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Retinal and Choroidal Imaging Update

Retromode imaging: Review and perspectives

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Abstract

Retromode imaging with infrared lasers is a novel imaging method which has been made possible by the newly introduced confocal scanning laser ophthalmoscope. Retromode imaging uses a laterally deviated confocal aperture with a central stop, which creates a shadow and allows deep retinal and retinal pigment epithelium changes to be visualized as pseudo-3-dimensional images. Its clinical value coupled with its simple, rapid, and noninvasive nature is increasingly appreciated. The combination of retromode imaging with conventional imaging methods such as fundus photography, fluorescein angiography, and optical coherence tomography can help to precisely and comprehensively evaluate pathophysiologic features of retinal disorders. This review summarizes basic principles of imaging and retromode findings in various retinal disorders and is expected to guide future investigations of retromode imaging.

Keywords: Retromode, Confocal, Scanning laser ophthalmoscope

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Introduction and principles of retromode imaging

Recently, based on the principles of retro-illumination, retromode imaging has been used to investigate several retinal pathologies. The newly introduced F-10 confocal scanning laser ophthalmoscope (cSLO; Nidek, Gamagori, Japan) implements retromode imaging to view the retina with an infrared laser. Retromode imaging can be useful to study deep retinal pathologies and retinal pigment epithelium (RPE) changes.

The F-10 is a newly developed cSLO apparatus that has 4 different wavelengths (blue, 490 nm; green, 532 nm; red, 660 nm; infrared, 790 nm) and 8 apertures (5 confocal apertures and 3 apertures with a central stop). In the cSLO, the light returning from the fundus consists of direct backscattered light as well as more multiply scattered light. A confocal aperture collects the directly backscattered light from the confocal plane. In the indirect (dark-field) mode, an aperture with a central stop (ring aperture) is used and direct backscattered light is blocked with a central stop. The detector collects more multiply scattered light than direct backscattered light. Retromode imaging, which is a modified version of indirect (dark field) imaging, uses infrared laser light because of its ability to penetrate deeper layers. Instead of the ring aperture used in indirect (dark-field) mode, retromode uses only part of the annular aperture. The annular aperture deviates laterally from the light pathway supplied by the confocal aperture, which collects backscattered light from one direction and blocks it from other directions. This creates a shadow to one side of the abnormal feature, creating pseudo-3-dimensional (3D) images (Fig. 1). The scattered light passing through the deviated aperture gives a shadow to abnormal features, thus enhancing their contrast and delineation. The shadows of lesions appear differently according to the laterality of the annular aperture. Both right-deviated and left-deviated annular apertures (''DR'' and ''DL'') are used.

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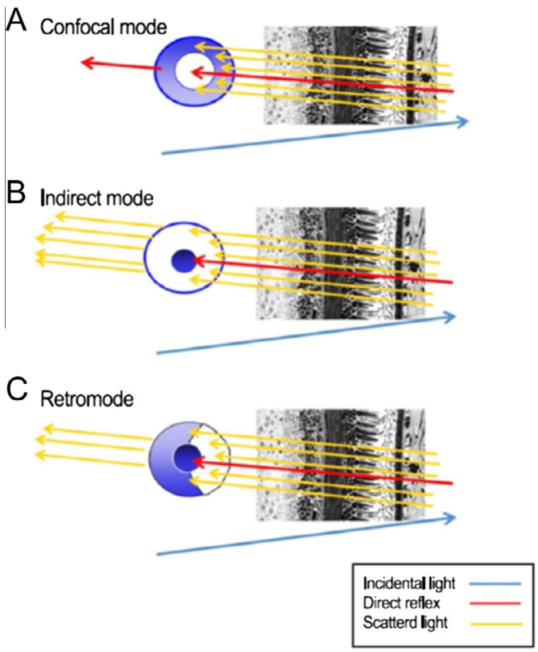

Figure 1. Schematic mechanism underlying retromode imaging with a confocal scanning laser ophthalmoscope. (A) Confocal mode: images consist primarily of direct backscattered light from the fundus. (B) Indirect (dark-field) mode using an aperture with a central stop (ring aperture): direct backscattered light is blocked with a central stop. More multiply scattered light from intraretinal structures is collected by the detector. (C) Retro-mode: The opening of the ring aperture is restricted and deviates laterally from the confocal light path. Multiply scattered light from only one direction is collected by the detector.

Clinical applications

Retromode imaging is used to investigate several retinal pathologies. Multiple clinical applications of retromode imaging are introduced below.

Cystoid macular edema (CME)

Retromode imaging is able to characterize CME secondary to polypoidal choroidal vasculopathy (PCV), retinitis pigmentosa, and retinal vascular disorders such as diabetic retinopathy (DR) and retinal vein occlusion.[1–3] In retromode imaging, scattered light that has passed through the aperture deviates laterally, shadowing the silhouetted cystoid spaces and enabling CME visualization. Retromode imaging shows numerous oval or polygonal cystoid spaces located in any layer of the retina (Fig. 2). Using retromode imaging, most eyes with CME show a large cystoid space beneath the fovea with surrounding small cystoid spaces. The area of the foveal cystoid space correlates with its height, as measured by optical coherence tomography (OCT).[2]

Retinoschisis

Retromode imaging shows characteristic alterations of the retina that correspond to the site of macular retinoschisis in highly myopic eyes. Retromode imaging shows two characteristic fingerprint patterns that contain either radiating retinal striae centered on the fovea and many light dots and lines in parallel to the striae, or a whorled pattern surrounding the radiating striae (Fig. 3). The central radiating retinal striae ob-

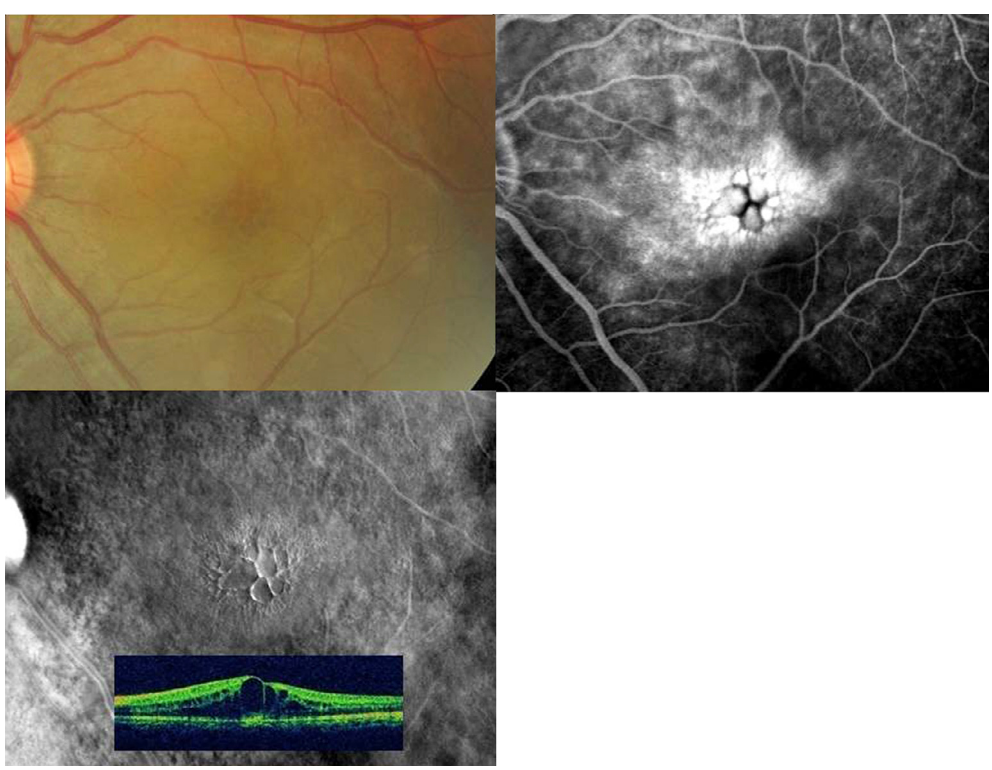

Figure 2. Representative retromode images of an eye with cystoid macular edema. (Top left) No cystoid spaces are detected on fundus photography. (Top right) Late-phase fluorescein angiography shows many cystoid spaces. (Bottom) Retromode imaging shows numerous polygonal cystoid spaces.