Progression of Parapapillary Choroidal Microvascular Dropout After Disc Hemorrhage in Glaucoma Patients: 2 Case Reports

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Purpose: Microvasculature dropout (MvD) is a novel finding seen in optical coherence tomography angiography (OCTA), which is characterized by a localized dehiscence of the choriocapillaris in the parapapillary atrophy area. Disc hemorrhage (DH) is an important factor often associated with the development and especially progression of glaucoma. Here, we present 2 cases of MvD progression with DH.

Methods and Results: Case 1: A 62-year-old female patient with normal tension glaucoma in both her eyes had recurrent DH at the inferior area of her right eye. A new DH was observed in the inferotemporal area of the right eye with MvD progression on OCTA in the same direction three months from the baseline. Case 2: A 57-year-old female patient with bilateral steroid-induced secondary glaucoma also had recurrent DH in her right eye. Four months from the baseline, DH occurred in the superotemporal and inferotemporal area of the right eye, and MvD was detected on OCTA in the superotemporal corresponding direction. After 19 months from the baseline, OCTA was repeated. The DH had resolved, but the superotemporal MvD persisted.

Conclusions: The 2 cases presented here are the first to report on the relationship between MvD progression and DH. MvD as visualized in OCTA imaging looks to be of clinical importance, and hopefully future studies will reveal the actual connection between MvD, DH, and glaucoma progression.

Key Words: glaucoma, optical coherence tomography angiography, microvasculature dropout, disc hemorrhage

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Glaucoma is a chronic disease of the optic nerve resulting from progressive loss of retinal ganglion cells.[1] The death of these retinal ganglion cells is not fully understood, but there is strong evidence to show that a reduction in blood supply to the optic nerve head (ONH) plays a primary role in the pathogenic mechanism of glaucoma development.[2–8]

Optical coherence tomography angiography (OCTA) is a noninvasive imaging modality that provides a visual assessment of the blood vessels of the retina, ONH, and choriocapillaris. Recent glaucoma studies using OCTA have revealed a localized reduction in the vascular density of the choriocapillaris in the area of parapapillary atrophy (PPA), which is termed as microvasculature dropout (MvD). MvD can be seen at the beta zone of PPA on OCTA choroidal vessel density maps.[9,10] There are many studies on the relationship of MvD with glaucoma,[9–21] and these suggest that MvD may be deeply associated with the progression of glaucoma.

Disc hemorrhage (DH) is bleeding that occurs in the retinal nerve fiber layer (RNFL) at the peripapillary area and is a predominant factor in the development and progression of glaucoma.[22–30]

A few recent studies have evaluated MvD and DH together.[17,18] However, to the best of our knowledge, a correlation between DH and MvD has not been reported yet. In this study, we present 2 clinical cases of glaucoma patients with MvD progression and DH.

CASE REPORT

Case 1

A 62-year-old female patient with normal tension glaucoma had recurrent DH in both eyes as noted during follow-up appointments. At the time of the baseline study, her visual acuity was 20/20 in the right eye (OD) and 20/25 in the left eye (OS), and the intraocular pressure (IOP) was 12 mm Hg (OD) and 14 mm Hg (OS) as measured by Goldmann tonometry. She was using a tafluprost agent before bedtime. An RNFL defect in the right inferotemporal retina and MvD in the inferior area of PPA were detected during the baseline examination.

Three months later, DH was observed in the inferotemporal area of the right eye, and MvD had further extended into the inferotemporal area relative to that observed on the baseline OCTA and in the same direction as that of the DH (Fig. 1).

Case 2

A 57-year-old female patient with Vogt-Koyanagi-Harada disease (VKH) and steroid-induced secondary glaucoma in both eyes, had recurrent optic DH in her right eye. She took oral prednisolone for about a month (started with 45 mg/d and tapered) and started using prednisolone eye drops every 3 hours after the first attack of VKH happened in 2008, about 10 years before the baseline. No intravenous agent was prescribed. The inflammation subsided without any use of oral prednisolone, and 1% rimexolone eye drops were

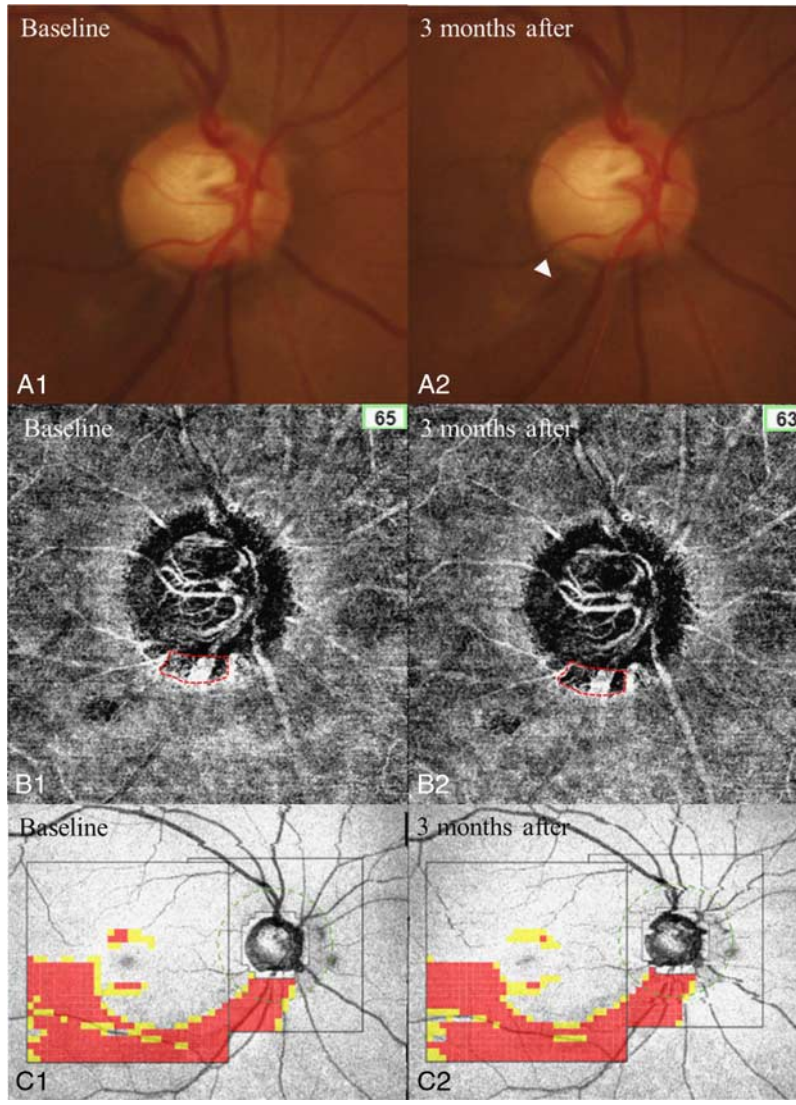

FIGURE 1. Serial disc photographs (A1 and A2), optical coherence tomography angiography (OCTA) images (B1 and B2), and wide field retinal nerve fiber layer (RNFL) deviation map images from swept-source OCT (C1 and C2) of the right eye of a 62-year-old woman. Microvascular dropout (MvD) was seen at the inferior area of the beta zone of the parapapillary area at baseline examination (broken line, B1). Three months after the baseline image was taken, a disc hemorrhage (DH) was observed in the inferotemporal area of the right eye (arrowhead, A2), and MvD had progressed further (compared with B1) in the same direction as that of the DH (broken line, B2). A RNFL defect was seen at the inferotemporal retina, and no significant change was shown. The image quality score of OCTA is provided at the top-right corner of B1 and B2.

prescribed for about a year as maintenance therapy. The highest measured IOPs were 38 mm Hg (OD) and 36 mm Hg (OS), respectively, while she was using 1% rimexolone eye drops 3 times a day without any IOP lowering agents about a year after the attack occurred. The IOP was soon normalized after stopping the 1% rimexolone eye drops and using 2 IOP lowering agents; dorzolamide/timolol and brimonidine eye drops twice a day. Timolol eye drops were administered instead of the 2 agents after several months, and the IOP level remained stable until the recent follow-up. At the time of the baseline study, her best-corrected visual acuity was 20/20 (OD) and 20/20 (OS), and the IOP was 12 mm Hg (OD) and 12 mm Hg (OS) as measured by Goldmann tonometry. The patient used a timolol agent every morning and did not use any steroidal eye drops. There was DH in the superotemporal and inferotemporal area (Fig. 2, A3). RNFL defects were observed in the superotemporal and inferotemporal retina, and no apparent parapapillary choroidal MvD was seen in her right eye (Fig. 2, B3 and C3).

Four months after the baseline, the old DHs had disappeared, and a new DH was observed in the superotemporal area of the right eye (Fig. 2, A4). MvD was first noted in Figure 2, B4 at the superotemporal side of the beta zone of the PPA, in the same direction that the DH had appeared.

OCTA was repeated 19 months after the baseline. DH had resolved, but the superotemporal MvD persisted (Fig. 2, B4). MvD was not apparent in the inferotemporal area.

DISCUSSION

In this case report, we showed sequential changes in MvD with DH in glaucoma patients. MvD is a novel finding of unknown clinical potential, which is only recently been studied. It is a real choroidal perfusion defect that can be confirmed on indocyanine green angiography (ICGA)[15] and is associated with low diastolic blood pressure, which

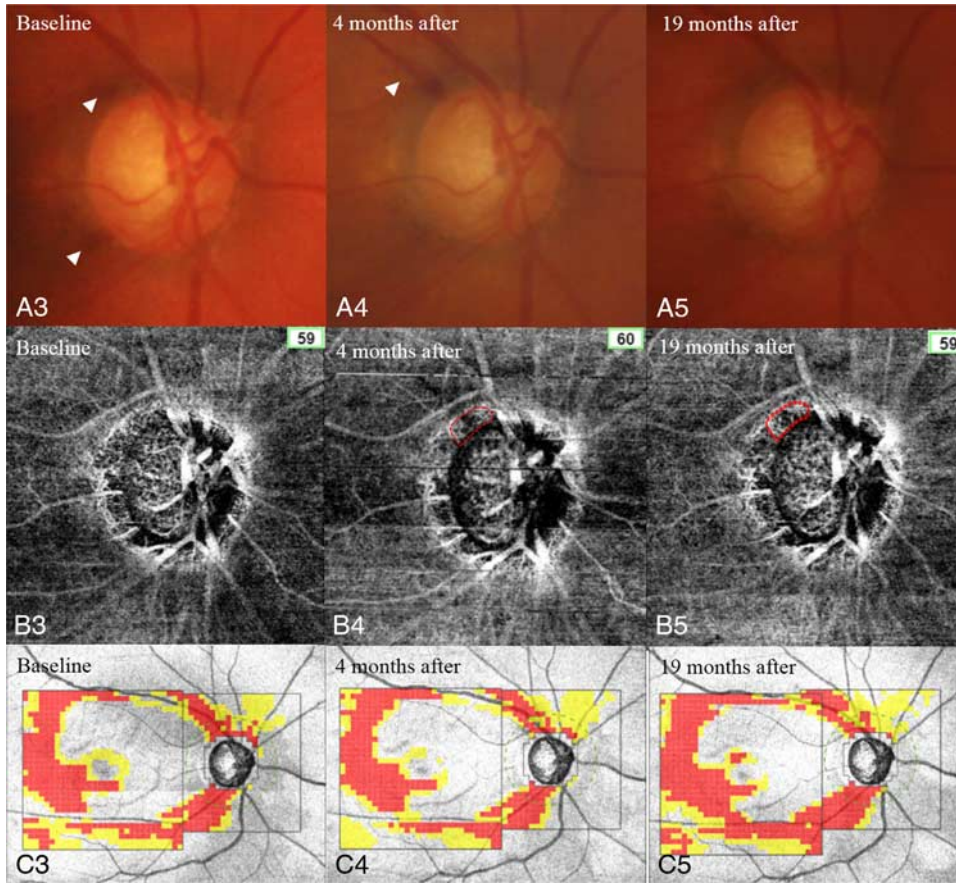

FIGURE 2. Serial disc photographs (A3, A4, and A5), optical coherence tomography angiography (OCTA) images (B3, B4, and B5), and wide-field retinal nerve fiber layer (RNFL) deviation map images from swept-source OCT (C3, C4, and C5) of the right eye of a 57-year-old woman. The disc hemorrhage (DH) was in the superotemporal and inferotemporal direction (arrowhead, A3). Microvascular dropout (MvD) was not detected in B3. Four months after the baseline imaging was taken, the old DHs had disappeared, and a new DH was observed in the superotemporal area of the right eye in A4 (arrowhead, A4). MvD was first noted in B4 at the superotemporal side of the beta zone of the parapapillary area, in the same direction that the DH had appeared (broken line, B4). RNFL defects were seen in the superotemporal and inferotemporal retina, and no significant changes were shown. Nineteen months after the baseline, DH had resolved (A5), but the superotemporal MvD (broken line, B5) persisted. MvD was not apparent in the inferotemporal area. The image quality score of OCTA is presented in the top-right corner of B3, B4, and B5.

seems to be a vascular factor of glaucomatous change.[10] It has a positive relationship with the level of glaucoma severity and deterioration, and its location is associated with the area of RNFL thinning and the corresponding visual field defect.[9–11,13] As seen in this report, MvD could be an important sign of progression of glaucoma. Recent studies have reported that MvD enlargement is associated with faster RNFL thinning in primary open-angle glaucoma (POAG)[12] and normal-tension glaucoma.[21] Our study also demonstrated temporal changes in MvD in eyes with glaucoma; however, our focus was the occurrence or progression of MvD with concomitant DH.

MvD seems to be associated with DH, and a few studies have speculated on the connection between them.[17,18] Many researchers speculated that DH and MvD were both consequences of choroidal perfusion loss. One study reported that MvD was detected more frequently at the location of a prior DH and suggested that choroidal insufficiency can aggravate the risk of glaucoma progression.[17] Others assumed structural damages in the ONH, including lamina cribrosa defects, may be a cause of DH, MvD, and glaucoma progression.[10,11,27,31] Another study demonstrated that the site of lamina cribrosa defects was significantly associated with the location of MvD in POAG patients, which highlights the fact that the microvasculatures within the lamina cribrosa and choriocapillaris share the same blood supply, that is, the short posterior ciliary artery as a source.[10] Two hypotheses can be formulated regarding the relationship of DH with MvD. First, DH could be the potential cause of MvD and second, DH and MvD could each be associated with glaucoma progression independently, with no relationship to each other. These hypotheses need to be tested through further studies and proper research models.

A recent cross-sectional study demonstrated that the prevalence of MvD was higher in POAG eyes with DH than in POAG eyes without DH.[18] The current study also reported cases of MvD with DH; however, a longitudinal relationship between these conditions was also demonstrated, giving rise to new theories regarding the relationship between MvD, DH, and glaucomatous changes, which need to be investigated in future studies.

In case 2, DH was also observed in the inferotemporal area in the follow-up period, but MvD did not appear in the corresponding sector. The relationship between MvD

occurrence and features of DH, including the location, shape, and recurrence, should be clarified in future studies.

This study, to the best of our knowledge, is the first to report changes in MvD that could be associated with DH. Considering the promising role of OCTA in the glaucoma field, the implications of our findings could be significant. In future studies, the pathophysiology and clinical effect of MvD could be further revealed, which could lead to advancements in the detection and prediction of glaucomatous progression. The detection of MvD, as well as DH, would help to better evaluate the progression of glaucoma.

Our study has several limitations. (1) First, many studies use a difference definition for MvD,[9,10,15] and the decision of MvD occurrence and progression is subjective. More exact criteria and precise imaging technology, which could be used to evaluate MvD, and its progression quantitatively, is required. (2) The precise causal relationship between DH, MvD, and glaucoma progression cannot be conclusively determined with only 2 cases. (3) There are no precise data on the temporal relationship between MvD and DH. Visualizations of their sequence of occurrence would be helpful; however, we could only observe simultaneous occurrence during the several months of follow-up in our clinical setting. Further studies should be designed appropriately to ascertain the relationship between them. Supplementary figures 1 and 2 (Supplemental Digital Content 1, http://links.lww.com/IJG/A470) show the modalities used, including red-free photos, and data for longer follow-up periods, including 1 year, in each case. (4) There is also another possibility that cannot be ruled out, which is that the choroidal vasculature is blocked by DH. One study used ICGA to demonstrate that MvD is a real perfusion defect of the choriocapillaris,[15] although ICGA was not taken at the time the MvD detected. (5) Meanwhile, a recent study revealed that the prevalence of artefacts in OCTA imaging is notably high.[32,33] There is a possibility that many factors affect the quality of imaging and the accuracy of detecting MvD, including medications, and the level of IOP. Such factors should be investigated in future studies. (6) The second case was associated with secondary glaucoma with VKH. There are concerns that VKH may affect the choroidal microvasculature of the peripapillary area. VKH causes choroidal inflammation; however, we could not find relevant evidence on the association between VKH and MvD. The relationship between the two should be ascertained in a future study.

CONCLUSIONS

In conclusion, MvD enlargement in OCTA images following DH was observed in 2 glaucoma patients, and this can possibly shed new light on monitoring glaucoma progression.

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