

# Spectral-domain Optical Coherence Tomography in Gas-filled Eyes

SD-OCT scans a broad area in a short time, allowing a more detailed and accurate identification of the macula after vitrectomy.

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Since the efficacy of pars plana vitrectomy (PPV) with gas tamponade for macular hole (MH) was first reported by Kelly and Wendel,<sup>1</sup> vitreous surgery with gas tamponade for MH has been improved. Internal limiting membrane (ILM) peeling with indocyanine green (ICG), triamcinolone acetate, or brilliant blue G staining, called chromovitrectomy has been shown to improve the macular hole closure rate. However, patients were required to maintain an inconvenient and uncomfortable face-down position postoperatively for several days to weeks. When MH closure can be confirmed in a gas-filled eye, vitreoretinal surgeons can then tell patients to discontinue a facedown posturing. We presented a recent prospective study to improve the detection of MH closure in gas-filled eyes by spectral-domain optical coherence tomography (SD-OCT) at the World Ophthalmology Congress in Berlin.<sup>2</sup>

## STUDY METHODS

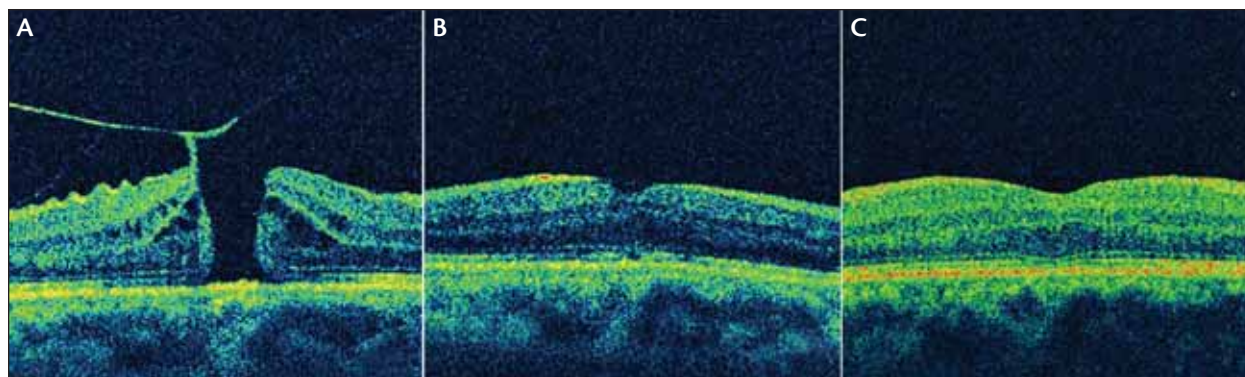
We studied 18 eyes with idiopathic macular hole, six eyes with macular hole retinal detachment (MHRD), and two eyes with myopic traction maculopathy between April 2009 and August 2009 at the Kyorin Eye Center in Tokyo. Standard PPV was performed in combination with removal of ILM after staining the ILM with triamcinolone acetate or 0.125% ICG. Gas tamponade was performed at the end of the surgery, and patients were instructed to

keep a face-down position for several days.

The entire macular area was scanned using SD-OCT (Cirrus HD-OCT 4000, Carl Zeiss Meditec, Inc., Dublin, CA) to avoid missing a macular hole in the sitting position. The five-line raster mode was used to obtain high quality images on postoperative days 1, 3, 7, and 30. When a macular image could not be obtained, patients were instructed to look slightly downward or upward until a clearer view of the macular area was obtained in the OCT images. The ability to detect a closed MH or the status of the foveal detachment or schisis with SD-OCT was evaluated, and the pre- and postoperative factors that affected the OCT images were investigated. The volume of intravitreal gas was estimated by the level of the inferior gas meniscus at the retina with indirect ophthalmoscopy in a sitting position.

## IMAGING RESULTS

In eyes with a macular hole, the postoperative status of the macular hole could be determined in 17 eyes (94%) by SD-OCT on postoperative day 1. The macular area could not be detected in one eye with less gas (60%) than in the 17 eyes with more than 80% gas. The macular hole was detected to be closed by SD-OCT in 16 of these 17 eyes and was still open in one eye. In all 18 eyes, only a reflection of the intravitreal gas bubble without any retinal image was seen on the monitor of the built-in line

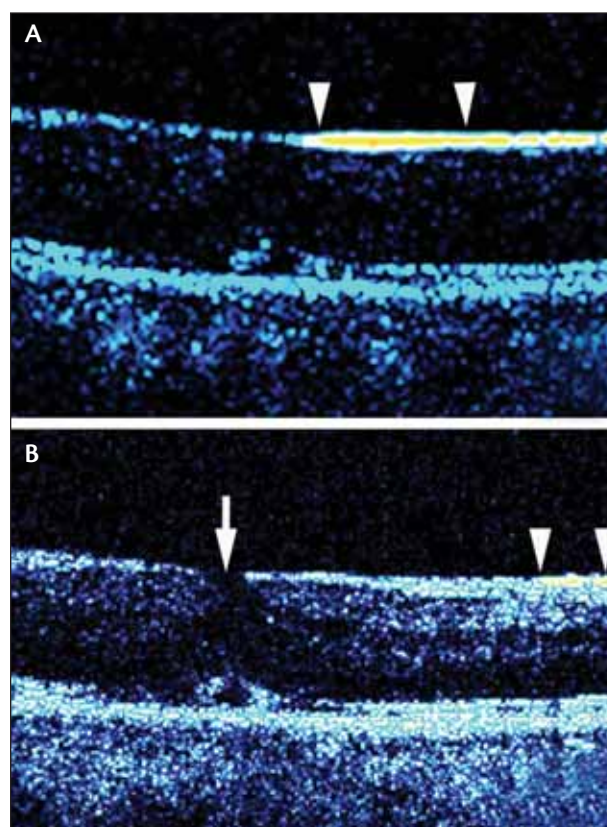


**Figure 1.** Optical coherence tomography (OCT) of an eye with a macular hole (MH). Longitudinal cross-sectional OCT image showing full thickness MH (A). OCT image showing that the MH is closed with a slight defect of the inner segment/outer segment (IS/OS) line on postoperative day 1 (B). OCT image shows a closed MH with improvement of the IS/OS line on postoperative day 10 (C).

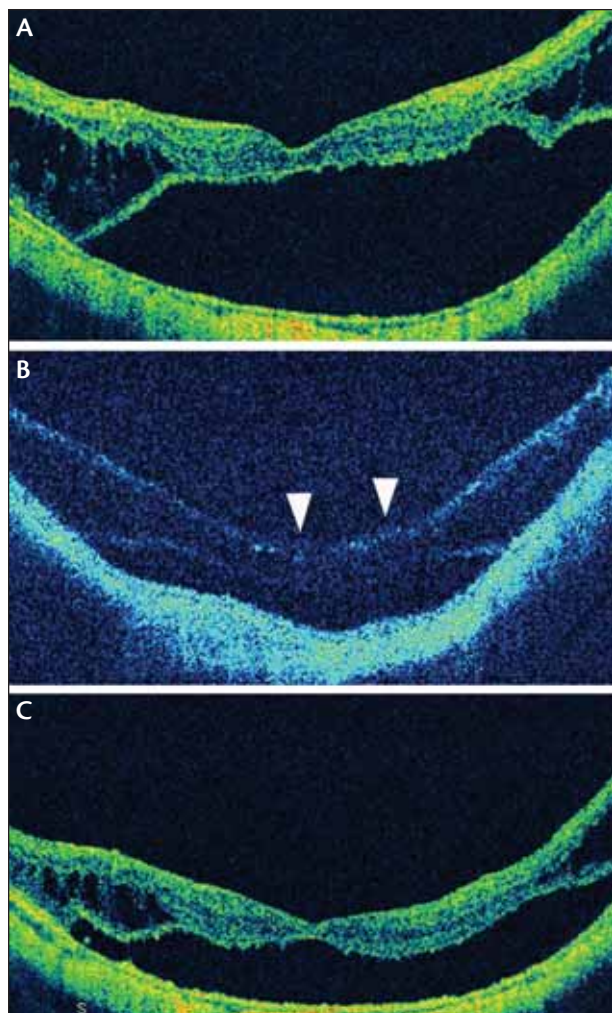
scanning ophthalmoscope of the Cirrus HD-OCT4000. SD-OCT imaging indicated an intense signal from the interface between the gas and the retina and decreased signals from the retinal microstructure including the inner segment/outer segment (IS/OS) line (Figure 1). The shorter focus of the OCT seemed to be controlled by sliding the OCT device slightly closer to the patient's eye or setting the focus toward the maximum of minus diopter.

With standard OCT examination in the sitting position, a clear macular image could not be observed in six eyes (38%) with gas volume greater than or equal to 80% on postoperative day 1 because the high reflection from the interface between the gas bubble and the retina decreased the retinal signal. When the patient was instructed to look slightly upward or downward, however, the gas bubble was shifted, and a clearer image of the retinal microstructure, including the status of the macular hole, was obtained in all six eyes (Figure 2). MH closure was detected in 11 eyes without shifting the eye position and in 17 eyes with shifting of the eye position. This improvement was significant ( $P=.041$ ; Fisher's exact probability test).

A clear view of the macula was obtained in four of 17 eyes on day 3 after the surgery, but the detection rate of the macular image decreased when the volume of gas decreased. The macular image became clearer in 15 of 17 eyes after the absorption of the intravitreal gas on postoperative day 7, when the intense signal from the interface between the gas and the retina decreased and the signal from the retinal microstructures increased. There was a period between postoperative days 1 and 7 when the macula could not be detected by SD-OCT because the intravitreal gas had decreased, allowing detection of the macular image only through the inferior part of the bubble of gas. This may be why the macular image was not detected on postoperative day 1 in the one eye with a macular hole with less



**Figure 2.** Optical coherence tomography (OCT) of an eye with a macular hole (MH). Longitudinal cross-sectional OCT image in the straight ahead sitting position showing a closed MH hidden by a strong reflection by the interface between gas bubble and retinal surface (arrowheads) on postoperative day 1 (A). OCT image at slightly upward gaze shows a shift of strong reflection from the interface (arrowheads) and a clearer image of the closed MH (arrow) on the same day (B).



**Figure 3.** Optical coherence tomography (OCT) of an eye with myopic traction maculopathy. Longitudinal cross-sectional OCT image showing tractional retinal detachment and retinoschisis (A). OCT image shows a decrease in the retinal detachment and retinoschisis (white arrowheads) on postoperative day 1 (B). OCT image shows a decrease in the retinal detachment and retinoschisis on postoperative day 60 (C).

intravitreal gas. After complete absorption of the gas at 1 month, the MH was closed in 17 eyes and not closed in one eye. This eye required a second surgery to close the MH. All the eyes with closed MH on postoperative day 1 were found to have a closed MH after absorption of gas until the latest follow-up.

In contrast, a clear macular image was not obtained in any of the eyes with MHRD even with a shift in the eye position ( $P=1.00$ ), and thus the status of the MH could not be determined in any of the six eyes with MHRD on postoperative day 1. The incidence rate of detecting the macular status in eyes with MHRD was significantly lower

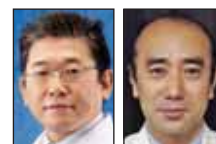
than that of MH in 17 of 18 eyes (94%,  $P=.0001$ ). A resolution of the retinal detachment or retinoschisis, however, could be seen in all eyes with a MHRD or myopic traction maculopathy (Figure 3). The eyes with MHRD were highly myopic and had deep posterior staphyloma but had sufficient volume of intravitreal gas (more than 80%) on postoperative day 1. In six eyes with a posterior staphyloma, the macular image was less detectable than in the 19 of 20 eyes with MH and myopic traction maculopathy but without a posterior staphyloma ( $P<.0001$ ). The MH was closed in three of six eyes with MHRD, and complete reattachment or a decrease in the degree of retinal detachment was achieved in all eyes at the last follow-up examination. The retinal detachment and retinoschisis were reduced or had completely resolved in the two eyes with myopic traction maculopathy.

Macular images could not be detected in highly myopic gas-filled eyes with a posterior staphyloma. A posterior excavation with an elongation of the axial length was present in eyes with posterior staphyloma. We assume that a thin fluid layer is present between the macula and the gas interface when the patient is in the sitting position because the gas bubble tends to be spherical and is not completely filled in the posterior staphyloma. The thin fluid layer may decrease the signal from the macula even in eyes filled with more than 80% gas. The status of the retinal detachment and retinoschisis, however, could be determined by SD-OCT, even with low quality images.

## SUMMARY

In summary, SD-OCT can scan a broad area in a short time, and this serial scanning of a broad area allows more detailed and accurate identification of the macula after vitrectomy. The status of a macular hole can be determined by SD-OCT in gas-filled eyes on postoperative day 1. This ability depends on the volume of intravitreal gas and the absence of a posterior staphyloma. The incidence of obtaining more precise macular images may be increased when patients look slightly upward or downward to shift the highly reflective signals of the gas bubble from the macula. ■

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2. Inoue M, Sano K, Taniuchi S, Hirakata A. Spectral-domain optical coherence tomography for gas-filled eyes. Paper presented at: World Ophthalmology Congress 2010; June 5, 2010; Berlin.