Retinal and choroidal abnormalities identified by multispectral imaging in patients with uveitis

Three case reports

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Abstract

Introduction: Multispectral imaging (MSI) shows increasing strengths in detection of retinal and choroidal disease. The aim of this study was to evaluate the capacity of javascript:void(0), detecting retinal and choroidal abnormalities of uveitis which have not been described previously.

Patient concerns: The first case was a 49-year-old male patient who presented with visual disturbance and metamorphopsia in both eyes for 5 days,companying by a history of headache and hearing loss recently. The second case was related to a 45-year-old female patient who complained of blurred vision and a dark shadow before her right eye for 3 months. The third case corresponded to a 36-year-old male patient who presented with blurred vision and slight pain in his left eye for > 1 week, and his blood tested positive for syphilis.

Diagnosis: Three Chinese patients with representative kind of uveitis were described in the study, including Vogt–Koyanagi–Harada syndrome, posterior uveitis with choroidal neovascularization, and syphilis-infected uveitis. Each affected eye had corresponding retinal and choroidal abnormalities evaluated by multiple ophthalmologic examinations.

Interventions: Case 1 was treated with oral prednisone at a dose of 1 mg/kg/d started at the early stage and then slowed tapering of the prednisone dose based on follow-up examinations. Case 2 received anti-VEGF treatment. Case 3 received the standard treatment for neurosyphilis.

Outcomes: Due to timely diagnosis and treatment, all patients had a better prognosis.

Conclusion: MSI provides a novel way to view retinal and choroidal abnormalities of uveitis, and may provide a supplemental method to morphological changes.

Abbreviations: CNV = choroidal neovascularization, FFA = fundus fluorescein angiography, FP = fundus photograph, ICGA = indocyanine green angiography, LEDs = light-emitting diodes, RPR = rapid plasma reagin, MSI = multispectral imaging, OCT = optical coherence tomography, RPE = retinal pigment epithelial, TPPA = T pallidum particle agglutination assay, VKH = Vogt–Koyanagi–Harada.

Keywords: choroids, multispectral imaging, optical coherence tomography, retina, uveitis

1. Introduction

Uveitis is an inflammatory disorder of the uveal tract, comprising choroid and other adjacent tissues such as the retina. It is believed to be the fourth leading cause of blindness among the working population. The uveitis causes retinal and choroidal abnormalities that can contribute to visual loss.[1,2]

The diagnosis of these retinal and choroidal abnormalities of uveitis requires an ophthalmological evaluation. Four main approaches have been proposed, such as fundus photograph (FP), fundus fluorescein angiography (FFA), indocyanine green angiography (ICGA), and optical coherence tomography (OCT).[3,4] These approaches are helpful in definitive diagnosis of uveitis, especially OCT and angiography. However, these imaging modalities mentioned above have several limitations. For example, FP cannot directly detect changes of the retinal pigment epithelium; angiography has a small chance of life-threatening events; OCT mostly offers horizontal cross-sectional images.[3,5] Now multispectral imaging (MSI) provides a new tool to help us to understand diseases and observe the change of condition comprehensively.

MSI is an novel noninvasive diagnostic imaging systems with high diagnostic value for retinal and choroidal abnormalities,
which use different light wavelengths from light-emitting diodes (LEDs), ranging from 550 to 850 nm, to visualize the entire span of the retina from the internal limiting membrane through to the choroid.\[6,7\] In addition to uveitis, MSI has been reported in some eye disease, such as polypoidal choroidal vasculopathy,\[8\] Stargardt disease,\[9\] and retinal vein occlusion.\[10\]

In this study, we aim to evaluate those retinal and choroidal abnormalities in 3 cases of uveitis by using MSI, and to explore a quick and repeatable imaging method to observe the change of condition.

2. Methods

2.1. Ethical approval and patient consent

Appropriate informed consents in accordance with the Declaration of Helsinki and the Zhejiang Institutional Review Board were obtained from all participants.

2.2. Imaging technique

This study is a prospective, observational case series evaluating retinal and choroidal abnormalities in patients with uveitis by MSI (RHA; Annidis, Ottawa, Canada), slit lamp (Topcon corporation, Topcon, Tokyo, Japan), FP (Canon Inc., Canon, Japan), FFA (HRA Spectralis; Heidelberg Engineering, Heidelberg, Germany), ICGA (Heidelberg Engineering Inc., Heidelberg, Germany), and OCT (Carl Zeiss Meditec, Inc., Dublin, CA /Heidelberg Engineering Inc., Heidelberg, Germany) examinations. Changes of choroid were compared between MSI and ICGA, and localized exudative retinal detachments were compared among MSI, FP, and FFA, and nonperfusion area images were compared between MSI and FFA, and choroidal neovascularization (CNV) was compared between MSI, FP, and OCT, and clinical features, such as hard exudates and retinal hemorrhage, were compared between MSI and FP.

MSI data were acquired by the same operator with an RHA instrument, using a modified fundus camera with 12 monochromatic, discrete LEDs ranging from 550 to 850 nm in wavelength. The RHA report manifests as a set of monochromatic enface fundus images, appearing as morphological structures approximately from the internal limiting membrane of retina to the choroid (Fig. 1A and B).

3. Case report 1

A Chinese 49-year-old man presented to our clinic with complaints of visual disturbance and metamorphopsia in both eyes for 5 days, with a history of headache and hearing loss recently. His best corrected vision was 20/200 in the right eye and 20/400 in the left eye. Intraocular pressures were normal, and slit lamp examinations of the both eyes showed moderate cells and flare in the anterior segment. Localized exudative retinal detachments were observed by FP (Fig. 2A, red arrow), and FFA showed pooling of the dye in the subretinal space in the late phase (Fig. 2B, red arrow). ICGA signs included choroidal perfusion inhomogeneity, early hyperfluorescent stromal vessels, and the choroidal folds also showing hypofluorescent lines (Fig. 2D), whereas MSI image (green-wavelength, 550 nm) of the same eye showed local fuzzy shadows (Fig. 2E, red arrow). The MSI image (infrared-wavelength, 850 nm) showed the black choroidal striations (Fig. 2F, red arrow) correspond to hypofluorescent lines on ICGA, revealing choroidal folds much clearly.

Infectious diseases were excluded, such as syphilis, tuberculosis, AIDS, and so on. According to his clinical characteristics and multiple imaging examinations, he was diagnosed as Vogt-Koyanagi-Harada (VKH) syndrome at the acute stage.

Oral prednisone at a dose of 1 mg/kg/d started at the early stage. Then based on frequent follow-up examinations, slow tapering of the prednisone dose was performed. After 1 year of follow-up, the patient’s eyesight improved to 20/20.

4. Case report 2

A Chinese 45-year-old woman complained of blurred vision and a dark shadow before her right eye for 3 months. Her best corrected vision was 20/40 in the right eye and 20/20 in the left eye. She was diagnosed as posterior uveitis with CNV in her right eye. The presence of yellow chorioretinal spots in the macular area was visible on color photography (Fig. 3A, red arrow). Corresponding spectral-domain OCT scans revealed a “sea fan” aspect lesion (Fig. 3B, red arrow). The MSI image (infrared-wavelength, 760 nm) showed the gray oval lesions circled with black ring (Fig. 3C, white circle) corresponds to the lesion found by color photography and OCT scans. It seems that MSI enhances visualization and accentuates details of CNV such as shape in different layers of retina and choroid by using discreet monochromatic wavelengths. Choroidal oxy-deoxy map of from the RHA showed some hyperreflective and hyporeflective areas,
indicating the choroidal perfusion inhomogeneity (Fig. 3D). Anti-VEGF treatment was undertaken. Two weeks later, the lesion area of CNV was shrunk (Fig. 3F, white circle).

5. Case report 3

A Chinese 36-year-old man presented with blurred vision and slight pain in his left eye for >1 week. His best corrected vision was 20/20 in the right eye and 20/100 in the left eye. Examination revealed moderate cells in anterior chamber and vitreous opacity was seen. Significant hard exudates in the inferotemporal region (Fig. 4A and B, white arrow) with linear hemorrhages (Fig. 4A and B, red arrow) could be detected with FP and MSI. Microaneurysms were shown in FFA (Fig. 4C, red arrow). Some nonperfusion areas in the inferotemporal could be seen in the FFA images (Fig. 4C, short arrow). The retinal oxy-deoxy map of MSI also showed poor oxygen supply in the same area (Fig. 4D, short arrow). This case showed the ability of MSI to detect hard exudates, hemorrhage, and nonperfusion areas.

The patient underwent a blood test. Rapid plasma reagin (RPR) titer and T pallidum particle agglutination assay (TPPA) were positive. The diagnosis of syphilitic uveitis was confirmed. The patient received the standard treatment for neurosyphilis, intravenous penicillin G at 18 million units/d for 2 weeks. The patient was followed up for 12 months, and laboratory evaluation for syphilis was repeated every 3 months.

6. Discussion

MSI is a high diagnostic value technology, which is easy to create spectral slices of the retina that result in an enhanced examination of fundus anatomical morphology and clear visualization of deep retinal architecture, including the retinal pigmented epithelium and choroid.[7,8] In addition, oxy-deoxy maps (using dual-wavelength techniques), which include both the retinal map and choroidal map, reflect oxyhemoglobin in the retinal and choroidal vessels. Based on the function and advantages of MSI, it seems like a very useful tool in examining the retinal and choroidal abnormalities of uveitis. However, only a few reports have been found involved uveitis. In this study, we aim to introduce MSI to detect morphological abnormalities of uveitis in those cases.

VKH syndrome is a bilateral panuveitis characterized by the presence of multiple exudative retinal detachments in the acute uveitic stage.[11] Choroidal folds were recently reported which seen in acute VKH disease.[12,13] Those authors pointed out the
troughs of the retinal pigment epithelial (RPE) undulations were seen clinically as choroidal striations in the acute uveitic stage of VKH disease. MSI extends the wavelength, including the reds, deep reds, and infrareds. Depending on a patient’s pigmentation, the changes of RPE and choroid revealed in these spectral slices. This novel observation may be a highly sensitive method to detect choroidal folds and evaluate choroidal inflammatory lesions early or further changes.

CNV is a well-known complication of uveitis, often resulting in severe visual loss in patients.\textsuperscript{14} As we know, FP, FFA, and OCT

\begin{figure}[h]
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\caption{Multimodal imagings of the right eyes in case 2. (A) Fundus picture of the right eye. (B) OCT (optical coherence tomography) pictures of the right eye. (C) ICGA (indocyanine green angiography) image of the right eye. (D) Choroidal oxy-deoxy map of the right eye. (E) MSI (multispectral imaging) image of the right eye (pretreatment). (F) MSI (multispectral imaging) image of the right eye (posttreatment).}
\end{figure}
have been used widely for CNV. However, the RHA instrument as a new imaging method is a useful tool for inflammatory CNV because it can not only enhance the visualization of CNV characteristics on different retinal layers, but also present inflammatory changes of retina and choroid in the same time.

Uveitis has been specifically associated with syphilis infection. The clinical presentation of intraocular inflammation varied. Syphilitic uveitis, the most common presentation of ocular syphilis, accounted for 1% to 2% of all uveitis patients.\textsuperscript{[15]} It may appear optic neuritis, retinal vasculitis, vitritis, panuveitis, and so on.\textsuperscript{[16]} In our study, intraretinal hemorrhages, microaneurysms, and hard exudates were presented in the patient with syphilitic uveitis.

However, compared with other imaging technology, MSI does have some drawbacks. For example, MSI is less sensitive in observing serous retinal detachment than OCT and unable to dynamically observe the exudative lesions in angiography.\textsuperscript{[8,17]} Therefore, OCT or angiography is still irreplaceable.

In conclusion, MSI, as a new imaging method for fundus imaging, offers several potential advantages when applied to diagnosing uveitis. MSI is capable of detecting retinal and choroidal abnormalities of uveitis. Those cases reported here add to the various possible applications of MSI in the field of retinal and choroidal abnormalities, although further research is needed to adequately demonstrate the clinical value.

**Author contributions**

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