detectable in the central macula suggesting initial ciliary junction disorganization before photoreceptor death. These noninvasive investigations can help in monitoring the patients. They may benefit from various visual aids such as a 4X dome magnifier, which was recommended for our patient. Genetic counselling should be done for patients and their families. These patients might require regular follow up with the internist for systemic associations.

The case presents an interesting diagnosis by an ophthalmologist for a multisystem disease, and it stresses the importance of good systemic evaluation along with eye examination.

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Footnotes and Disclosure

The authors have no proprietary or commercial interest in any materials discussed in this article.

Optical coherence tomography angiography in choroidal metastasis before and after treatment

Choroidal metastases represent the most common intraocular malignant tumor in adults.[1] With the advent of optical coherence tomography angiography (OCTA), there is a unique opportunity to visualize choroidal vascular pathologies in more detail using a noninvasive technique concurrent with anatomical evaluation of the retina, retinal pigment epithelium (RPE), and choroid. Depth-selective characterization is one of the most significant advantages of OCTA, allowing better visualization of choroid circulation and, particularly, the choriocapillaris layer, which is the main source of perfusion to the RPE and photoreceptors. Previous investigators have shown the role of optical coherence tomography (OCT) in assessment of choroidal metastasis.[2–4] In addition, there are reports of its dramatic response to epidermal growth factor receptor (EGFR) inhibitors,[5] but OCTA findings in choroidal metastasis has not been described.

Here, we present a case of asymptomatic choroidal metastasis, leading to the primary diagnosis of stage IV EGFR-positive lung adenocarcinoma, with OCTA findings in the choriocapillaris at presentation. Choroidal changes in OCTA almost completely resolved with near normal restoration of choriocapillaris vascular perfusion signal, even in areas without visible choroidal lesions, only 3 weeks after systemic treatment with EGFR inhibitor.

Case Report

A 50-year-old Hispanic woman presented for annual examination with no specific complains. She had a past medical history of migraines and was taking oral multivitamin supplements. She had no history of smoking. On examination, visual acuities were 20/30 in each eye. Intraocular pressures and pupillary exam were within normal limits, and anterior segments were unremarkable. Dilated fundus examination was notable for a hypopigmented lesion in the inferior macula of the right eye (Fig. 1A) and multiple yellowish deep lesions with overlying hyperpigmented brown stippling in the central and inferior macula of the left eye (Fig. 1B). Fluorescein angiogram (FA) indicated early hypofluorescence with increasing multifocal hyperfluorescence corresponding to choroidal lesions (Fig. 1 C, D). Enhanced depth spectral domain (EDI-SD) OCT (Spectralis, Heidelberg, Germany) showed multiple discrete hyper-reflective nodules in choroid highly suggestive of choroidal infiltrative process (Fig. 1 E, F).

OCTA (RTVue-XR Avanti, Optovue, Fremont, Calif) in the right eye showed multiple scattered areas of dark, hypointense flow voids surrounded by a more uniform flow pattern of choriocapillaris structure (Fig. 2A1, A2); in the left eye, there were more distinct and larger areas of dark, hypointense flow voids in variable sizes and shapes, causing a general reduction in signal density in favor of choroidal infiltration (Fig. 2 C1, C2). The patient was urgently referred for systemic work-up of metastasis. Whole-body positron emission tomography revealed multiple lung and bone lesions; subsequent lung biopsy was compatible with asymptomatic stage IV adenocarcinoma of the lung with positive EGFR mutation. Systemic therapy with erlotinib, an EGFR-inhibitor, was initiated. Three weeks after treatment, visual acuity remained stable in both eyes, and OCTA showed resolution of flow voids throughout the macula in both eyes. In the right eye, the scattered areas of flow void noted at presentation were largely replaced by

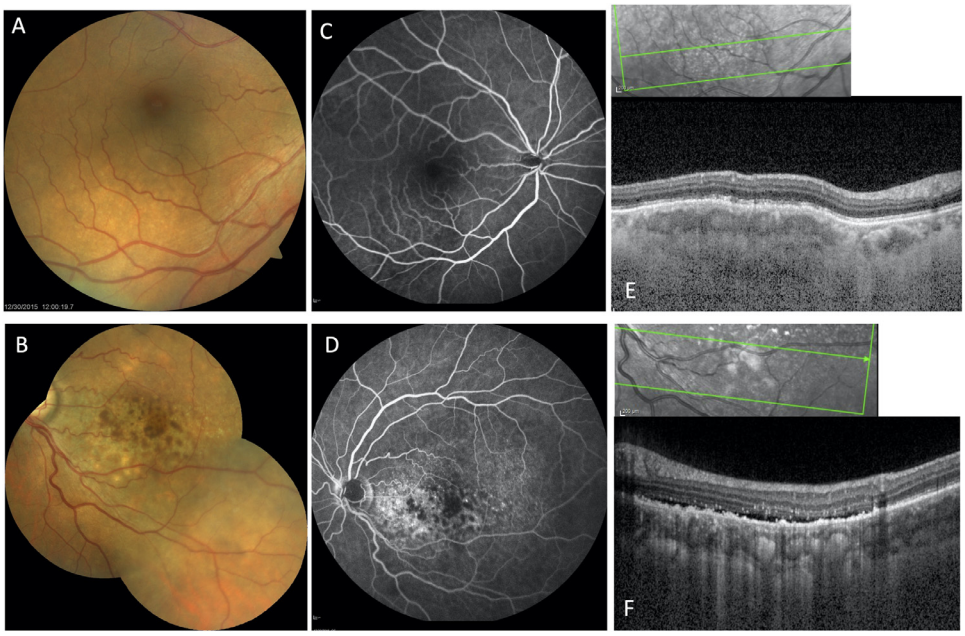

Fig. 1—Fundus photos (A, B), fluorescein angiography (C, D), enhanced depth spectral domain optical coherence tomography (OCT) (E, F) at presentation. A hypopigmented lesion was noted in the inferior macula of the right eye (A) and multiple yellowish deep lesions with overlying hyperpigmented brown stippling was noted in the central and inferior macula of the left eye (B). In OCT, choroidal thickening with multiple hyper-reflective nodular lesions in intra-choroidal space and overlaying RPE irregularity and "shaggy" photoreceptors were notable in the inferior macula of the right eye (E). In the left eye, there were discrete hyper-reflective choroidal nodules suggesting infiltrative process in addition to patchy disruption of outer retina and subretinal fluid (F); In FA, a mild hyperfluorescence in late phase in inferior macula of the right eye (C) and an early hypofluorescence with increasing multifocal hyperfluorescence corresponding to choroidal lesions in the left eye was noted (D). En-face infrared images show location of OCT scans through lesions in E and F panels.

flow signals not only in the inferior macula where the lesion was noted, but also in the central foveal area that no visible lesions were seen in OCT (Fig. 2B1, B2). In the left choroid, flow signals were even more significantly increased in the choriocapillaris compared with presentation, which is consistent with resolution of choroidal infiltrates. (Fig. 2D1, D2)

Discussion

Choroidal metastases are the most common intraocular tumors in adults. The most common primary site of the cancer is breast carcinoma in females and lung cancer in males.[1] FA and indocyanine green angiogram have been traditionally used for characterization of choroidal metastasis and differentiation from other choroidal tumors or pathologies[1]; OCT characteristics of choroidal metastasis have been described previously.[4–5] OCTA enables evaluation of choroidal and retinal vascular pathology in more detail using a noninvasive technique. To our knowledge there is no report in English literature characterizing OCTA findings of choroidal metastasis.

Our patient was asymptomatic despite bilateral macular involvement at presentation. Macular OCTA revealed flow signal abnormalities in the Choriocapillaris of both eyes, including areas corresponding with choroidal lesions on exam. These abnormalities could be described as large areas of dark hypointense flow voids in variable sizes and shapes causing a general reduction in signal density in CC suggestive of an infiltrative process. The areas of abnormal flow correlated with choroidal nodules in B-scan, particularly in the inferior macula of the left eye where hypointense flow voids were more prevalent. Three weeks after initiation of erlotinib immunotherapy, OCTA showed significant resolution of flow voids throughout the central macula in both eyes, resulting in more homogeneous signal and thus blood flow in the choriocapillaris. Interestingly, we noticed increase of CC blood flow signal even in the central fovea in the right eye, and microscopic flow voids resolving even though there were no visible lesions on OCT B-scan, indicating that subclinical micro-metastases were likely present (Fig. 2 A1, A2, B1, B2). Superficial and deep retinal capillary plexus showed normal flow pattern before and after the treatment.

Here, we present a case of lung adenocarcinoma with clinical signs of choroidal metastasis, exhibiting OCTA findings indicative of flow voids in CC highly suggestive of an infiltrative process, even in areas without choroidal lesions in structural OCT. The OCTA choriocapillaris flow changes almost completely resolved with near normal restoration of choriocapillaris vascular architecture 3 weeks after systemic treatment with epidermal growth factor receptor inhibitor, even in areas of subclinical choroidal lesions likely representing micrometastasis. Our hypothesis is that reduced signals are more likely owing to mass effect from the metastasis rather than direct infiltration of the choriocapillaris or vascular steal effect.

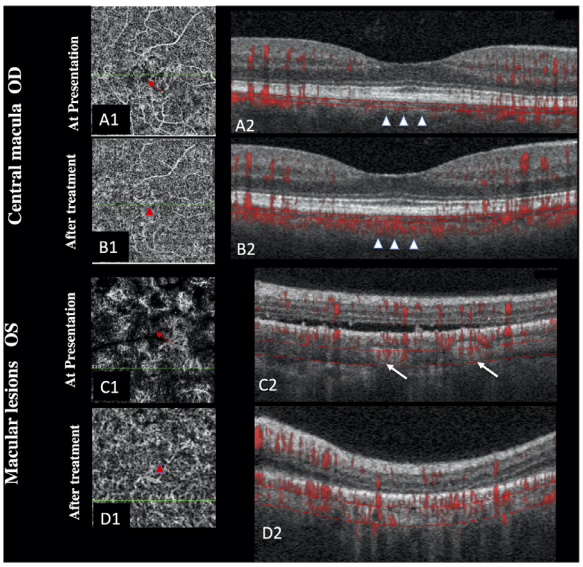

Fig. 2—En-face and B scan optical coherence tomography angiography (OCTA) images of choriocapillaris of right eye at presentation (A1, A2) and 3 weeks after erlotinib treatment (B1, B2); Left eye at presentation (C1, C2) and 3 weeks following immunotherapy (D1, D2). Images representing central (A1, A2, B1, B2) and inferior (C1, C2, D1, D2) macula. Hyper-reflective choroidal nodules (white arrows, C2) with significant flow void in the choriocapillaris (A1, C1) suggestive of tumor infiltration. Three weeks after systemic erlotinib treatment, OCTA showing regression of choroidal lesions and resolution of flow voids in choriocapillaris (B1, B2, D1, D2). Scattered areas of flow void noted at presentation (red arrow, A1, C1) were largely replaced by flow signals (red arrowhead, B1, D1) not only in inferior macula where lesions were noted (C2) but also in central foveal area that no visible lesions were seen (compare arrowheads in A2 and B2). En-face images clearly indicate that vascular flow in choriocapillaris was restored to near normal post immunotherapy (B1, B2, D1, D2).

One potential cause of flow voids is shadowing from overlying structures such as retinal layers and vitreous or lens opacities; however, there was no apparent OCT or OCTA signal attenuation in the retina or underlying choriocapillaris at presentation (Fig 2 A2, C2), making this possibility unlikely. Another cause for flow voids is the low velocity of flow such that it falls under the OCTA decorrelation threshold for detection (less than 0.3 mm/s in this case). This is also unlikely given the clinical setting and significant improvement of signal after treatment using the same machine. One may test this possibility using a custom variable interscan time analysis hardware–software framework to detect slower flow.

This case signifies the value of multimodal imaging and particularly OCTA not only to diagnose a life-threatening condition but also to utilize this imaging technique to determine the extent of choroidal infiltration at a microscopic level and to monitor the course of ocular disease with restoration of choroidal vascular flow indicating a response to treatment.

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Footnotes and Disclosure

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Late progression of visual loss from ocular quinine toxicity

A 64-year-old Caucasian man was admitted to hospital with acute loss of vision after ingesting at least 3 grams of quinine, risperidone, and paracetamol. His medical history was significant for schizophrenia and nocturnal leg cramps. His usual medications were risperidone and quinine as required. No ophthalmic history was noted. An inpatient examination revealed bilateral no-light-perception vision and grossly constricted visual fields. Electrocardiogram showed sinus rhythm and blood tests, including glucose, haematology, liver, renal, coagulation profiles, and paracetamol levels were normal. The patient was given supportive therapy and empirical high dose vitamin C and E supplements. No gastrointestinal decontamination was attempted given the