyes | 110 (68.8%) | 3 (1.9%) | 4 (2.5%) |

*All of complete PVD, retinal tear, and fundus hemorrhage were more frequent in the stardust (+) group than in the stardust (−) group ($P < 0.001$).

Both retinal tears and fundus hemorrhage were more frequent in the stardust (+) group than in the stardust (−) group (Table) ($P < 0.001$).

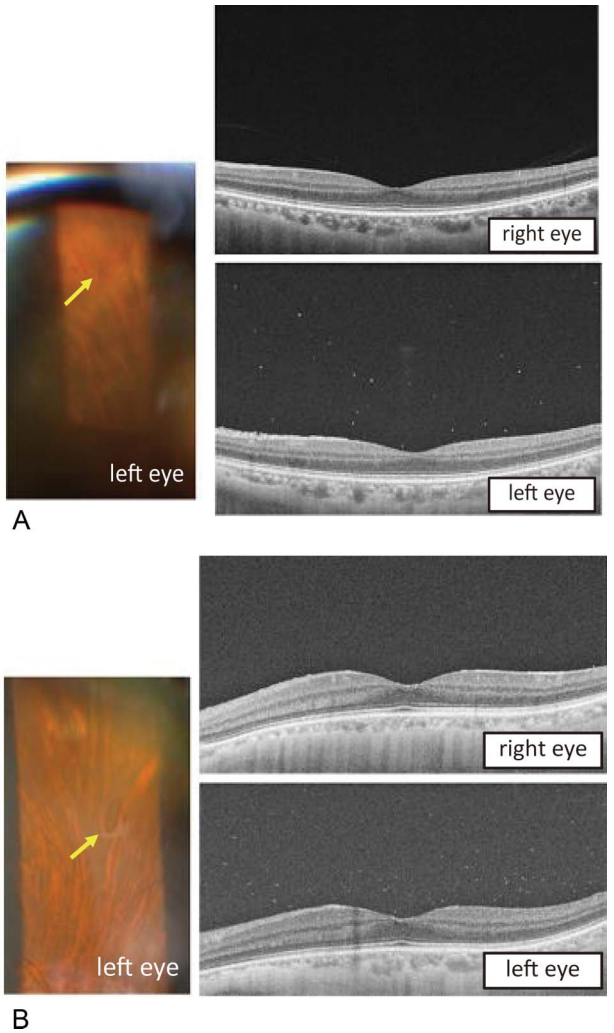


**Fig. 3.** Stardust sign with retinal tears. A: The left eye of a 56-year-old woman. The patient suddenly became aware of the floater in the left eye a day prior, SS-OCT revealed partial PVD and no reflectivity in the vitreous in the right eye. However, SS-OCT showed complete PVD, and many dot reflections in the vitreous cavity appeared similar to stardust in the night sky (stardust sign) in the left eye. A horseshoe tear with retinal hemorrhage (arrow) was observed in the peripheral retina, which was observed using a slit lamp with a Volk Superfield lens. B: The left eye of a 56-year-old man. The patient became aware of the floater in the left eye 4 days prior, SS-OCT revealed no reflectivity in the vitreous in the right eye. However, SS-OCT showed complete PVD and stardust sign in the left eye. A tear with retinal hemorrhage (arrow) was observed in the peripheral retina, which was observed using a slit lamp with a Volk Superfield lens.

## Discussion

One in five cases with floaters had dot reflections in the vitreous on SS-OCT. We named these findings as the stardust sign because the dot reflections in the SS-OCT image of the vitreous cavity appeared similar to the stardust in the night sky. The stardust sign observed in the cases with floaters indicates a high risk of retinal tear (26.2%) and fundus hemorrhage (50.0%). This finding may support the early detection of retinal tears, which is crucial in preventing retinal detachment, thereby reducing the risk of blindness.

The dot reflections are presumed to be red blood cells owing to vitreous hemorrhage or pigments floating from the retinal tear. This sign has a lower reflex density than the dense reflex density because of vitreous hemorrhage associated with proliferative diabetic retinopathy.

When an outpatient visits the hospital owing to floaters, instilling a drop of mydriatic medicine into the patient's symptomatic eye and performing a fundus examination is recommended; however, the patient may refuse mydriasis for various reasons, such as the need to drive. There is a risk of missing retinal detachment if a fundus examination is performed without mydriasis. Recently, an ultra–wide-angle nonmydriatic camera has been introduced, which has made it possible to observe the fundus at 200° without mydriasis; however, the upper and lower peripheral retinas are difficult to visualize. In such cases, the vitreous can be imaged using SS-OCT; in the presence of a stardust sign, the photograph can be shown to the patient to explain the risk of retinal tear and mydriasis. In case detection of a retinal tear is possible in an early stage, photocoagulation can be performed to prevent the development of retinal detachment.[13]

However, the absence of stardust does not indicate the absence of a retinal tear. Although retinal tears of all eyes with a stardust sign were horseshoe tears caused by PVD, three of the six eyes with no stardust sign had horseshoe tears associated with PVD and the other three eyes had atrophic holes in lattice degeneration without PVD. There may be no stardust sign in cases in which the days have passed since the tear was formed because it is mostly absorbed, and the stardust is decreased. Stardust signs associated with preretinal

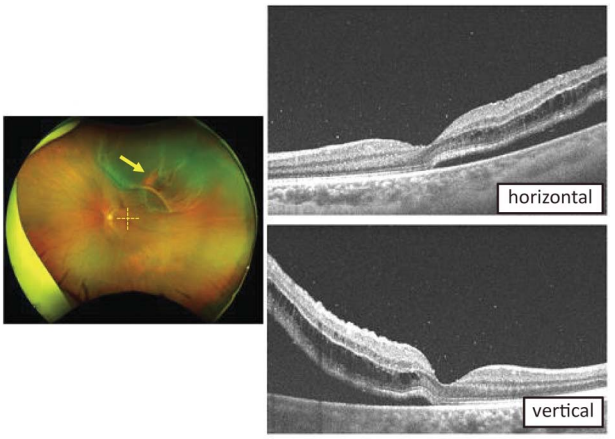


**Fig. 4.** Stardust sign with rhegmatogenous retinal detachment. The left eye of a 49-year-old woman. The patient had been aware of the floaters at 2 weeks before consultation. A horseshoe tear with retinal hemorrhage (arrow) was observed on the upper temporal side of the peripheral retina, which progressed to rhegmatogenous retinal detachment. Swept source optical coherence tomography reveals complete PVD, retinal detachment, and stardust signs in both horizontal and vertical sections (right).

hemorrhage decreased within one week (Figure 5). There may also be no stardust signs in cases of atrophic holes with no PVD.

The vitreous fibers have a tangential layered structure at the retinal interface although there are fibers that run perpendicular to the retina,[11] and the cross section of the fibers is mistaken as granular reflection. In cases without PVD, the cross sections of vitreous fibers and vitreous cells could be visualized as a stardust sign. By contrast, in the case of complete PVD, dot reflections can be asserted as a stardust sign and not a cross section of the vitreous body. PVD can be accurately determined using SS-OCT.[9] When the posterior precortical vitreous pocket or posterior vitreous cortex is observed, no PVD or partial PVD is considered; else complete PVD is ascertained.

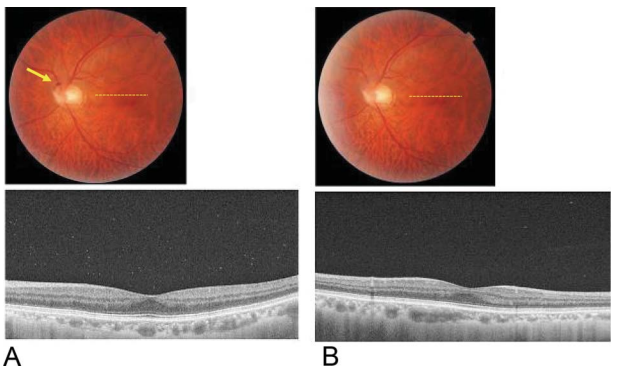


**Fig. 5.** Gradually decreased stardust sign based on the absorption of fundus hemorrhage. The left eye of a 65-year-old man. The patient visited the clinic on the day he became aware of the floater, it had just occurred. Complete PVD and bleeding with Weiss ring in front of the optic disc (arrow), with numerous dot reflections on the SS-OCT image (stardust sign) (**A**). After one week, the hemorrhage had been absorbed and the stardust sign decreased (**B**).

A large proportion of stardust was observed in cases with retinal tear and fundus hemorrhage. We speculate that the more the dots, the higher the risk of retinal tear and fundus hemorrhage. Although we judged stardust positive if there was even one dot reflex on the OCT image in this study, a small number of reflexes could be meaningless, especially in cases where the posterior vitreous has not been detached. Artificial intelligence diagnostic imaging could help in the determination of the number of brightness points that are actually stardust sign positive. The stardust sign could be useful in detecting the risk of retinal tears in new functions using AI-equipped OCT.

**Key words:** posterior vitreous detachment, retinal detachment, retinal tear, swept source optical coherence tomography, vitreous hemorrhage.

## References

1. Los LI, van der Worp RJ, van Luyn MJ, Hooymans JM. Age-related liquefaction of the human vitreous body: LM and TEM evaluation of the role of proteoglycans and collagen. Invest Ophthalmol Vis Sci 2003;44:2828–2833.
2. Hollands H, Johnson D, Brox AC, et al. Acute-onset floaters and flashes: is this patient at risk for retinal detachment?. JAMA Ophthalmol 2009;302:2243–2249.
3. Uhr JH, Obeid A, Wibbelsman TD, et al. Delayed retinal breaks and detachments after acute posterior vitreous detachment. Ophthalmology 2020;127:516–522.
4. Morita H, Funata M, Tokoro T. A clinical study of the development of posterior vitreous detachment in high myopia. Retina 1995;15:117–124.
5. Crim N, Esposito E, Monti R, et al. Myopia as a risk factor for subsequent retinal tears in the course of a symptomatic posterior vitreous detachment. BMC Ophthalmol 2017;17:226.
6. Uchino E, Uemura A, Ohba N. Initial stages of posterior vitreous detachment in healthy eyes of older persons evaluated by optical coherence tomography. Arch Ophthalmol 2001;119:1475–1479.
7. Johnson MW. Perifoveal vitreous detachment and its macular complications. Trans Am Ophthalmol Soc 2005;103:537–567.
8. Itakura H, Kishi S. Evolution of vitreomacular detachment in healthy subjects. JAMA Ophthalmol 2013;131:1348–1352.
9. Itakura H, Kishi S, Li D, Akiyama H. Observation of posterior precortical vitreous pocket using swept-source optical coherence tomography. Invest Ophthalmol Vis Sci 2013;54:3102–3107.
10. Schaal KB, Pang CE, Pozzoni MC, Engelbert M. The premacular bursa's shape revealed in vivo by swept-source optical coherence tomography. Ophthalmology 2014;121:1020–1028.
11. Gal-Or O, Ghadiali Q, Dolz-Marco R, et al. In vivo imaging of the fibrillar architecture of the posterior vitreous and its relationship to the premacular bursa, Cloquet's canal, prevascular vitreous fissures, and cisterns. Graefes Arch Clin Exp Ophthalmol 2019;257:709–714.
12. Hwang JC, Barile GR, Schiff WM, et al. Optical coherence tomography in asteroid hyalosis. Retina 2006;26:661–665.
13. Garoon RB, Smiddy WE, Flynn HW Jr. Treated retinal breaks: clinical course and outcomes. Graefes Arch Clin Exp Ophthalmol 2018;256:1053–1057.