



Optical coherence tomography angiography findings before and after onset of foveal retinal neovascularization in diabetic retinopathy

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ABSTRACT

Purpose: To report a rare case of foveal retinal neovascularization (RNV) in a patient with diabetic retinopathy in whom the retinal microcirculation structure before and after the onset of the disease was evaluated using optical coherence tomography angiography (OCTA).

Observations: A 54-year-old woman with diabetes mellitus was referred to our department for fundus evaluation, and was diagnosed with cataract and severe non-proliferative diabetic retinopathy in the left eye. Two years after we performed cataract surgery and pan-retinal photocoagulation in the left eye, OCTA detected a previously unidentified foveal RNV arising from the perifoveal capillary network. The vitreous retinal interface slab of OCTA and cross-sectional OCT images confirmed that this foveal RNV was an aberrant vessel invading the vitreous cavity.

Conclusions and Importance: The findings in this case indicate that foveal RNV in diabetic retinopathy is derived from vessels outside the foveal avascular zone (FAZ), and OCTA is a useful examination for the diagnostic investigation of foveal RNV.

1. Introduction

Retinal neovascularization (RNV) is frequently observed in the optic disc and mid-periphery in eyes with proliferative diabetic retinopathy (PDR). Although RNV in the foveal avascular zone (FAZ) is rare, some studies have identified it by fluorescein angiography (FA).^{1–3} Recently, there have been two reports on the morphology of foveal RNV, based on the ability of optical coherence tomography angiography (OCTA) to depict the microvascular structure in detail.^{4,5} However, these reports only describe the morphology and post-treatment changes in foveal RNV, and not the changes that preceded the appearance of foveal RNV. We report a rare case of foveal RNV in a patient with PDR in whom the retinal microcirculation structure before and after the onset of the disease could be evaluated by OCTA.

2. Case report

A 54-year-old woman was diagnosed with type 2 diabetes mellitus (DM) with an HbA1c level of 14% by her primary care physician and referred to our department. Her best-corrected visual acuity (BCVA) was 20/40 in the right eye and 20/40 in the left eye. Anterior segment ex-

amination showed the presence of posterior subcapsular cataracts in both eyes. Fundus examination revealed PDR in the right eye and severe non-PDR (NPDR) in the left eye (Fig. 1A). Fluorescein angiography (FA) confirmed PDR with RNV in the mid-periphery of the right eye, and NPDR with a large non-perfusion area in four quadrants, including the macula in the left eye (Fig. 1B). Additionally, 6 × 6 mm swept-source OCTA (SS-OCTA) captured by PLEX Elite 9000 (Carl Zeiss Meditec, Dublin, California, USA) as well as FA showed capillary dropout and non-perfusion areas in the left eye. OCTA demonstrated more detailed vascular structures than FA (Fig. 1C, D, E). We performed pan-retinal photocoagulation following cataract surgery in both eyes. After surgery, BCVA of the left eye improved to 20/20. Two years later, although it was not evident on fundus photography (Fig. 1F) and there was no loss of vision, OCTA showed previously unidentified RNV in the FAZ in the left eye (Fig. 1H, I, J). In addition, FA depicted a vessel with active leakage in the FAZ, supporting that this finding was RNV (Fig. 1G). The detailed path of the foveal RNV from the outside of the FAZ to the inside and back to the outside was revealed by 3 × 3 mm SS-OCTA (Fig. 2 A, B). Furthermore, the vitreous retinal interface (VRI) slab of SS-OCTA and cross-sectional OCT images clearly showed that this foveal RNV penetrated the internal limiting membrane (ILM) into the vitreous cavity

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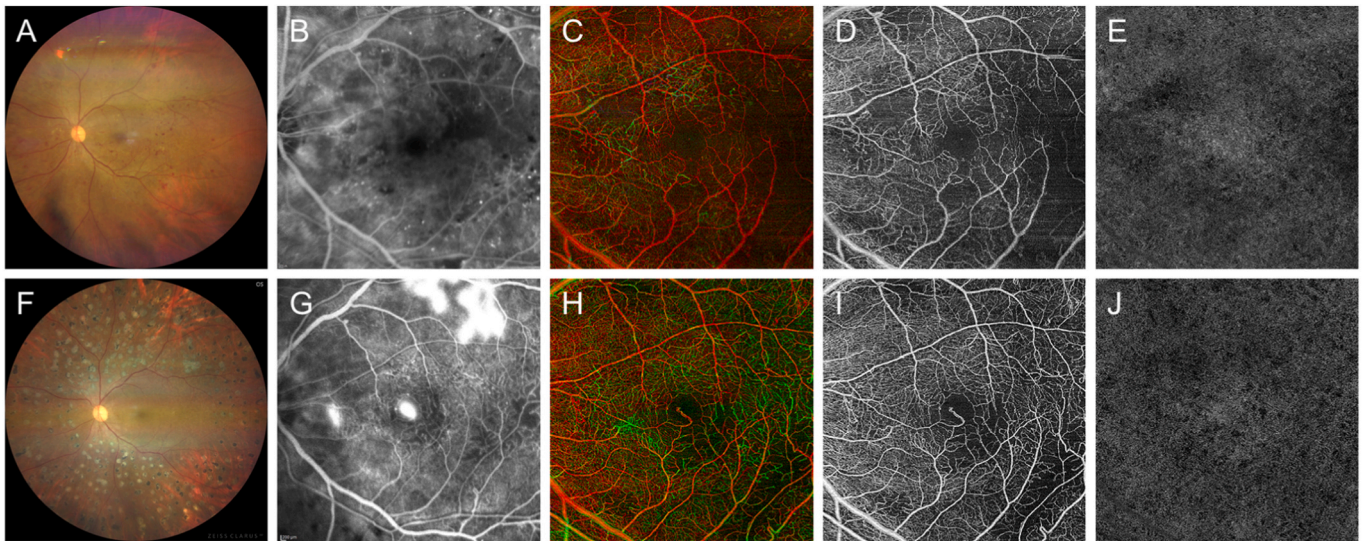


Fig. 1. Color fundus photograph, fluorescein angiography (FA), and 6×6 mm optical coherence tomography angiography (OCTA) images of the left eye at the initial examination (A–E) and 2 years later (F–J)

A: Color fundus image showing severe non-proliferative diabetic retinopathy (NPDR) with multiple microaneurysms as well as dot and blot hemorrhages. B: Fluorescein angiography (FA) showing capillary dropout along with a large non-perfusion area C, D: Color-coded (red indicates blood vessels in the superficial layer and green indicates blood vessels in the deep layer) and monochrome optical coherence tomography angiography (OCTA) of the whole retinal layer showing capillary dropout and a large non-perfusion area in more detail than FA. E: OCTA of the choriocapillaris layer showing decreased blood flow around the fovea. F: Color fundus image 2 years after cataract surgery and pan-retinal photocoagulation showing scattered laser photocoagulation. G: FA showing dye leakage from retinal neovascularization (RNV) in the fovea and arcade vessels. H, I: Color-coded and monochrome OCTA of the whole retinal layer shows foveal RNV arising from the perifoveal capillary network. J: OCTA of the choriocapillaris layer showing decreased blood flow around the fovea. . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

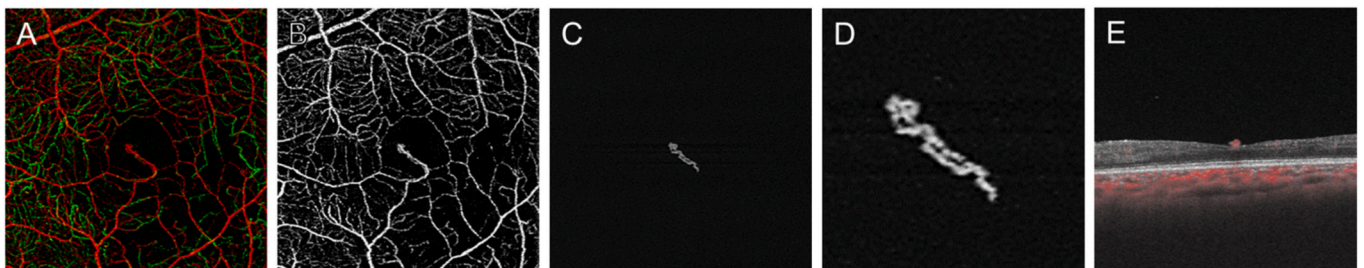


Fig. 2. Optical coherence tomography angiography (OCTA) (3×3 mm) and OCT images of the left eye 2 years after the cataract operation and pan-retinal photocoagulation

A, B: Color-coded (red indicates blood vessels in the superficial layer and green indicates blood vessels in the deep layer) and monochrome optical coherence tomography angiography (OCTA) of the whole retinal layer showing capillary dropout. C: OCTA image of the vitreous retinal interface (VRI) showing foveal retinal neovascularization (RNV) spreading into the vitreous cavity. D: Enlarged figure of foveal RNV depicted by an OCTA image of the VRI. E: Cross-sectional OCT at the level of the foveal RNV showing flow signals (shown in red) penetrating forward through the internal limiting membrane (ILM). . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

(Fig. 2C, D, E).

3. Discussion

Neovascularization in PDR is caused by high levels of intraocular vascular endothelial growth factor and is commonly seen at the optic disc and mid-periphery. In general, the FAZ is spared from neovascularization because the underlying choriocapillaris is dense and oxygen concentration is maintained even if retinal capillary dropout occurs around the fovea. However, it has been reported that choroid blood flow is reduced in patients with diabetic retinopathy.^{6,7} If the ischemia affects not only the retina but also the choroid, RNV can develop in the FAZ.⁴ In our case, OCTA image prior to the development of foveal RNV showed reduced blood flow in the retinal layer along with the choriocapillaris layer, which seems to be the main cause of the development of foveal RNV. Although typical leakage from RNV is

detected by FA, it is difficult to assess the detailed microvascular structure of RNV due to leakage. However, because the contrast between the retinal vessels and surrounding tissue is high, OCTA is more suitable than FA for assessing the retinal microvascular structure. Hence, in our case, OCTA depicted the detailed structure of foveal RNV invading from the outside of the foveal avascular zone to the inside and back to the outside, as described previously in two reports.^{4,5} Unfortunately, these two reports did not describe the OCTA findings before the onset of foveal RNV. In our case, since OCTA was performed before the development of foveal RNV, it clearly confirmed that the foveal RNV originated from capillaries adjacent to the capillary dropout outside the FAZ. Furthermore, taking advantage of the characteristics of OCTA, which can evaluate the vascular structure layer by layer unlike FA, the VRI revealed that the foveal RNV extended into the vitreous cavity.⁸

The pathogenesis of foveal RNV remains unclear. One report suggested that foveal RNV is a compensatory mechanism to maintain

macular perfusion because the FAZ increases after removal of orbital neovascularization by vitrectomy.⁵ As there is no decrease in the BCVA at present, no therapeutic intervention is planned in this patient. However, it has been reported that PRP increases choroidal blood flow,^{9,10} which may result in regression of the foveal RNV.¹¹ Hence, regular follow-up including OCTA examination will be necessary in the future.

4. Conclusion

We have reported a rare case of foveal RNV in a patient with diabetic retinopathy in whom the structure of the retinal microcirculation before and after the onset of the disease was evaluated using OCTA. The findings, in this case, indicate that foveal RNV in diabetic retinopathy is derived from vessels outside the FAZ and OCTA is a useful examination for the diagnostic investigation of foveal RNV.

Patient consent

Consent to publish this case report has been obtained from the patient in writing. This case report does not contain any personal identifying information.

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Authorship

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

Declaration of competing interest

No conflicting relationship exists for any author.

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