



Swept-source optical coherence tomographic findings in eyes with metastatic choroidal tumor



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ABSTRACT

Purpose: To report the swept-source optical coherence tomographic (OCT) findings in two eyes with choroidal metastases.

Observations: Two patients with choroidal metastasis were studied. The metastasis was from a breast cancer in Case 1 and from a lung cancer in Case 2. In Case 1, swept-source OCT showed a highly reflective solid tumor with low optical reflective tissues that had replaced the choroidal tissue. Swept-source OCT was able to image the choroidal mass where other fundus imaging methods such as fluorescein angiography did not show the mass. Ophthalmoscopy of Case 2 showed hemorrhages in the inner retina, on the tumor, and in the vitreous. Swept-source OCT showed a subretinal mass with a steeply-crowned cap and a ruptured Bruch's membrane on the tumor.

Conclusion and importance: Swept-source OCT imaging can detect the inner structure of a choroidal mass and retina around it in good detail.

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1. Introduction

Choroidal metastases are the most frequent malignancy of the eye.¹ The most common primary site is the lung in men and breast in women.¹ The diagnosis of a choroidal metastasis is based on the clinical history, ophthalmoscopic appearance of the fundus, and images of fluorescein angiography (FA), indocyanine green angiography (ICGA), fundus autofluorescence (FAF), optical coherence tomography (OCT), and ultrasonography (US). In 66% of the patients with choroidal metastasis, there is a history of systemic cancer but the other 34% do not.¹ The appearance of the fundus and the images obtained by the different methods are very important not only for the diagnosis but also for the monitoring of the effectiveness of the therapies. Thus, it is essential to updated the findings made with new fundus imaging devices.

Many characteristics of choroidal metastasis have been obtained by time domain OCT (TD-OCT) and spectral domain OCT (SD-OCT).^{2,3} Recently, new retinal and choroidal findings of choroidal metastases have been obtained by enhanced depth imaging OCT

(EDI-OCT)^{4,5} and swept-source OCT. Both instruments have allowed clinicians to examine the choroid in greater detail. The swept-source OCT device uses a wavelength-tunable laser and dual balanced photodetector which allows higher imaging speed, and the longer wavelengths increase the depth of imaging to include the choroid. The resolving power is 20 μm transversely, 8 μm longitudinally.⁵ Francis et al. have reported the findings of a choroidal nevus using the swept-source OCT images, and they reported that certain intralésional characteristics were depicted better by swept-source OCT than EDI-OCT.⁶

There is only one case report of a choroidal metastasis examined by swept-source OCT.⁷ The authors of that publication reported the results of intensity-modulated radiotherapy for a patient with choroidal metastasis using information obtained with SS-OCT. However, the characteristics of the metastasis were not presented. Other findings made by this new imaging technology have not been reported.

We have examined two cases of choroidal metastasis and determined their characteristics from the swept-source OCT images. The first case was a choroidal metastasis of a breast cancer, and the swept-source OCT findings were compared to those obtained by FA, FAF, and ICGA. The second case was a choroidal metastasis of a lung cancer, and the swept-source OCT findings of the tumor and a vitreous hemorrhage will be presented.

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2. Findings

2.1. Case 1

In 2014, a 68-year-old woman presented with blurred vision in her left eye that had developed one month earlier. She had undergone mastectomy for left breast cancer in 2006. The pathological report of the breast cancer showed that the primary lesion had adenoidal structure with mucin. Metastases to the lung and brain were treated by chemotherapy and radiation since 2010.

Our findings showed that her decimal best-corrected visual acuity (BCVA) was 1.5 OD and 0.3 OS. The other findings in her right eye were within the normal limits. The left fundus had a large yellowish elevation of the retina with many brown pigments in an area superior and superior-temporal of the optic disc. A serous macular detachment was detected (Fig. 1A). FA showed a subretinal tumor that was hyperfluorescent with hypofluorescent patches, and FAF showed the reverse pattern (Fig. 1B and C). ICGA showed the tumor as a hypofluorescent area in the early and middle phases (Fig. 1D).

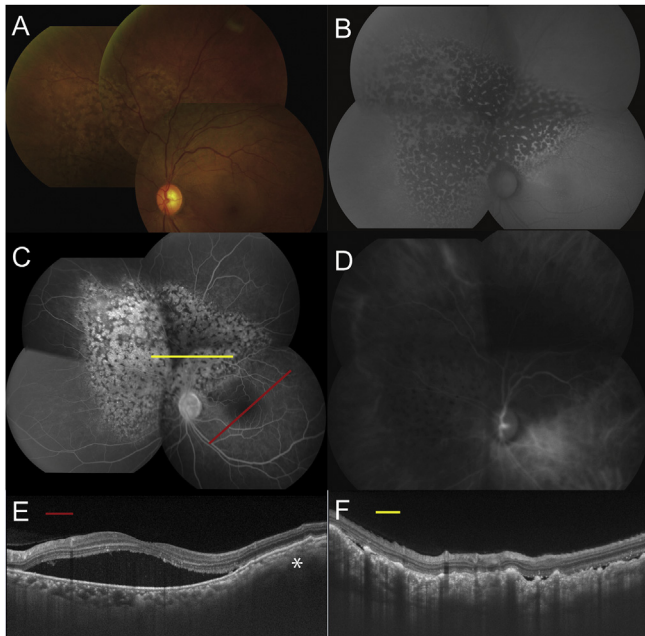


Fig. 1. Case 1. Findings in Case 1 with a choroidal metastasis from a breast cancer.

- Fundus photograph of the left eye showing a large yellowish elevated mass in the macular area with many brown pigment granules superior and superior-temporal to the optic disc.
- Fluorescein angiography (FA) shows the subretinal tumor as hyperfluorescent with hypofluorescent patches.
- Fundus autofluorescence images shows the reverse pattern of FA.
- Indocyanine green angiogram (ICGA) shows the tumor as hypofluorescent in the early and middle phases.
- Swept-source optical coherence tomography (OCT) shows subretinal fluid in the macular area without the choroidal tumor beneath. In the region temporal to superior-temporal to the macula where the FA and FAF images did not show any abnormalities, swept-source OCT shows that the RPE and retina are elevated with a dark optical reflective choroidal mass (*) which has pushed the large choroidal vessels upward. The retina is intact in this area in the swept-source OCT image.
- Swept-source OCT shows a high optical reflective solid tumor with low optical reflections which appears to have replaced the choroid in the area of the tumor. The RPE layer is not present and Bruch's membrane is partially observed. High optical reflective elevations are seen between the retina and tumor with subretinal fluid.

Swept-source OCT showed a highly reflective solid mass with low optical reflection that had replaced the choroid (Fig. 1F). The thickness of the choroid was about twice that of normal choroid, and no normal choroidal structures were seen. The retinal pigmented epithelial (RPE) layer was not detected but Bruch's membrane was partially observed. A large optical reflective mass was seen between the retina and the tumor, and it corresponded with the pigments that were seen as hypofluorescent areas in the FA images and hyper-autofluorescent in the FAF images. Subretinal fluid and an elongated and irregular photoreceptor layer with hyper-luminescent speckles were seen. The retinal structure was intact except for the changes in the photoreceptor layer. Subretinal fluid was also seen to have accumulated in the macular area away from the choroidal tumor (Fig. 1E). On the other hand, swept-source OCT showed an elevation of the RPE and retina in the area superior and superior-temporal to the macular where FA and FAF showed no abnormality. The choroid appeared as a dark optical reflective mass which pushed the large choroidal vessels upward. The small and middle size choroidal vessels were not altered, and the RPE and retina were intact in this area in the swept-source OCT images.

Unfortunately, the patient did not return for further examinations because she could still use her other eye, and she felt that her life expectancy was very short.

2.2. Case 2

A 65-year-old woman had undergone partial lung excision for a lung adenocarcinoma in 2009 and presented in our clinic in 2010 because of blurred vision. We diagnosed her with choroidal metastasis with subretinal fluid in her left eye, and she underwent systemic chemotherapy with oral Gefitinib. One month later, the subretinal fluid was not present, and the size of the tumor had decreased. The chemotherapy was reinstated when she had a relapse in her lungs in 2012; 4 courses with Pemetrexed, Cisplatin and Bevacizumab, and 4 courses with Pemetrexed and Bevacizumab.

She noted floaters in May 2014 and returned to our clinic. Her BVCA was 1.0 OU, and the findings in her left eye were within the normal limits. The anterior segments were normal but there were many white cells in the anterior vitreous of her right eye. A high dome-shaped, yellowish-white subretinal tumor with some hemorrhages was observed in the nasal-temporal periphery of her right eye where the first choroidal metastasis was seen in 2009 (Fig. 2A). Only a small amount of subretinal fluid had accumulated in the peripheral inferior area. FA and ICGA showed the tumor as a hyperfluorescent mass in the early to late phases (Fig. 2C and D). B-mode ultrasonography showed the lesion as a dome-shaped mass (Fig. 2B). The tumor was so large that swept-source OCT could not examine all of it in detail. She was diagnosed with a local relapse of the choroidal metastasis, and chemotherapy was reinstated with oral Gefitinib. One month later, the height of the tumor was reduced, but four months later, hemorrhages were detected in the inner retina (Fig. 3A). FA and ICGA did not detect any choroidal neovascularization (Fig. 3B and C). Swept-source OCT showed the tumor as a subretinal mass like a steeple-crowned cap (Fig. 3D), and the structure of the retina was indistinct because of the retinal hemorrhages (Fig. 3D and E). Bruch's membrane could not be identified.

She returned to our clinic nine months after starting chemotherapy because of a sudden development of blurred vision from a vitreous hemorrhage. Her BVCA in the right eye was reduced to 0.4, but B-mode ultrasonography showed no enlargement of the tumor compared to the last examination. Because of the possibility that the tumor had worsened, we decided to supplement the treatment with local external-beam radiotherapy (total 30 Gy/10 times, X ray)

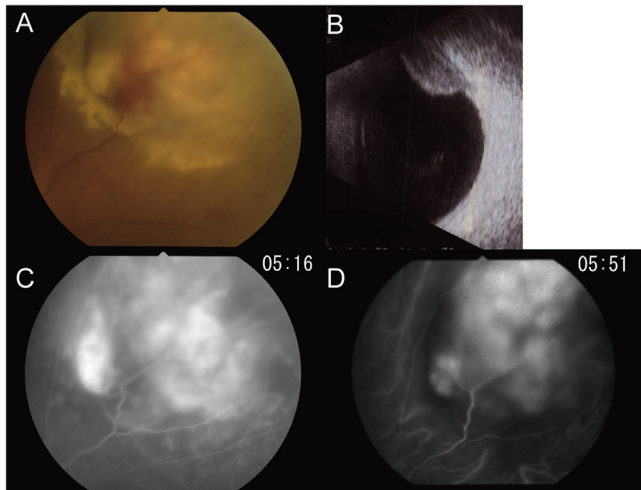


Fig. 2. Case 2. The findings in Case 2 with a choroidal metastasis from a lung adenocarcinoma when the choroidal metastasis recurred.

- (A) A high dome-shaped, yellowish-white subretinal tumor with some hemorrhages can be seen.
- (B) B-mode ultrasonographic image shows a dome-shaped mass.
- (C) Fluorescence angiography (FA) shows the tumor as a hyperfluorescent mass.
- (D) Indocyanine green angiography (ICGA) shows the tumor as a hyperfluorescent mass.

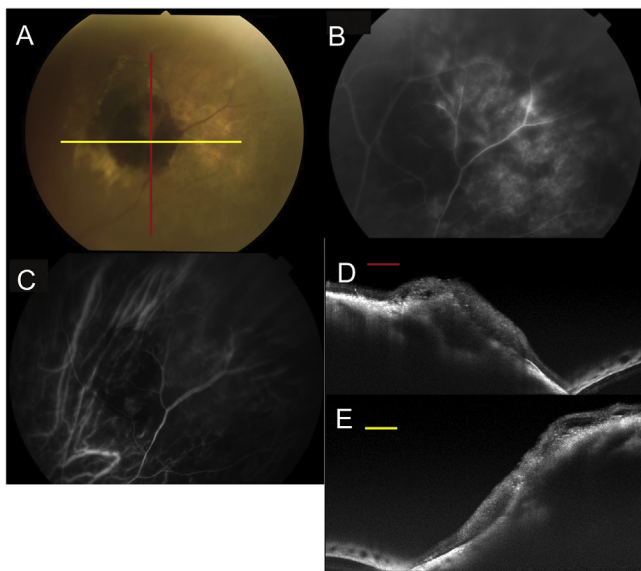


Fig. 3. Case 2. Findings four months after beginning the treatment.

- (A) A hemorrhage can be seen on the tumor in the inner retina.
- (B) Fluorescence angiography (FA) shows no choroidal neovascularization.
- (C) Indocyanine green angiography (ICGA) does not show the choroidal neovascularization.
- (D) Swept-source optical coherence tomography (OCT) shows the tumor as a subretinal mass with a steeply-crowned cap. The structure of the retina is uniform and unclear because of the retinal hemorrhage.
- (E) Bruch's membrane cannot be identified.

and a change in the chemotherapy regimen (13 courses of Docetaxel followed by oral Erlotinib). One week later, the vitreous hemorrhage was not present, and we could see the tumor, and it had a retinal hemorrhages on it.

About three years after beginning of chemotherapy, the hemorrhage was not present, and B-mode US and swept-source OCT showed that the tumor was flatter (Fig. 4A, B, 4C). The structure of

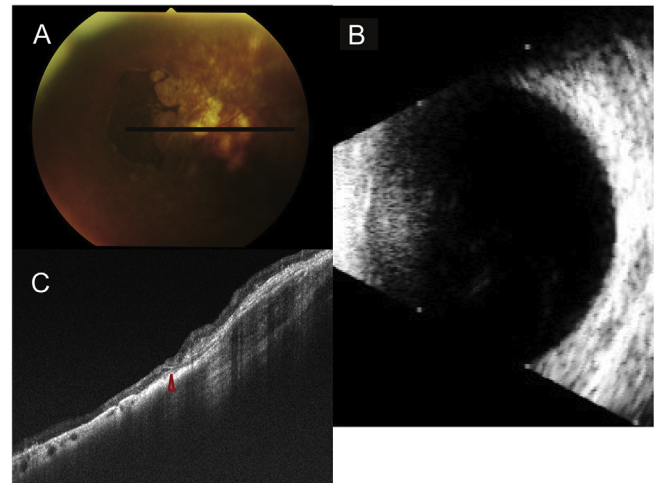


Fig. 4. Case 2. Findings about three years after beginning the treatment.

- (A) Color fundus photograph showing hypertrophy of the retinal pigment epithelium (RPE), depigmented area, and yellow scar.
- (B) B-mode ultrasonographic image shows no tumor.
- (C) Swept-source optical coherence tomography (OCT) shows the tumor is flatter. The structure of the retina around the tumor is destroyed, and Bruch's membrane is partially ruptured and rolled at the center of the former hemorrhagic area (arrow head).

the retina around the tumor was severely damaged, and Bruch's membrane was partially ruptured and curled at the center of the former hemorrhage (Fig. 4C). Chemotherapy is being continued, and we have scheduled her for more examinations.

3. Discussion

Our results showed that Case 1 had a typical choroidal metastasis of a breast cancer with brown pigment and destruction of the RPE. The inner structure of the tumor could not be detected clearly even with the swept-source OCT. Al-Dahmash et al. examined a choroidal metastasis by EDI-OCT and reported that the internal structure of the tumor could not be evaluated because the EDI-OCT signals were attenuated by shadowing in 86% of the cases.⁴ Demirci et al. reported that 71% of choroidal tumors were seen as low optical reflective masses and 30% were seen as a high reflection masses.⁵ We observed the inner structure of the tumor as a highly reflective solid mass with low reflective areas where the RPE and choroidal structures were destroyed. The swept-source OCT appearance suggested an adenoidal structure with mucin of a choroidal tumor which was the same as the pathology of the primary lesion. These OCT features of the choroidal mass may represent the pathological structural appearance of choroidal metastasis.

In Case 1, the RPE was intact in the inferior-temporal area of the tumor, and the FA and FAF images were normal. The choroidal tumor beneath the choroidal vessels was visible in the swept-source OCT images, and it was recognized as an invasion from the main lesion. It is generally believed that choroidal metastases develop from the choriocapillaris,⁴ but our findings suggest that the root of the invasion may be the outer regions of the choroid. In this area, OCT showed the tumor as a dark mass but the inner structure of the tumor could not be observed in detail because of the RPE and choroid. However, it is important to note that swept-source OCT did show the tumor invasion which could not be detected by FA and FAF. Part of this choroidal tumor was seen as a dark island in the ICG angiograms.

We were not able to scan the entire retina by swept-source OCT but we were able to scan the retina where ICGA showed abnormalities which allowed us to determine the extent of the tumor invasion more accurately.

In Case 2, we detected a local relapse of the choroidal metastasis and vitreous hemorrhage in the swept-source OCT images. The primary lesion in this case was the lung, and the metastasis was to the choroid. The local relapse occurred at the same site as the first metastasis suggesting that the relapse might have developed from residual malignant cells. A literature search on PubMed on December 19, 2016 did not extract any publication on the OCT findings in cases with a local relapse and vitreous hemorrhages.

The local relapse occurred four years after completing the ophthalmological observations on the first choroidal metastasis. After chemotherapy, ultrasonography showed no tumor in spite of the swept-source OCT observation of a flatten choroidal tumor. We were able to observe the retinal and choroidal lesion using the swept-source OCT in a range of micrometers. Thus, we recommend that choroidal tumors be examined by swept-source OCT to determine whether the treatment was successful, and the examinations should be continued periodically to determine if any relapse of the tumor had occurred.

The findings in Case 2 showed the tumor as a low reflective mass unlike Case 1 where the RPE was destroyed. The appearance of choroidal metastases tend to be different between breast cancers and lung cancers,⁸ and the pathological differences may have been the cause of the differences in the OCT appearances.

Case 2 also had a massive retinal hemorrhage with accompanying vitreous hemorrhages. Vitreous hemorrhages are rare in choroidal metastasis, and Shield et al. reported one case of lung cancer metastasis with vitreous hemorrhages.⁹ This histopathological study reported of a necrotic tumor stated that the retina was thin but intact. On the other hand, melanomas with vitreous hemorrhages are not rare, and they tend to grow to dome-shaped or mushroom-shaped masses.¹⁰ They tend to perforate Bruch's membrane which then cause the vitreous hemorrhages.¹⁰ Our case had a subretinal mass with a steeply-crowned cap at the center of the retinal hemorrhage before the vitreous hemorrhage occurred. Bruch's membrane on it was unclear unfortunately, but after the tumor flattened, the hemorrhage disappeared and a partially ruptured Bruch's membrane was seen. These findings of the retina suggest an infiltration of the tumor into the retina, and the steeply-crowned tumor might indicate a retinal infiltration after a rupture of Bruch's membrane.

Intravitreal bevacizumab has been recently reported to be an optional treatment for choroidal metastasis when systemic chemotherapy and radiation therapy fail.¹¹ One of the contraindication of systemic bevacizumab is the development of necrotic hemorrhages which can cause uncontrolled hemoptysis. As best we know, there has not been any reports on the use of bevacizumab for a tumor with retinal hemorrhage, and it is not known if the tumor with massive retinal or vitreal hemorrhages can safely undergo intravitreal injections of bevacizumab.

Patients with metastases tend to have shorter life expectancy (average one year),¹² but more effective treatments of malignant tumor have been developed, and the life expectancy has increased as in Case 2. Moreover, new treatment options such as photodynamic therapy and intravitreal injection of bevacizumab have been developed.^{10,13} Thus, it is important that ophthalmologist use the latest technology and treatments to improve the quality of life and vision.

4. Conclusions

The findings of swept-source OCT can help clinician diagnose and determine the extent of the tumor or infiltration into retina or perforation the Bruch's membrane to decide the treatments. Further studies with swept-source OCT are needed to determine the characteristics of choroidal metastasis so that earlier diagnosis can be made and the effectiveness of the therapy can be monitored.

5. Patients consent

Informed consent in writing from patients for use their information and fundus photographs for research was obtained.

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Conflict of interest

The following authors have no financial disclosures: TI, KM, YT, RS, MU and KOM.

Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

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