Multimodality Imaging in Diagnosing Polypoidal Choroidal Vasculopathy

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ABSTRACT

**Purpose.** Report a case of polypoidal choroidal vasculopathy (PCV) and reveal its characteristics in multispectral imaging (MSI), a novel modality that examines individual retinal layers and enhances visualization of deep retinal structures.

**Case Report.** A 60-year-old Chinese woman presented with blurred vision in her left eye for over 1 week. Fundus examination revealed massive subretinal hemorrhage in the posterior pole with reddish orange polyp-like structure on the fovea of the left eye. Optical coherence tomography showed classic hyperreflectivity in the choroidal layer, known as the “double-layer” sign, adjacent to a serous retinal pigment epithelial detachment, which was further confirmed in fluorescein angiography of the left eye. Indocyanine green angiography demonstrated the features of PCV, including multiple polyps arising out of inner choroidal vessels in the early phase as hyperfluorescent spots and ringlike silhouette staining of the polyps in the late phase. Multispectral imaging as a new modality was introduced to visualize the polypoidal lesion as a polyp-like cluster of hyperreflectance in the short-wavelength images (green and yellow) with subsequent highly defined ringlike hyperreflectance in the longer-wavelength images (near-infrared and infrared). According to the manifestations above, this patient’s final diagnosis was PCV in the left eye.

**Conclusions.** This is the first report using MSI as a novel imaging modality for the detection of PCV. Multispectral imaging can reveal highly defined hyperreflective polyp-like structures in the longer-wavelength images, which is compatible with the indocyanine green angiography findings, indicating preliminarily the advantages of noninvasiveness, simplicity, and effectiveness of MSI in diagnosing PCV.

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Polypoidal choroidal vasculopathy (PCV), also described as posterior uveal bleeding syndrome, is a unique ocular exudative disorder that is characterized by a branching choroidal vascular network with adjacent polyp-like vascular dilations at the end of the network. It can cause recurrent serous or hemorrhagic pigment epithelial detachment (PED) and subretinal hemorrhage. Indocyanine green angiography (ICGA) and optical coherence tomography (OCT) are useful in understanding the pathophysiology of this disorder and establishing a diagnosis. Emerging techniques like multispectral imaging (MSI) have widened our ability to detect PCV as seen in the following case.

CASE REPORT

A 60-year-old Chinese woman presented with blurred vision in her left eye for more than 1 week. She denied any ocular history and
FIGURE 2.
High-definition OCT of the left eye demonstrating a large PED (arrow) adjacent to two small finger-like ones and the “double-layer” sign.
FIGURE 3.
Fluorescein angiography findings of the left eye. (A) Choroidal silence sign in the posterior pole and window defects supratemporal to the fovea in the early phase. (B) Fluorescein pooling temporal to the optic nerve head in the late phase.

FIGURE 4.
Indocyanine green angiography findings of the left eye. (A) A cluster of small polypoidal hyperfluorescence in the macular area in the early phase (0 minute 43 seconds). (B) Ringlike silhouette staining of polyps in the late phase (1 hour 22 minutes).

FIGURE 5.
A collection of MSI images from RHA (arranged in order of wavelengths).
systemic disease. Examination revealed best-corrected visual acuity of 20/20 in the right eye and 20/40 in the left eye. Pupils were equal, round, and reactive to light with no afferent pupillary defect. The anterior segment examination was unremarkable in both eyes and intraocular pressures were within normal limits. Dilated fundoscopic examination of the right eye was normal; however, her left eye showed a significant deep red subretinal hemorrhage in the posterior pole with a reddish orange polyp-like structure on the fovea and a large serous PED temporal to the optic papilla (Fig. 1).

Optical coherence tomography (Cirrus HD-OCT 4000; Carl Zeiss Meditec Inc), using the macular cube scan, indicated no abnormality in the right eye, whereas OCT of the left eye showed a large PED adjacent to two small finger-like ones with optically dense material inside. Two highly reflective layers, one at the level of the retinal pigment epithelium (RPE) and another beneath the RPE, known as the “double-layer” sign, were observed (Fig. 2).

Fluorescein angiography (Carl Zeiss VISUCAM 500) revealed choroidal silence sign attributed to subretinal hemorrhage in the posterior pole and window defects supratemporal to the fovea (Fig. 3A). Fluorescein pooling temporal to the optic nerve head was observed in the late phase (Fig. 3B). Indocyanine green angiography (Carl Zeiss VISUCAM 500) showed a collection of

FIGURE 6.
RHA images of the left eye as viewed with green (550 nm) (A), yellow (580) (B), near-infrared (740 nm) (C), and infrared (850 nm) (D) wavelengths.
small polypoidal hyperfluorescence of the vessels in the macular area within the first 6 minutes (Fig. 4A). In the late phase, these hyperfluorescent dilated vessels were “washed out,” appearing as ringlike silhouette staining of polyps (Fig. 4B).

This patient also underwent MSI (RHA; Annidis) examination (Fig. 5). The short-wavelength images (green and yellow) showed nodule-like hyperreflectivity at the edge of subretinal hemorrhage and temporal to a serous PED that was slightly hyperreflective (Fig. 6A, B). As the wavelength of MSI became longer, the nodule-like lesion extended and the contour became well defined (Fig. 5), which indicated that the lesions are deeper down in the choroidal layer. The longer-wavelength images (near-infrared and infrared) revealed ringlike hyperreflectance (Fig. 6C, D), which was quite like staining of polyps in the late phase of ICGA (Fig. 7). This similarity allows clinicians to focus on the particular spectral slices of the retina and assess only this portion in diagnosing PCV and doing regular follow-ups with an RHA instrument, which is more convenient and time saving. Chorioidal oxy-deoxy map, used to detect variations in the distribution of chorioidal blood, revealed an obvious hyperreflective grapelike area (Fig. 8) that is consistent with elevated oxyhemoglobin level caused by the dilated end of polypoidal vessels.

The final diagnosis was PCV in the left eye, and the patient was referred to retinal specialists for further treatment.

**DISCUSSION**

The diagnosis of PCV is mainly based on fundoscopic examination and intravenous angiography. Because fluorescein angiography findings of PCV can imitate those of occult choroidal neovascularization in neovascular age-related macular degeneration (AMD), the diagnostic criteria for PCV are proposed based on ICGA findings, which can visualize the characteristic aneurysmal lesions. Koh and the Expert PCV Panel, published guidelines recently on the diagnosis and treatment of PCV, which was defined as “the presence of single or multiple focal areas of hyperfluorescence arising from the chorioidal circulation within the first 6 minutes after injection of ICG, with or without an associated BVN. The presence of orange red subretinal nodules with corresponding ICG hyperfluorescence is pathognomonic of PCV.” Optical coherence tomography can help
detect PED and subretinal fluid. Pigment epithelial detachment along with a “double-layer” sign on OCT alerts the clinician to the presence of PCV rather than choroidal neovascularization in neovascular AMD. Optical coherence tomography may also help in monitoring the response to treatment.

Multispectral imaging, as a new imaging method in diagnosing fundus diseases, was introduced to detect PCV in this case. Differing from conventional digital fundus photography, which uses white light as a light source and broad color filters, the RHA instrument acquires MSI data by using a modified fundus camera with 12 monochromatic, discrete light-emitting diodes ranging from 550 to 950 nm in wavelength as the illuminants. Filters that target certain spectra are also used to enhance the visualization of a particular retinal structure. The standard scanning mode takes less than 5 minutes to adjust the focus and acquire data from both eyes. The subject will encounter flashes eight times, which may cause a slight dizzy sensation during the acquisition process. The RHA report is a photograph essay of monochromatic en face fundus spectral slices of the retina that are acquired and arranged in order of wavelengths. As the wavelength becomes longer, specifically greater than 670 nm, deeper layers of the retina can be revealed. Near-infrared and infrared wavelength images approximately correspond to RPE and choroidal vasculature, respectively. Retinal structures and tissues observed in images depend on the reflectivity characteristics of the different parts of the fundus and this in turn depends on the distribution, quantities, and characteristic optical absorption properties of the pigments. What deserves mention is that oxy-deoxy maps (including both the retinal map and choroidal map), which are the combined images of two wavelengths, reflect oxyhemoglobin in the retinal and choroidal vasculature. The oxy-deoxy maps are supposed to mimic the images in fundus fluorescein angiography and ICGA, because the vessels full of oxygenated blood have a different absorption pattern, which is hyperreflective (white in appearance), from blood that is not oxygenated, just as the enhanced images using a contrast medium. In this case, the choroidal map showed an obvious polyp-like hyperreflective area, indicating that the lesion was ascribed to abnormal choroidal vascular network with dilated ends of the vessels. The RHA instrument also provides clinicians a stereo image of the retina that allows three-dimensional observation and calculation of cup-to-disk ratio. Multispectral imaging does have some drawbacks compared with angiography. The major one is that MSI is unable to dynamically observe the exudative lesions like central serous chorioretinopathy as the active leakage of contrast in angiography. Viewed from this aspect, fundus fluorescein angiography or ICGA is still irreplaceable.

CONCLUSIONS

Polypoidal choroidal vasculopathy is now considered to be a variant of exudative AMD and can cause acute visual loss owing to spontaneous rupture of the polypoidal lesions. The severe visual loss can be irreversible in patients with repeated bleeding and leakage. Quite a few testing methods have been recommended in the detecting of PCV, especially ICGA, which is essential to establish a definitive diagnosis of PCV. Multispectral imaging, as an emerging technology used in retinal diagnostic imaging, is now challenging the traditional methods. Multispectral imaging has the advantage of being quick, simple, and repeatable to perform in a primary care setting. Multispectral imaging also has the ability to map retinal and choroidal vasculature by detecting oxygenation of the blood and is basically an injection-free angiography, which can avoid potentially life-threatening complications (anaphylactic shock). For those patients who are allergic to contrast agents, MSI is an alternative noninvasive method. Although still in its infancy, MSI is a promising diagnostic method that will provide additional information in fundus imaging.

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REFERENCES


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