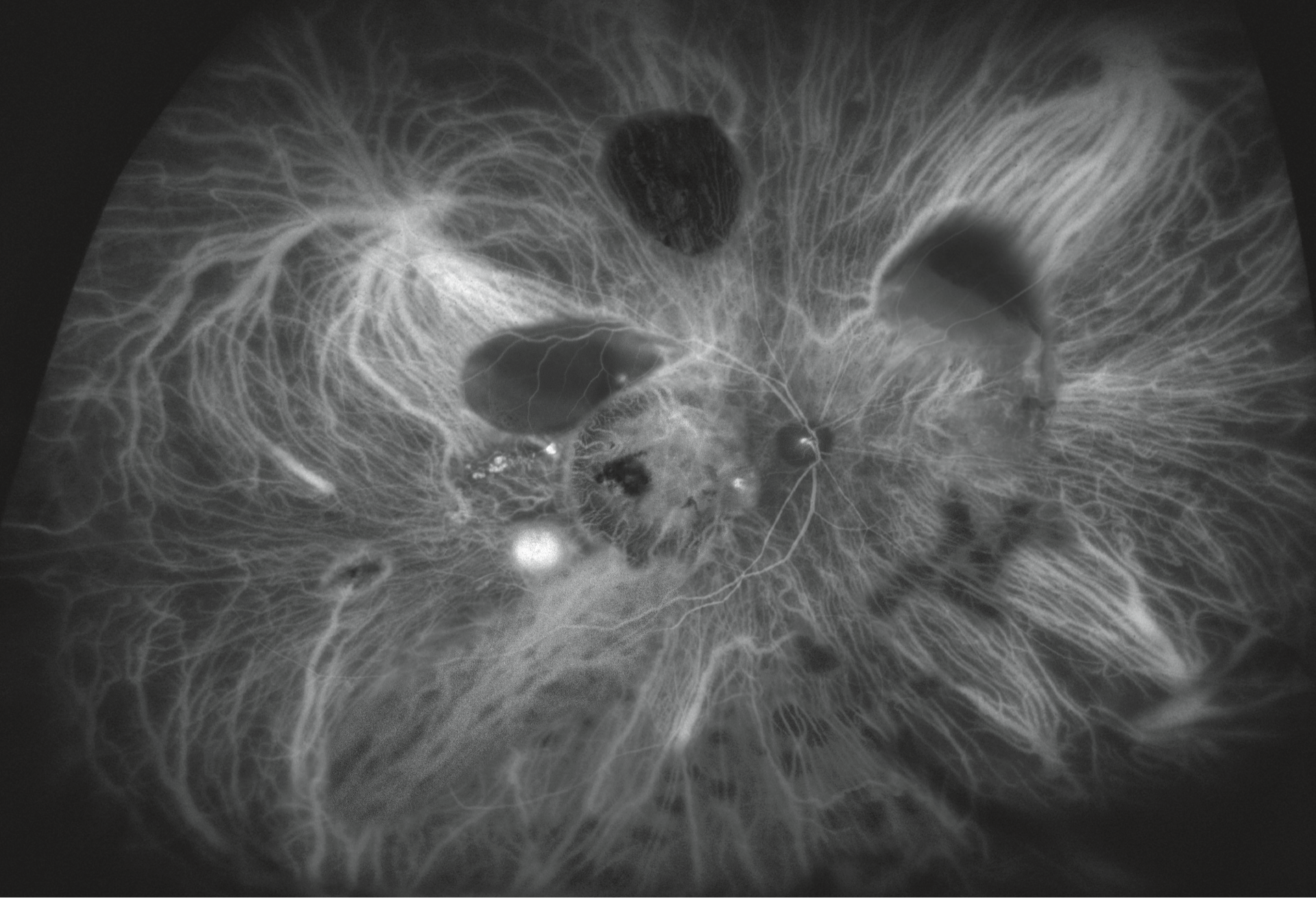


Nikon

optomap® *icg* Diagnostic Atlas: A Retinal Reference Guide

optos®

Optos devices produce ultra-widefield (UWF™), high-resolution digital images (**opto**map) of approximately 82% (200°) of the retina, documenting from the macula and beyond the vortex ampullae, something no other device is capable of capturing in a single image.

An **opto**map *color* image provides more clinical information which facilitates the early detection, management and effective treatment of disorders and diseases found in the retina. Retinal imaging can also offer evidence of systemic diseases such as hypertension and certain cancers.

optomap *color* images consist of two channels of information, a red channel (635nm) which visualizes the choroidal layer and a green channel (532nm) which visualizes the retinal pigment epithelium (RPE). **opto**map *af* images are captured using the green wavelength (532nm) and visualize the function of the RPE. **opto**map *fa* images use the blue wavelength (488nm) to capture the circulation of the retina. **opto**map *icg* images use the infrared wavelength (802nm) to capture the circulation of the choroid.

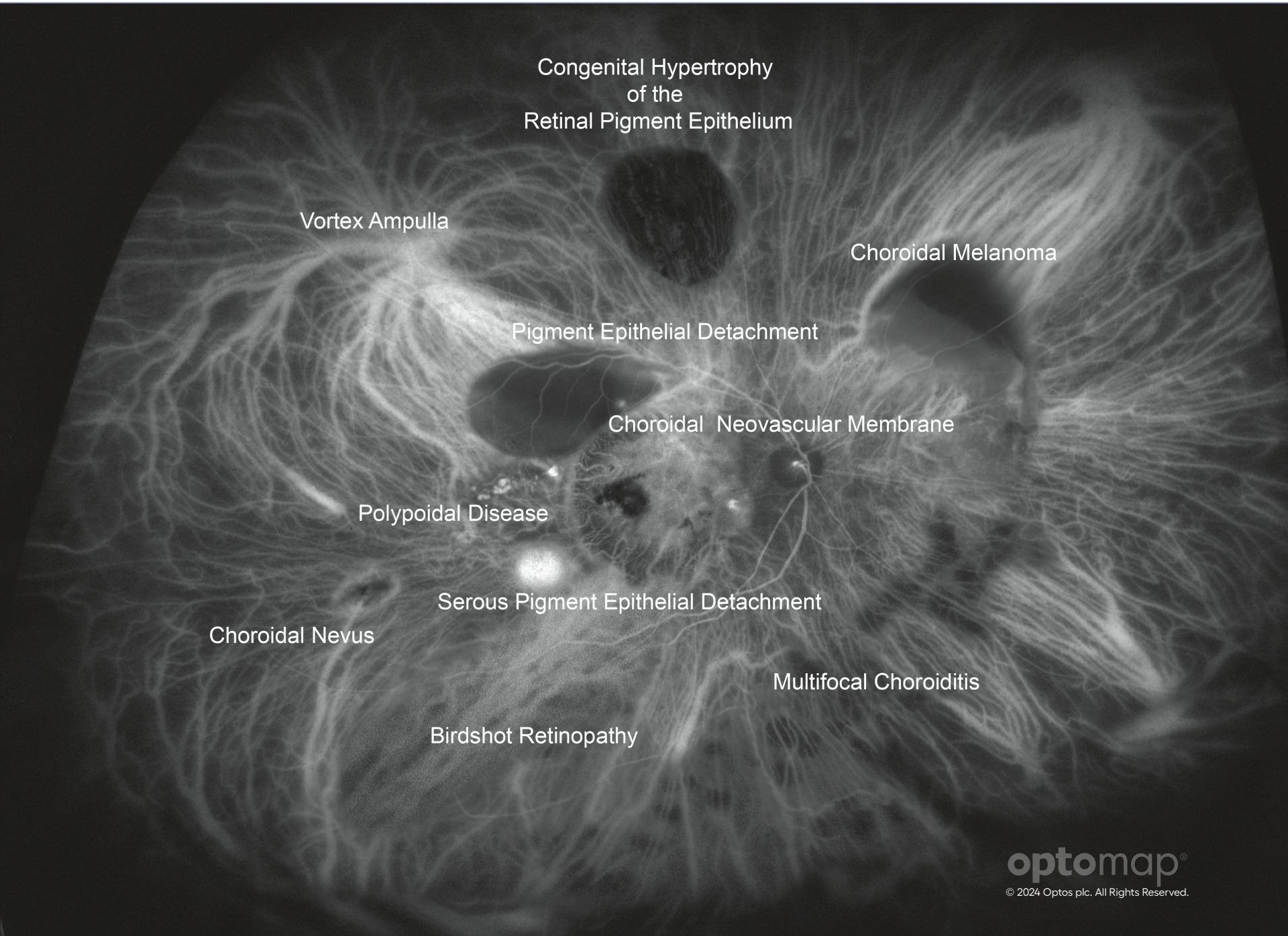
An indocyanine green angiogram (ICGA) is used to analyze the integrity of the choroidal vascular system, looking for leakages, blockages and vascular abnormalities to confirm diseases. The **opto**map *icg* Diagnostic Atlas: A Retinal Reference Guide is designed to illustrate how different pathologies are visualized on an indocyanine green angiogram.

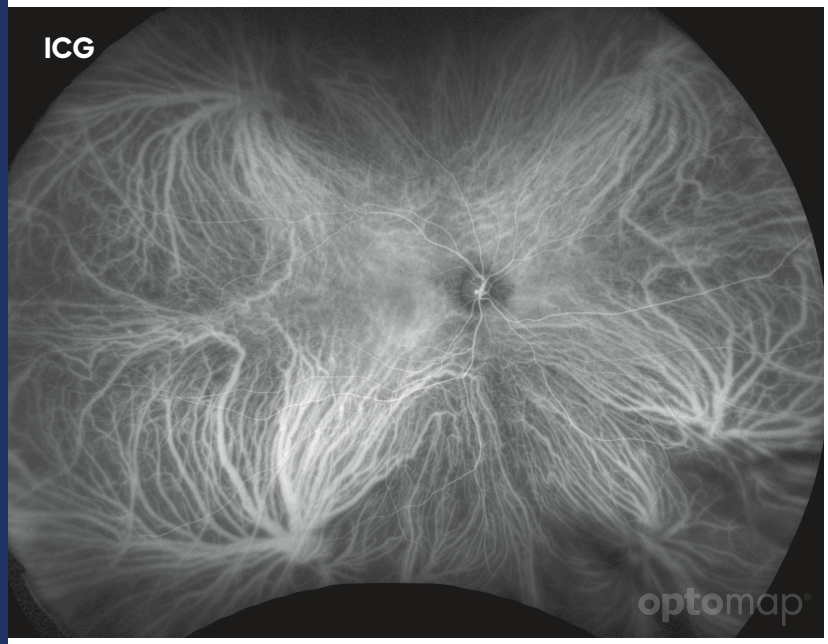
Reference for Definitions

Dictionary of Eye Terminology. Sixth Edition. 2012.
Barbara Cassin and Melvin L. Rubin, MD.
Triad Communications, Inc.

Fluorescein and Indocyanine Green Angiography: Technique and Interpretation. Second Edition. 1997
Joseph W. Berkow, MD; Robert W. Flower; David H. Orth, MD; James S. Kelley, MD
American Academy of Ophthalmology

The Retinal Atlas. Second Edition. 2017
Bailey Freund, MD; David Sarraf, MD; Wiliam F. Mieler, MD;
Lawrence A. Yannuzzi, MD Elsevier





optomap offers multimodal imaging capabilities.

optomap *icg* images are captured using the infrared wavelength (802nm) to visualize the circulation of the choroidal vasculature. ICG fluoresces between 790-805 nm, with a peak absorption around 800 nm and emission around 830 nm.

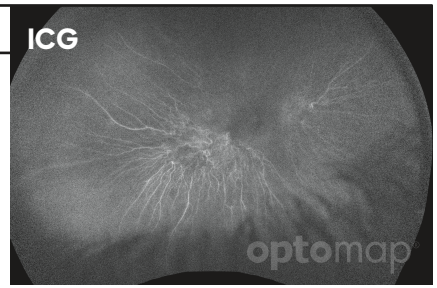
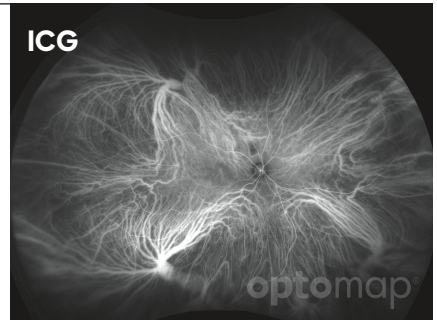
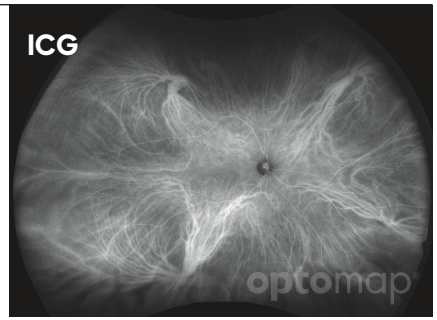
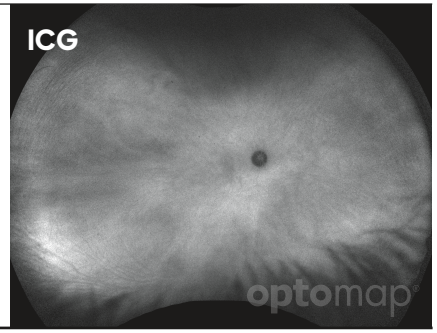
The dye is injected intravenously and is comprised of a concentration of indocyanine green and sodium iodide. Upon injection, images are captured and each image has a timestamp to track the circulation time of the choroidal vessels.

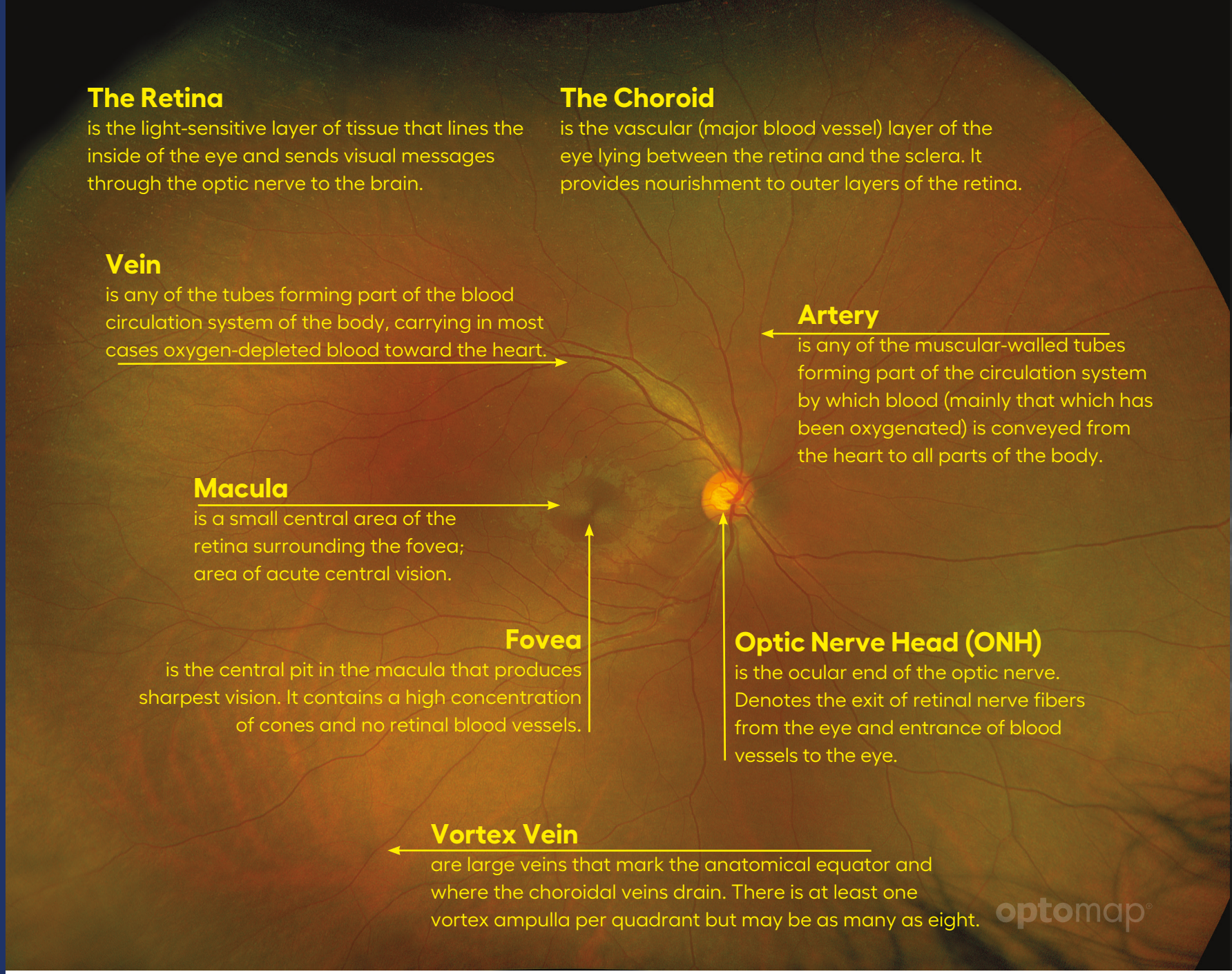
Hypercyanescence is the increased fluorescence of indocyanine green dye in the choroidal circulation observed during ICG angiography.

Hypocyanescence is the decreased fluorescence of indocyanine green dye in the choroidal circulation observed during ICG angiography.

optomap *fa/icg* interweave imaging is available to track circulation of the retina and the choroid in tandem.

Indocyanine Green Angiography Phases

Phase	Timing	Description	
Early	First 60 seconds post injection.	First appearance of dye in choroidal arteries; retinal arteries and veins are dark.	
Early Mid	1 – 3 minutes	Dye filling in choroidal veins and retinal vessels.	
Late Mid	3 – 15 minutes	Choroidal vessels fading and retinal vessels still visible.	
Late	15 – 45 Minutes	Hypocyanescent choroidal vessels and gradual fading of diffuse hypercyanescence.	



The Retina
is the light-sensitive layer of tissue that lines the inside of the eye and sends visual messages through the optic nerve to the brain.

The Choroid
is the vascular (major blood vessel) layer of the eye lying between the retina and the sclera. It provides nourishment to outer layers of the retina.

Vein
is any of the tubes forming part of the blood circulation system of the body, carrying in most cases oxygen-depleted blood toward the heart.

Artery
is any of the muscular-walled tubes forming part of the circulation system by which blood (mainly that which has been oxygenated) is conveyed from the heart to all parts of the body.

Macula
is a small central area of the retina surrounding the fovea; area of acute central vision.

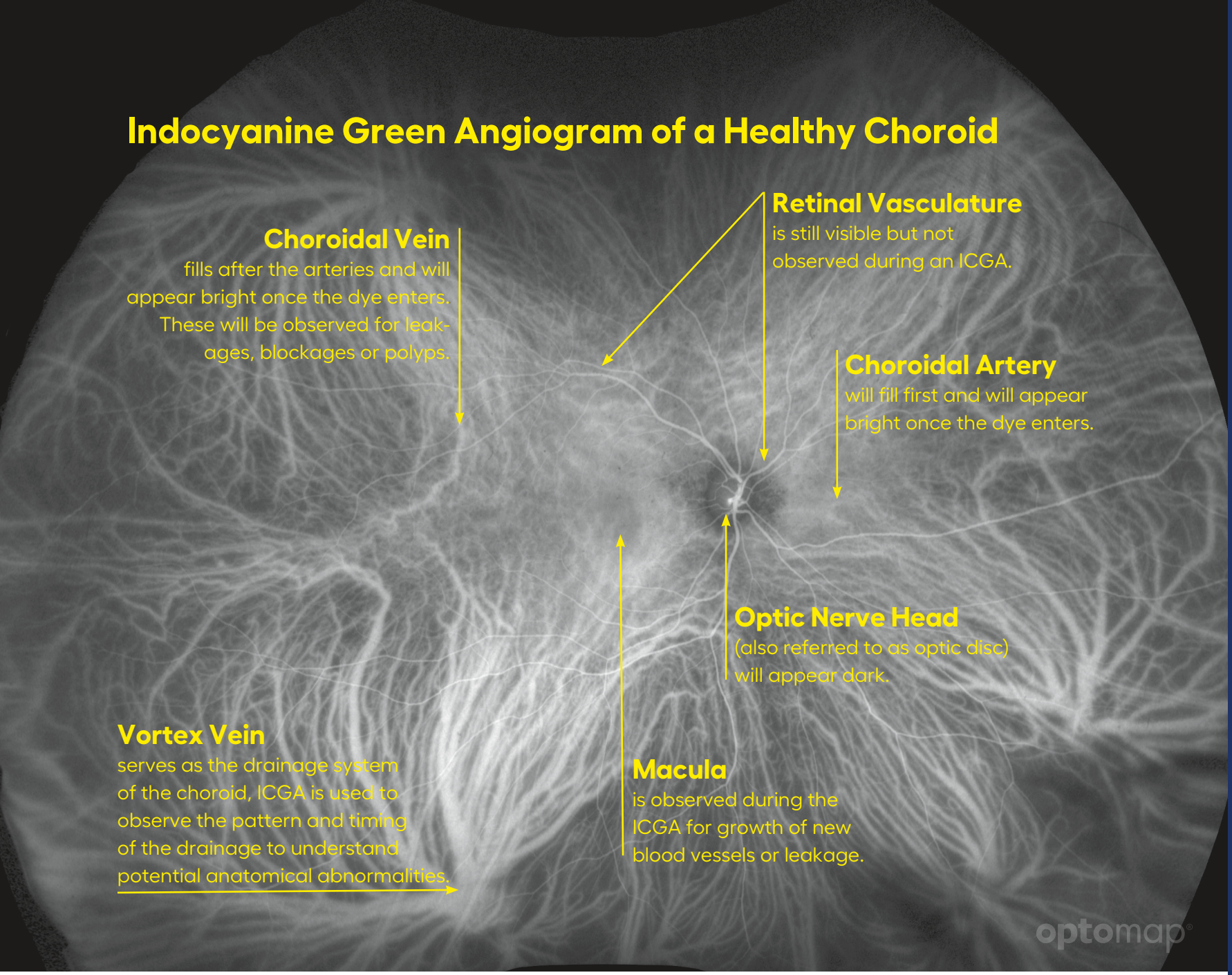
Fovea
is the central pit in the macula that produces sharpest vision. It contains a high concentration of cones and no retinal blood vessels.

Optic Nerve Head (ONH)
is the ocular end of the optic nerve. Denotes the exit of retinal nerve fibers from the eye and entrance of blood vessels to the eye.

Vortex Vein
are large veins that mark the anatomical equator and where the choroidal veins drain. There is at least one vortex ampulla per quadrant but may be as many as eight.

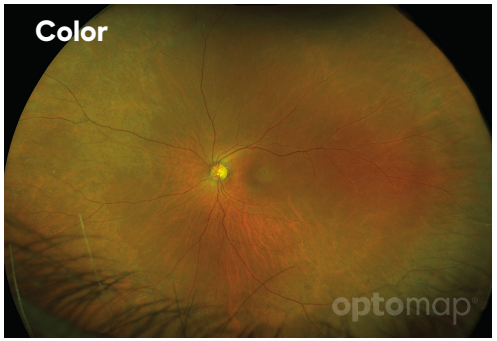
optomap®

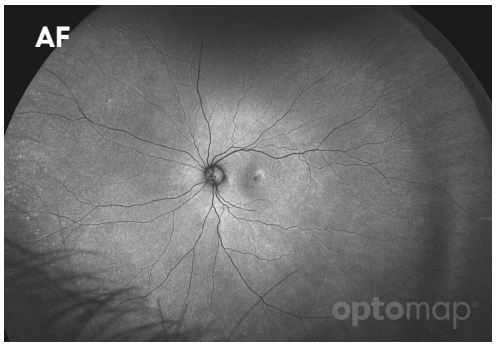
Indocyanine Green Angiogram of a Healthy Choroid

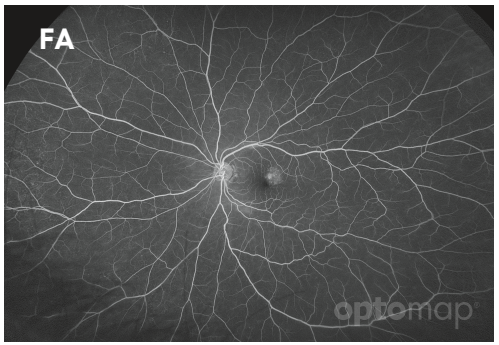


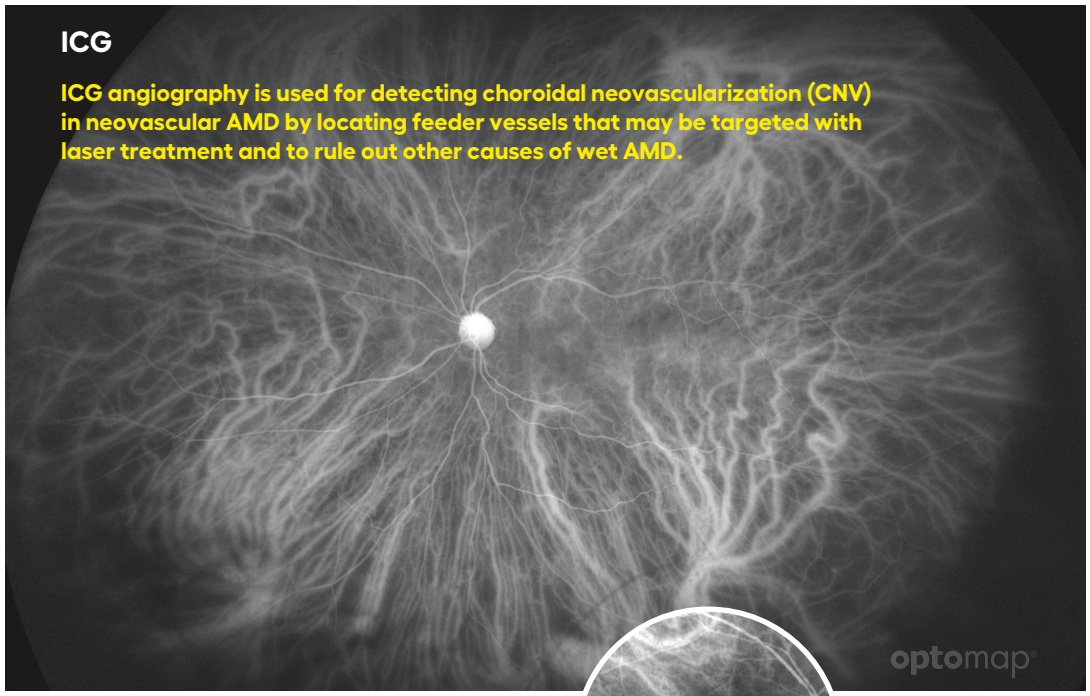
Age-Related Macular Degeneration (AMD, ARMD)

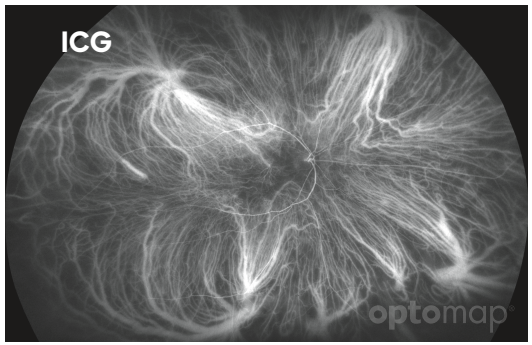
is a group of conditions that include deterioration of the macula, resulting in loss of sharp central vision. There are two types of AMD: wet and dry. Wet AMD is abnormal new blood vessel growth under the retina which leaks fluid and blood, further disturbing macular function. ICG angiography is more commonly used for wet AMD.

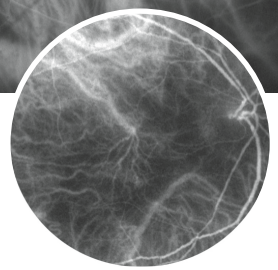










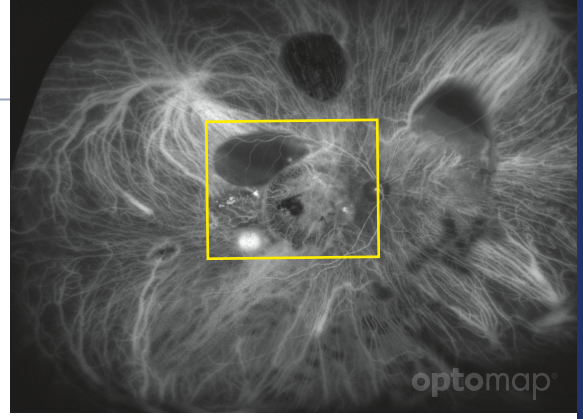


In neovascular AMD, classic choroidal neovascularization was graded comparably with other non-UWF platforms.[1]

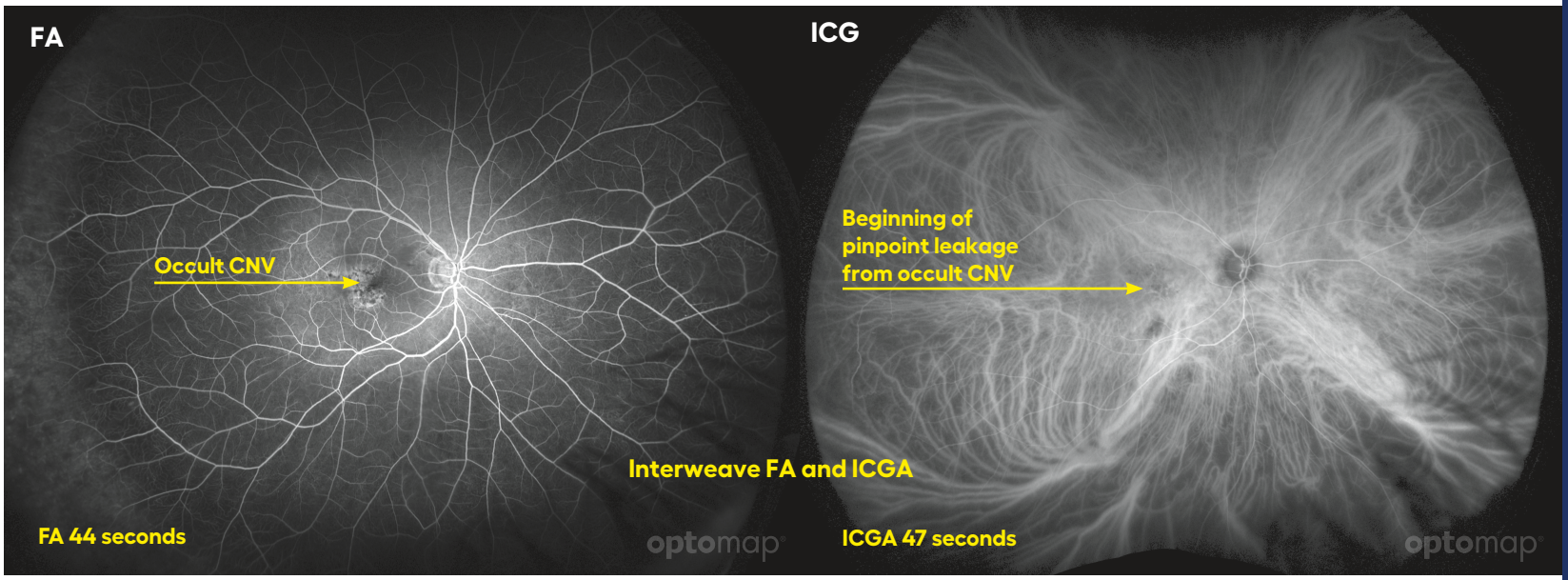
1. Klufas. Feasibility and Clinical Utility of Ultra-widefield Indocyanine Green Angiography. Retina. 2014.

Choroidal Neovascular Membrane (CNV, CNVM)

is associated with wet AMD and there are three types: Classic, Retina Angiomatous Proliferation (RAP) and Occult. On ICG angiography, classic CNV may appear in the early phase with a well-defined area of hypercyanescence. RAP presents as a well-defined single vessel which is hypercyanescent in the early ICG phase unless blocked by pre-retinal hemorrhage causing hypocyanescence. Occult may appear as poorly defined and areas of neovascularization are blurry, bright hypercyanescent regions.



optomap *fa/icg* imaging can be captured in tandem using interweave mode.

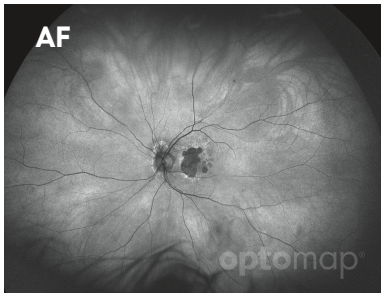


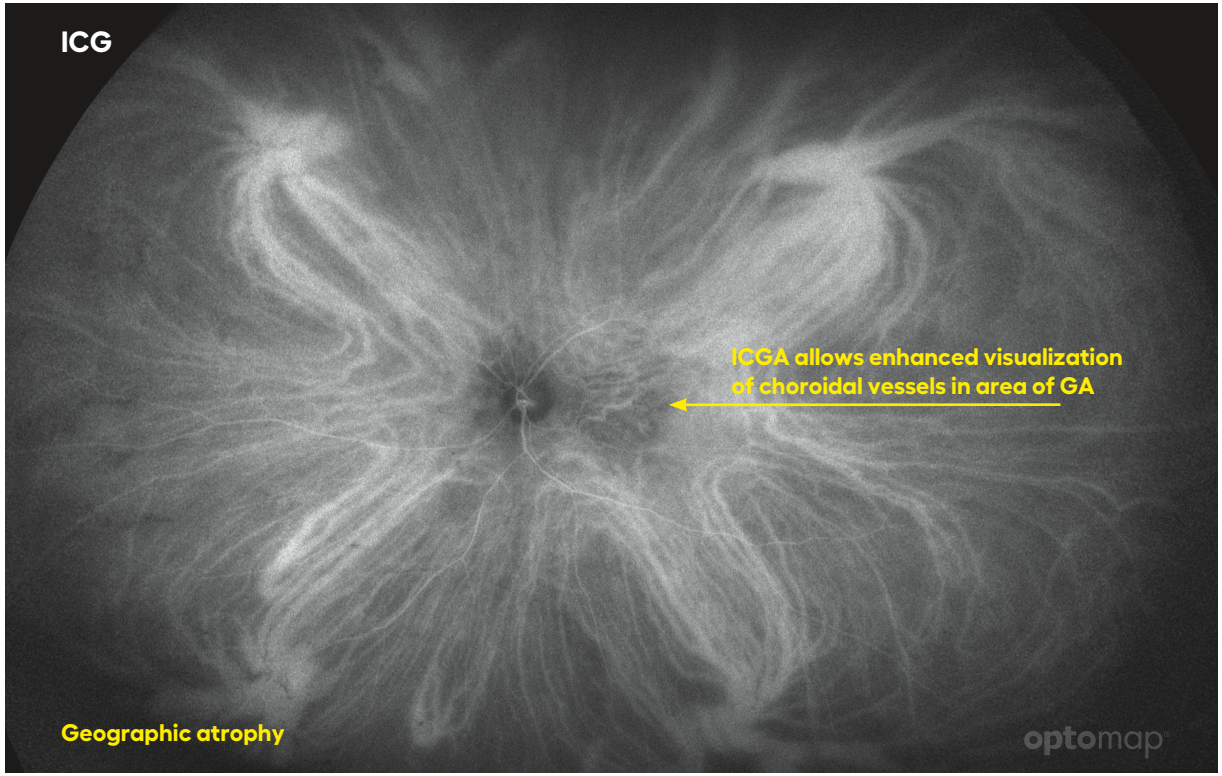
Recent research found that using **opto**map *icg* captured significant peripheral changes in 80% of AMD patients.[1]

Dry AMD

is usually evident as a disturbance of macular pigmentation and drusen which are deposits of yellowish material under the pigment epithelial layer in the central retinal zone.

Geographic Atrophy (GA) associated with dry AMD, is any sharply delineated round or oval area of hypopigmentation, or apparent absence of the retinal pigment epithelium (RPE) at least 175 m in diameter, in which choroidal vessels are more visible than in the surrounding areas.



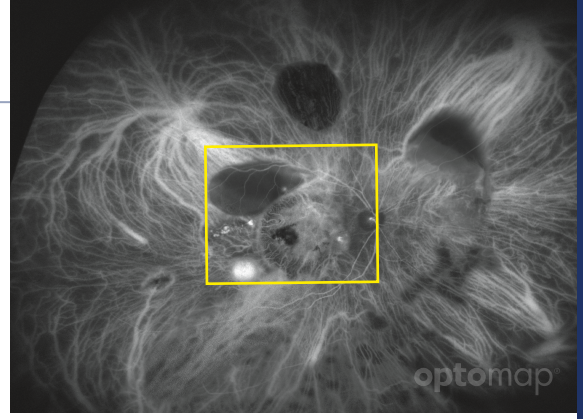


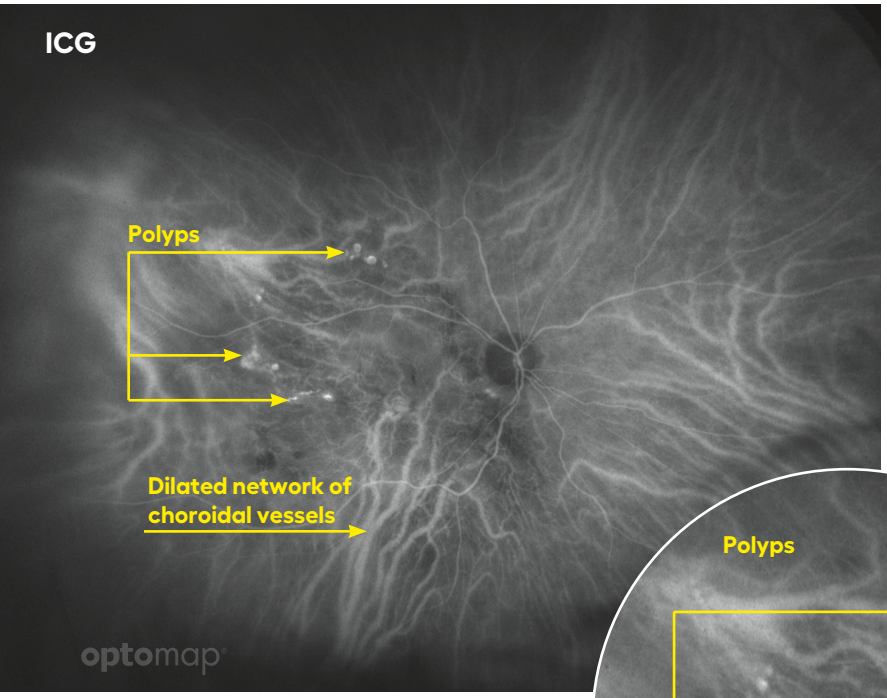
Age-related macular degeneration is best managed with multimodal imaging and may be more than a “macular” condition but one that involves the entire retina.[2]

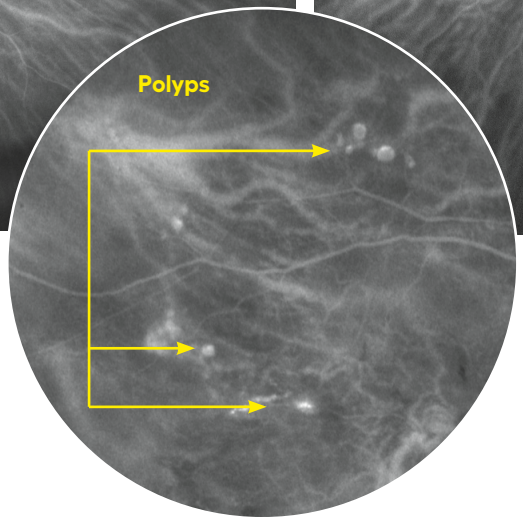
2. Friberg. Peripheral Retinal Changes Associated with Age-Related Macular Degeneration in the Age-Related Eye Disease Study 2. Ophthalmology. 2016.

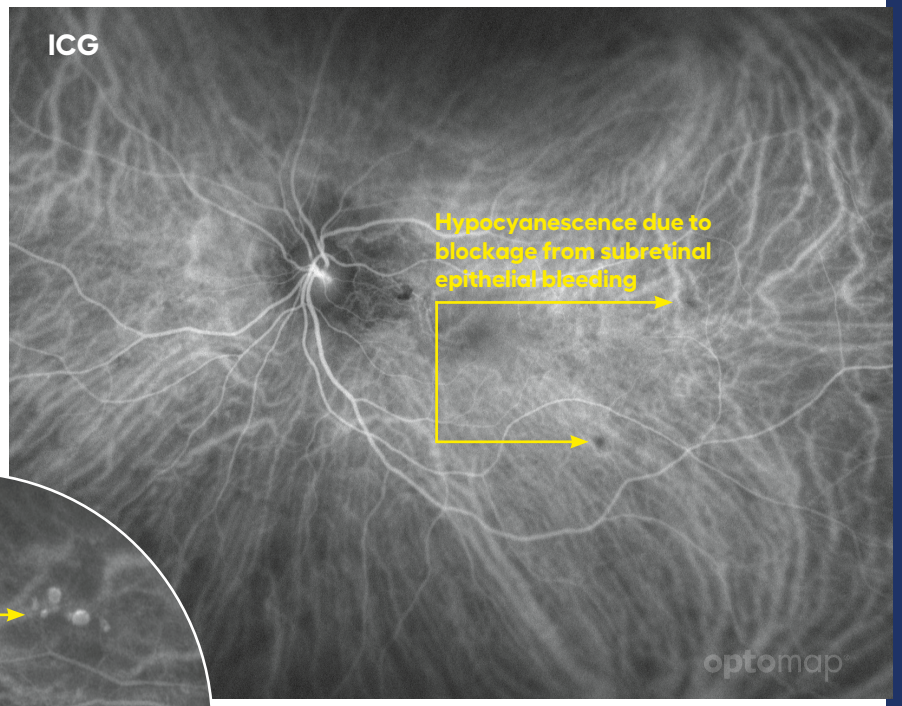
Polypoidal Choroidal Vasculopathy (PCV)

is a choroidal vasculature disease, characterized by recurring subpigment epithelial bleeding and polyps seen in early phase ICG angiography. ICG angiography is often used for diagnosing PCV and helps determine and guide treatment. It is more common in Asian populations.









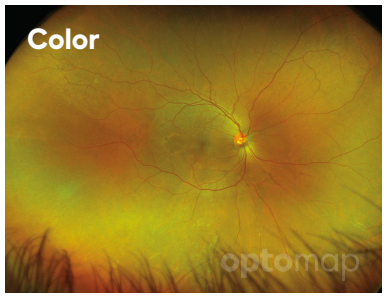
Polyps may appear as hypercyanescent pinpoint leakage on **opto**map *icg*.

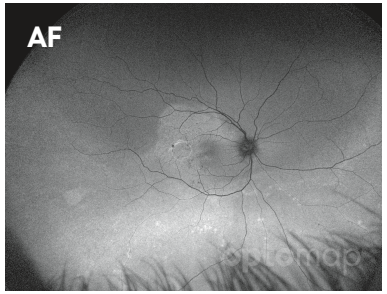
Peripheral findings were noted in 37% of PCV cases noted in one study.[1]

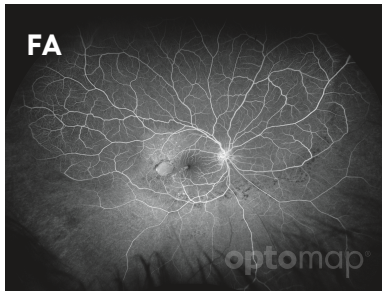
Central Serous Chorioretinopathy (CSCR, CSR)

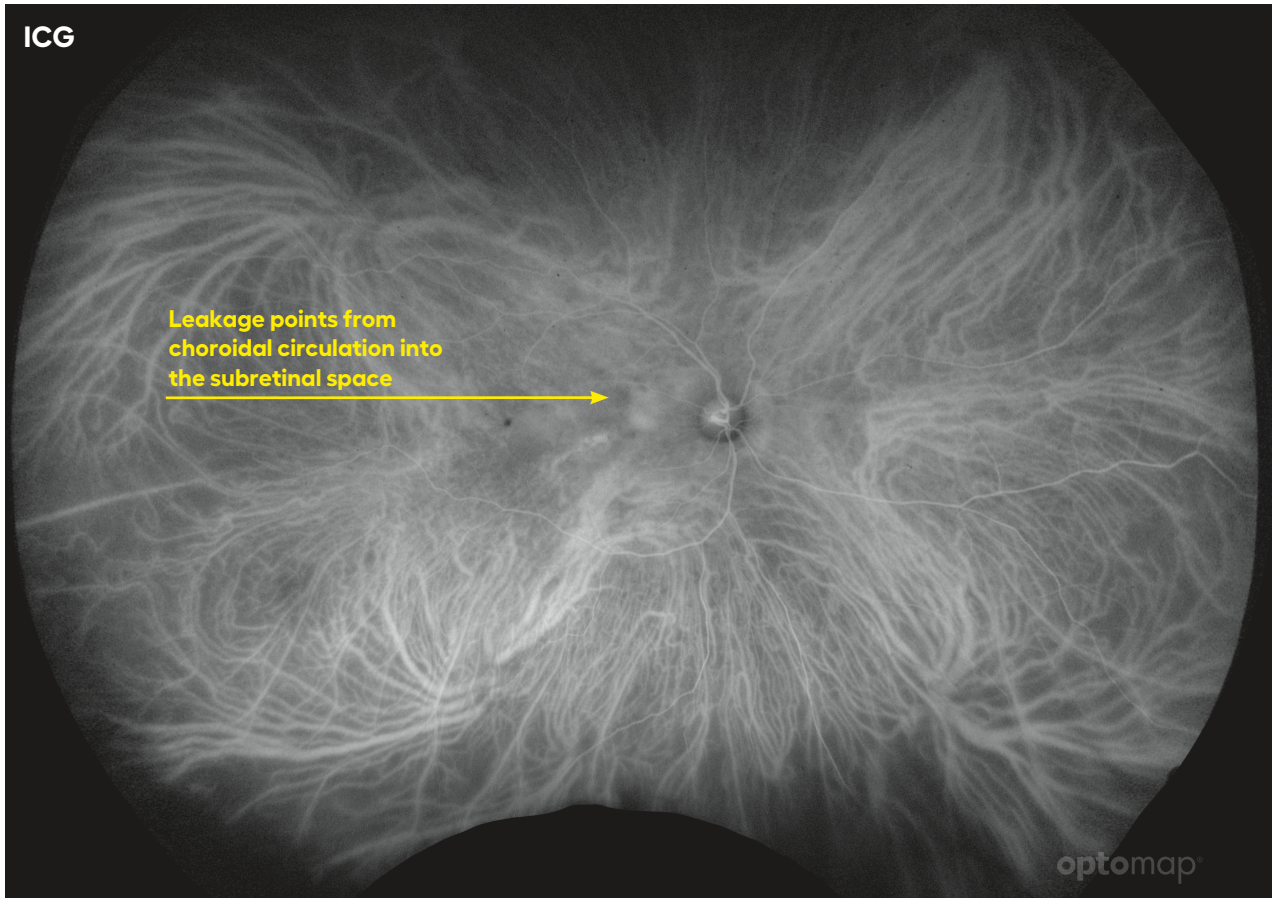
is a blister-like elevation of sensory retina in the macula (area of central vision), with localized detachment from the pigment epithelium. Results in reduction and/or distortion of vision that usually recovers within a few months.

Multimodal imaging is helpful in visualizing CSCR. **opto**map *color* shows areas of hypopigmentation from chronic epithelial retinal detachments. **opto**map *af* shows fluid collections with hyperautofluorescence present. **opto**map *fa* shows pinpoint leakage and pooling. **opto**map *icg* shows choriocapillaris leakage points which may be a potential conversion to neovascularization.

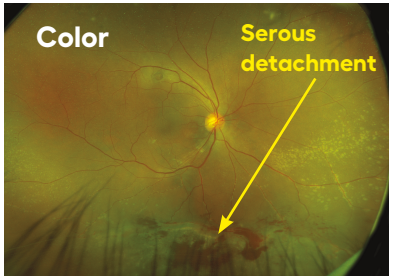


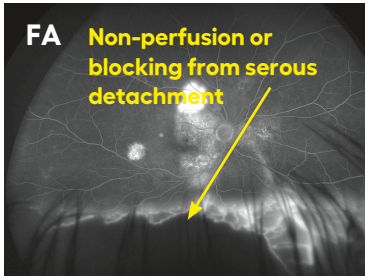


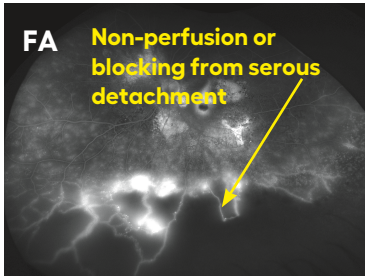


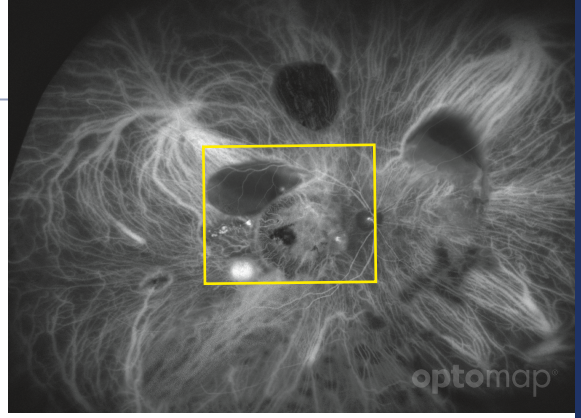


Using **opto**map *icg*, peripheral changes not visible with limited field ICG angiography were observed in 64% of eyes with CSCR.[1]

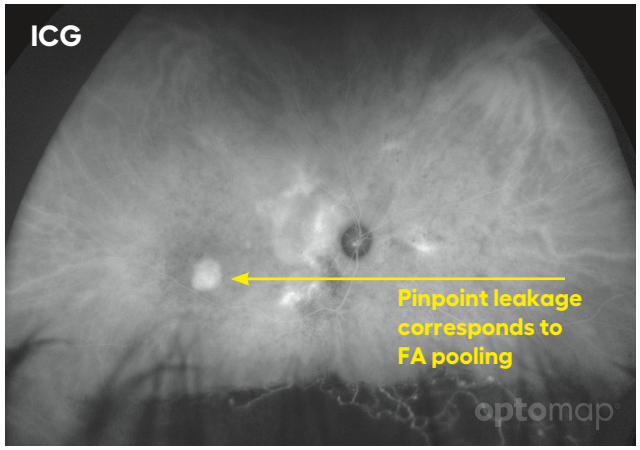


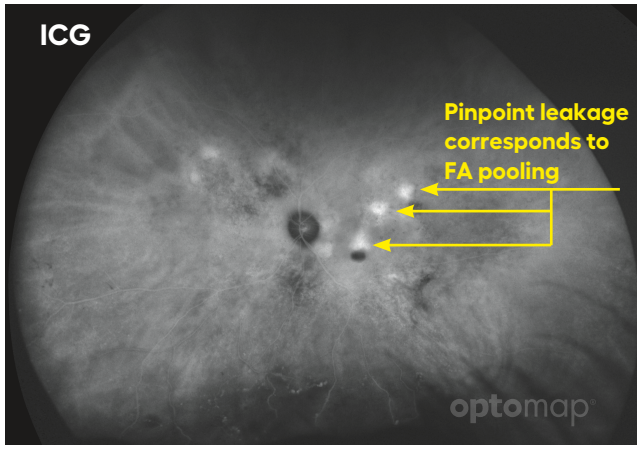


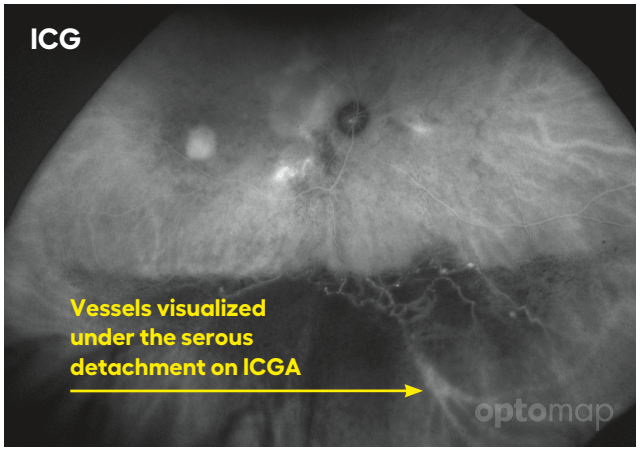


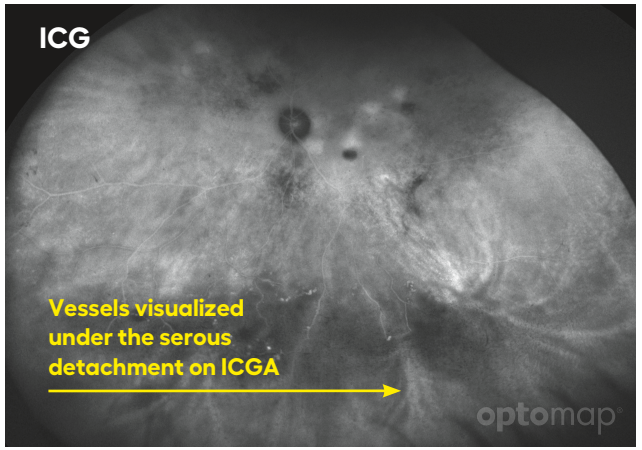


optomap *color* shows a serous detachment in the inferior periphery. **opto**map *fa* shows multiple focal areas of hyperfluorescence corresponding to leakage points in the choroid as seen on the **opto**map *icg*. Serous detachment in the inferior retina corresponds to non-perfusion or blocking in the **opto**map *fa*. **opto**map *icg* shows visualization through the serous detachment to visualize the vessels in the choroid. This helps to confirm location of the detachment in the retina.

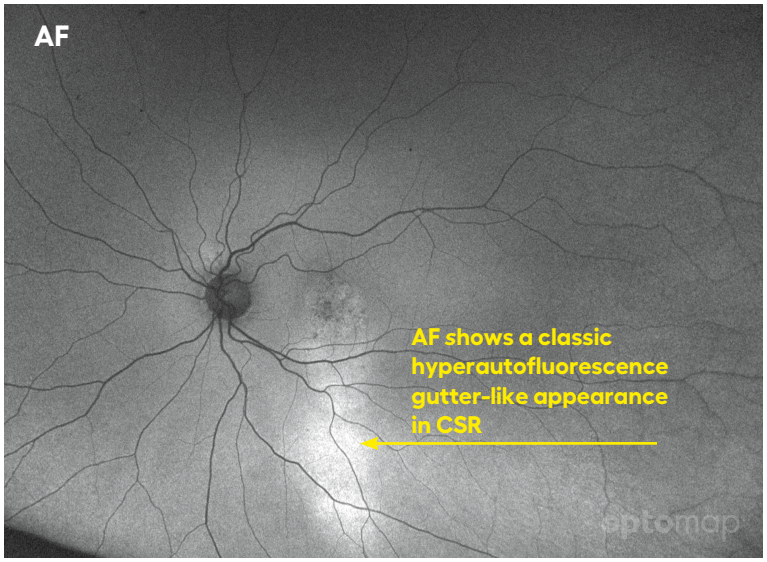


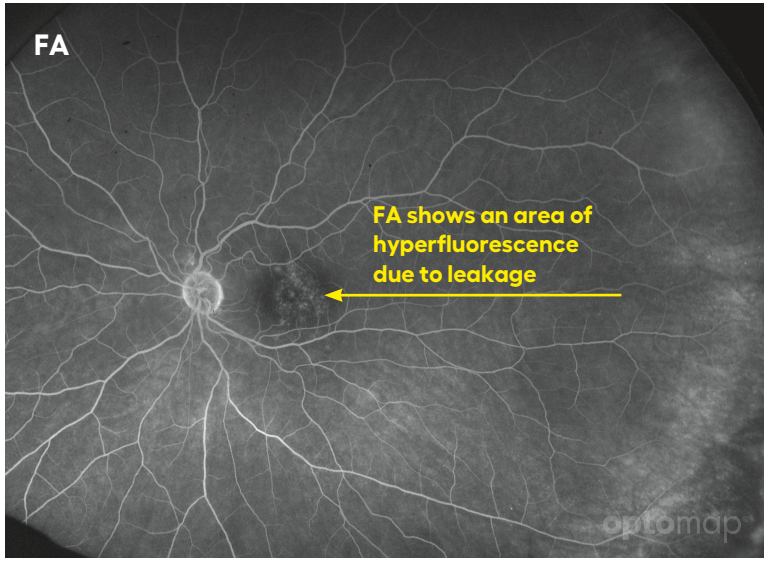


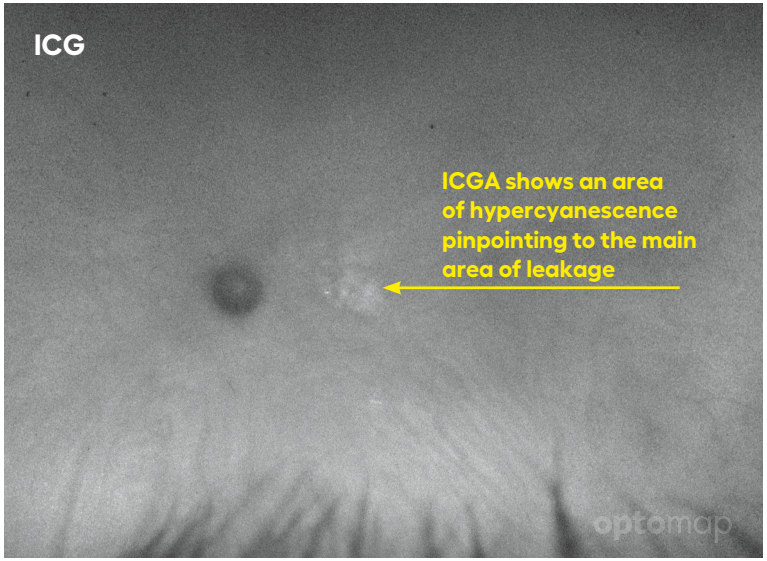




Central Serous Chorioretinopathy (CSCR, CSR)





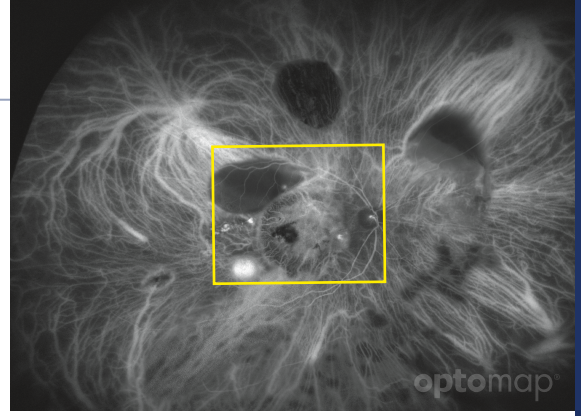


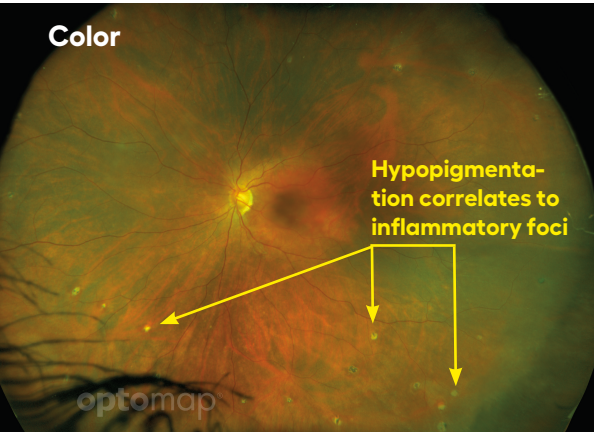
optomap *fa/icg* interweave has corresponding findings of hyperfluorescent and hypercyanescent leakage.

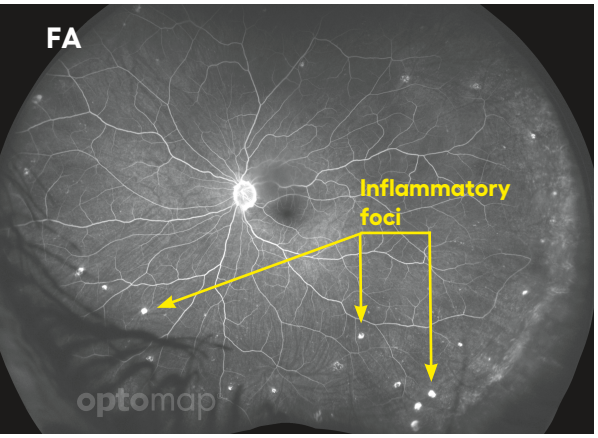
Vogt–Koyanagi–Harada disease (VKH)

is an inflammatory disease that is characterized by panuveitis with exudative retinal detachments.

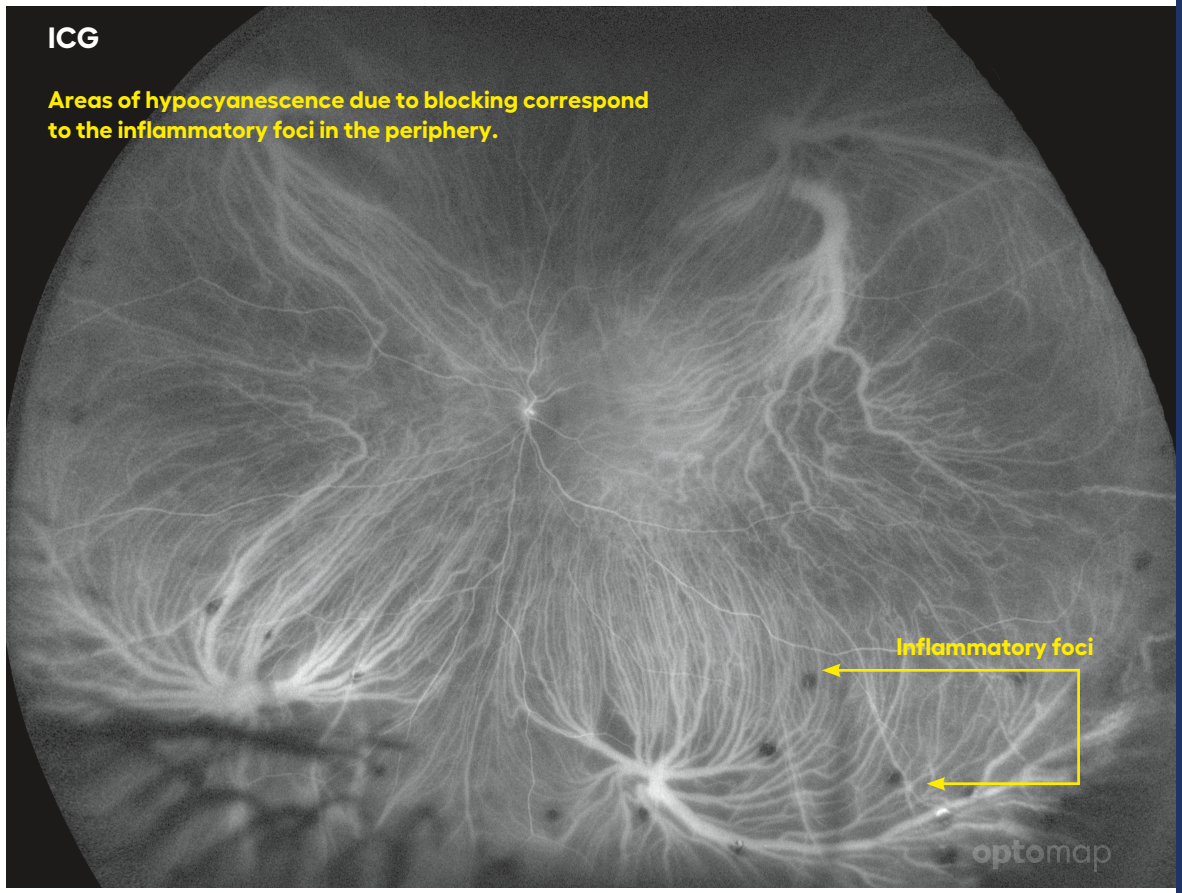
ICG angiography is used to visualize inflammatory leakage and vasculitic changes such as, early choroidal vessel hypercyanescence and leakage, hypocyanescent dark lesions, a blurry vascular pattern and disc hypercyanescence. ICG angiography can pinpoint the inflammatory lesions that were seen in multimodal imaging to confirm the disease.







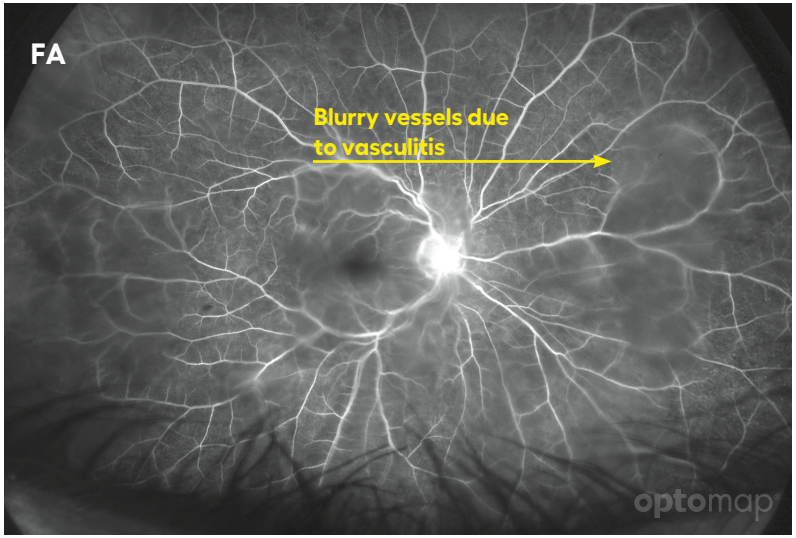
optomap *fa* shows areas of hyperfluorescence due to staining of inflammatory foci.

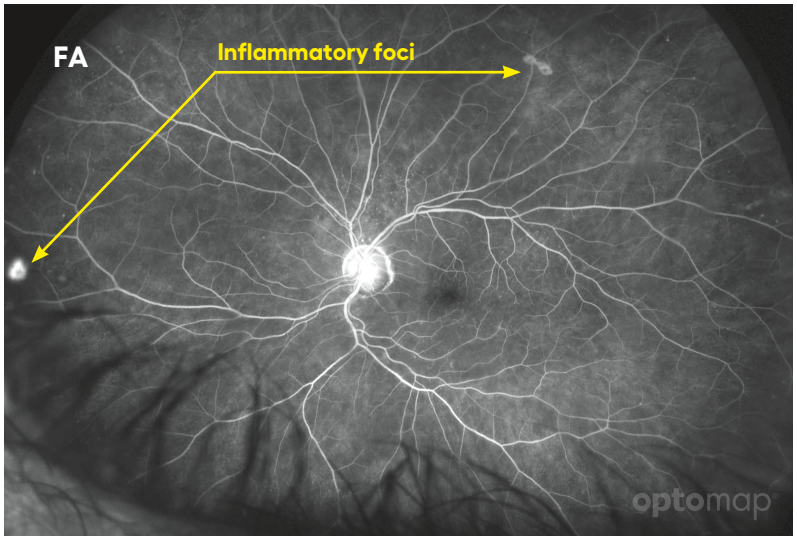


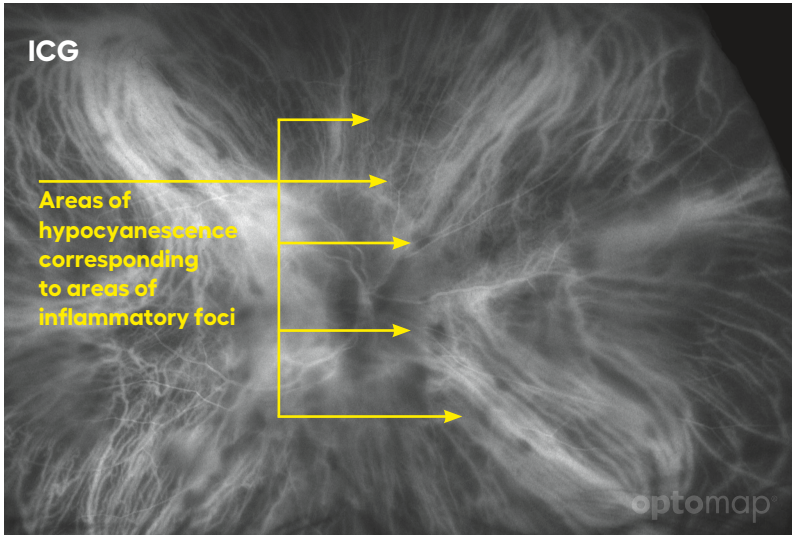
Lesions/inflammatory areas found in VKH correspond across multimodal imaging.

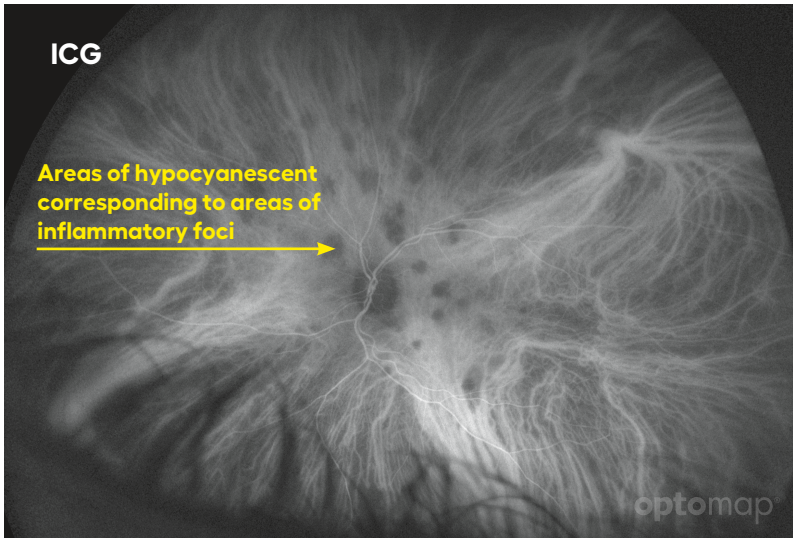
Uveitis

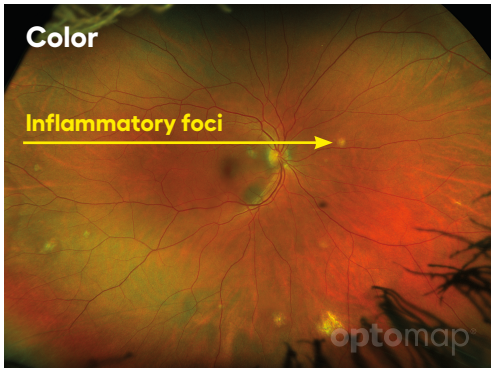
is inflammation of any of the structures of the uvea: iris, ciliary body or choroid. Interweave *fa/icg* is useful when imaging uveitis. **opto**map *fa* shows localized and diffuse leakage throughout the retina. **opto**map *icg* shows the inflammatory lesions seen on **opto**map *fa* for confirmation of disease. Images may appear slightly blurred due to inflammatory cells in the vitreous, called vitreous haze, or due to vasculitis.

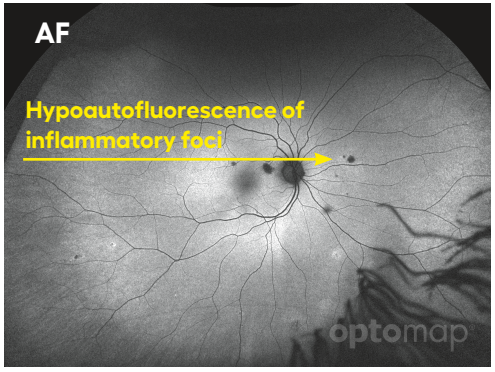


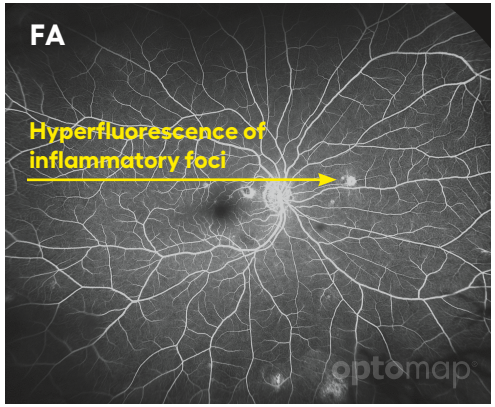




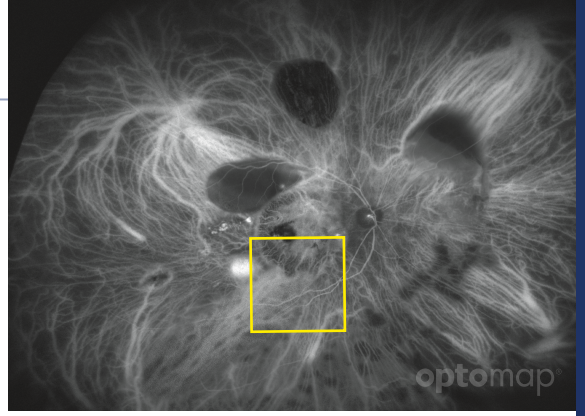


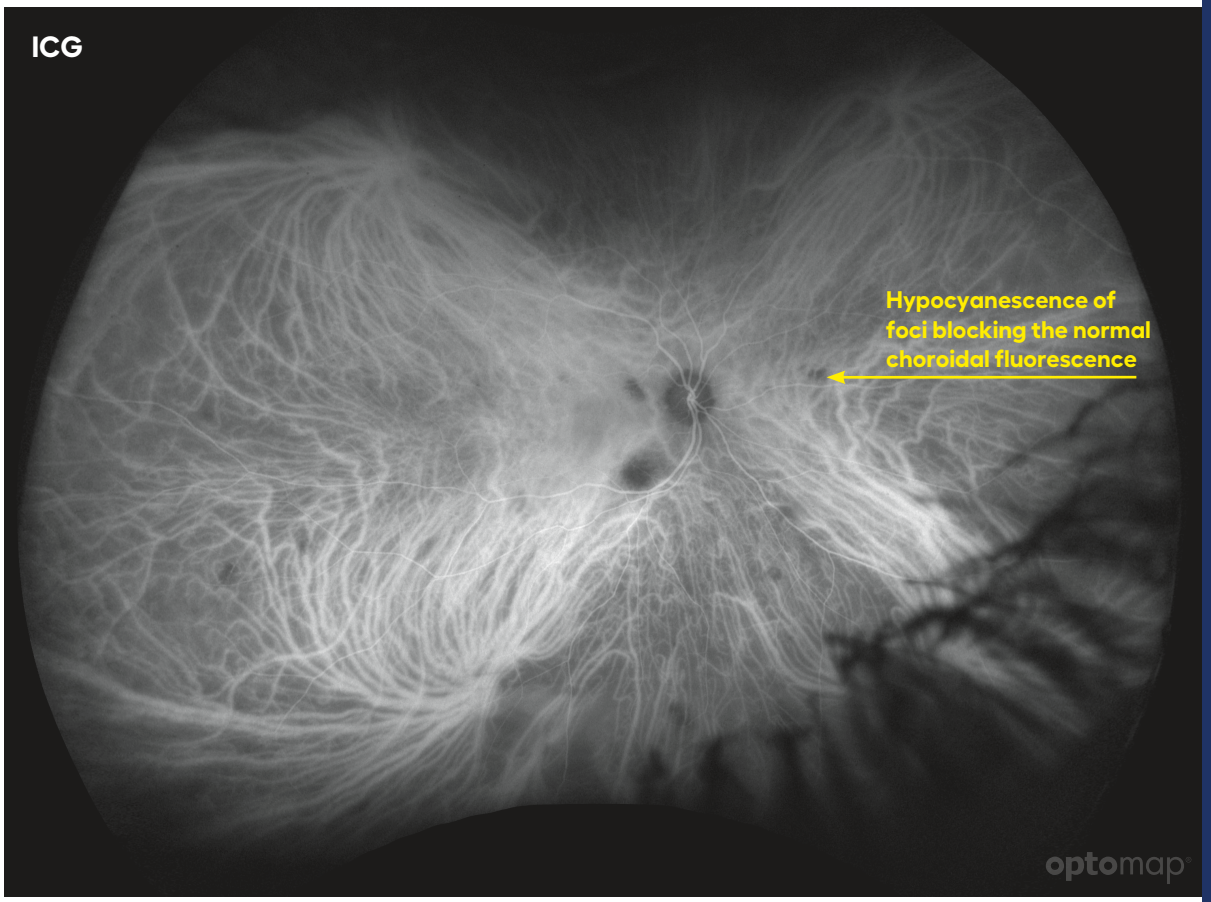






One study found that 59% of uveitis cases had peripheral findings on **opto**map *icg*.[1]



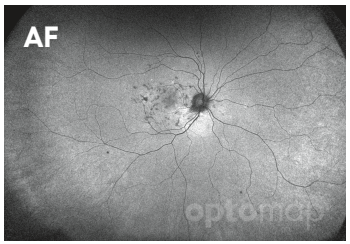


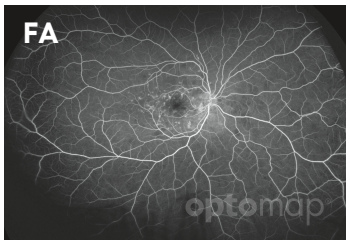
Inflammatory foci found in uveitis, correspond to each other on multimodal imaging.

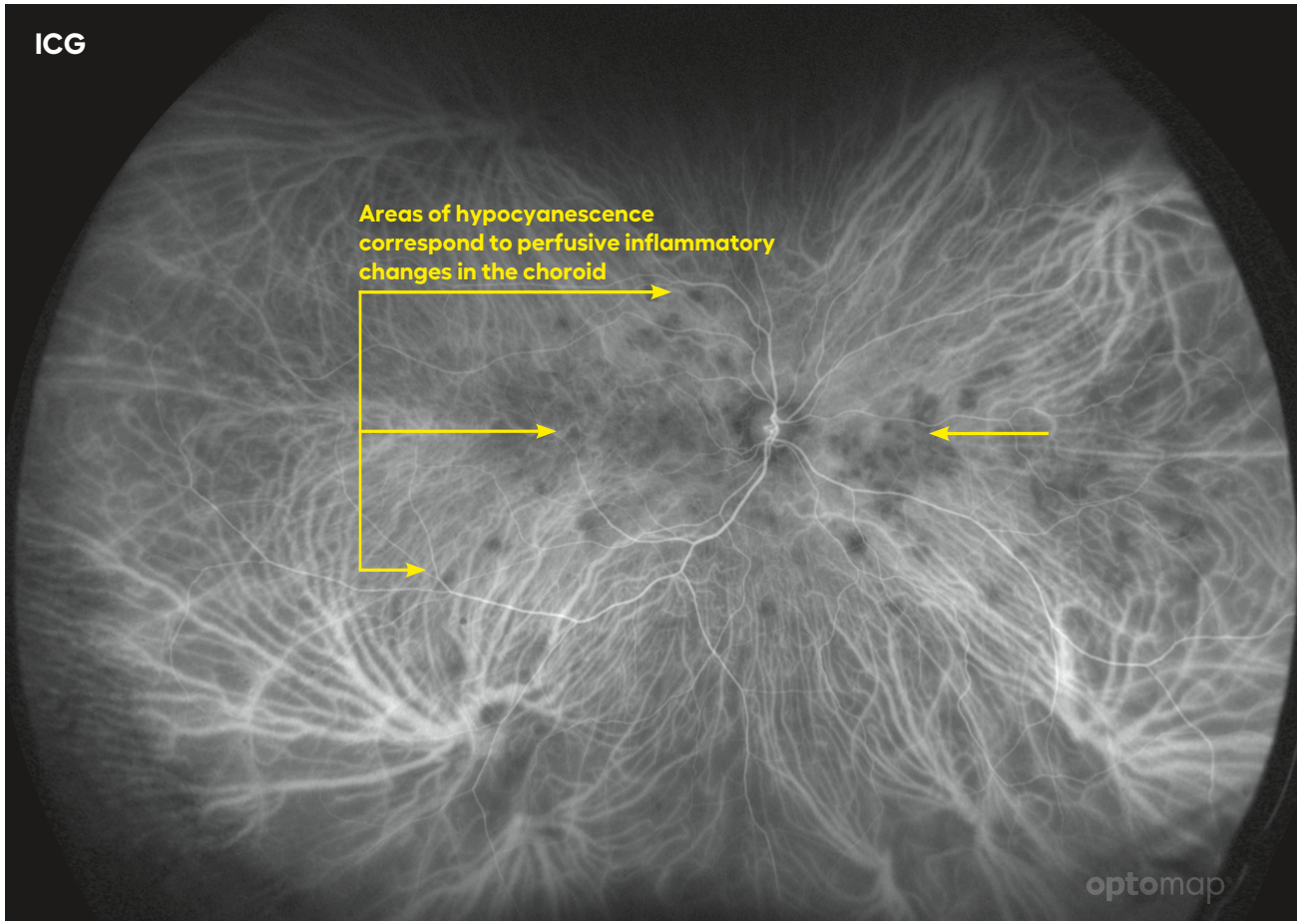
Multifocal Choroiditis

is an inflammatory condition that can manifest with vitritis and chorioretinal lesions extending from the posterior pole.

Multimodal imaging shows hypopigmentation on the **opto**map *color* image. **opto**map *af* demonstrates retinal pigment epithelial (RPE) hyperautofluorescence. **opto**map *fa* shows pinpoint areas of leakage with vasculitis. **opto**map *icg* shows areas of hypocyanescence which are perfusive inflammatory changes in the central and peripheral choroid.

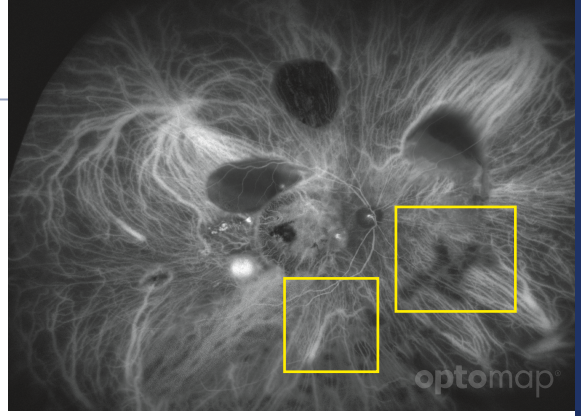


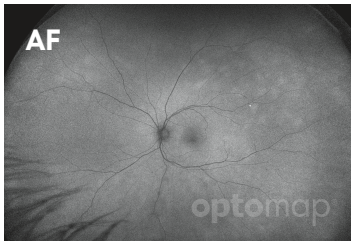


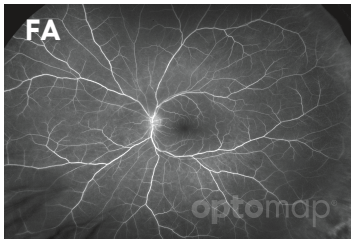


Birdshot Chorioretinitis

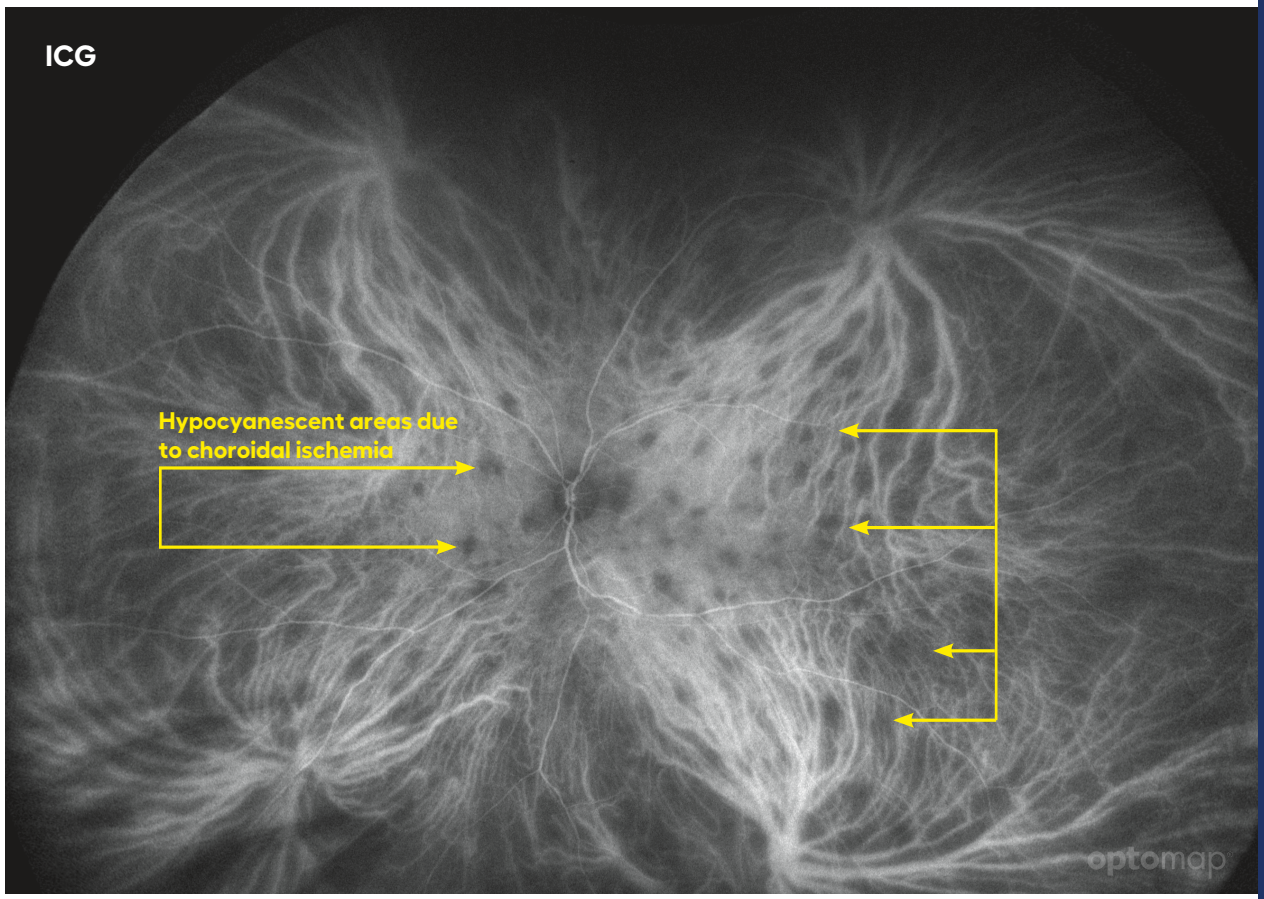
is an inflammatory disease of the choroid, characterized by small, yellowish choroidal spots and vitreous inflammation. **opto**map *color* shows areas of hypopigmentation extending to the far periphery. **opto**map *af* shows hyperautofluorescence areas corresponding to the inflammatory spots. The spots are not easily visible in **opto**map *fa* as the other imaging modalities due to the location of the spots in the choroid. **opto**map *icg* shows inflammatory spots which result in small choroidal hypocyanescent lesions.







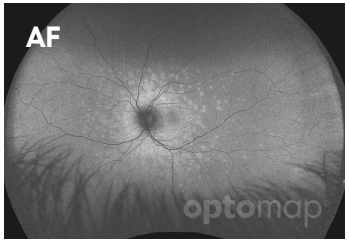
A study found that 66% of birdshot chorioretinitis cases had peripheral findings on **opto**map *icg*.[1]



1. Friberg. Peripheral Retinal Changes Associated with Age-Related Macular Degeneration in the Age-Related Eye Disease Study 2. Ophthalmology. 2016.

Multifocal Evanescent White Dot Syndrome (MEWDS)

a condition in which white dots appear in the deep layers of the retina caused by inflammation. **opto**map *color* shows subtle RPE disturbances centered on the macula. **opto**map *af* shows increases in RPE hyperautofluorescence in the posterior pole to the periphery. **opto**map *fa* shows leakage in a circular pattern around the fovea spreading into the peripheral retina. **opto**map *icg* shows the absence of the MEWDS lesions in the choroid and may help to rule out other inflammatory diseases. If the lesions are not visible with the **opto**map *icg*, then this may suggest this is MEWDS.

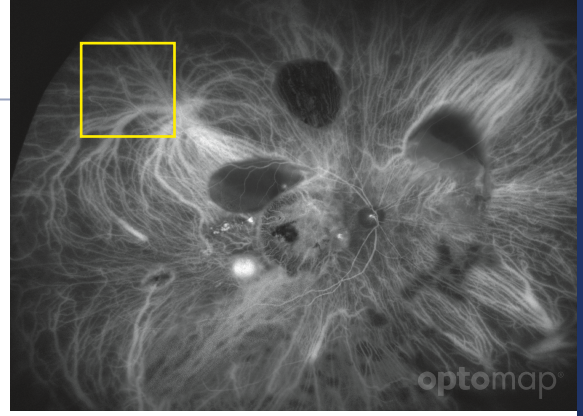


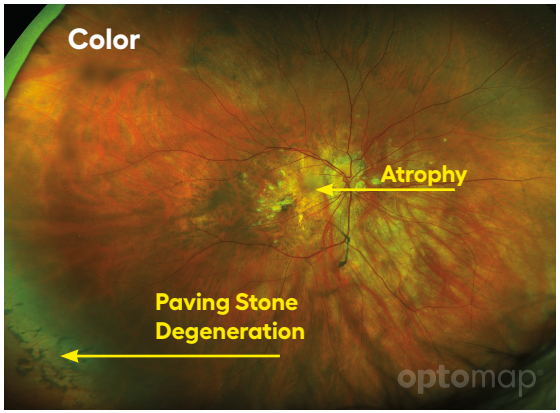
The absence of lesions in **opto**map *icg* may suggest this is MEWDS.

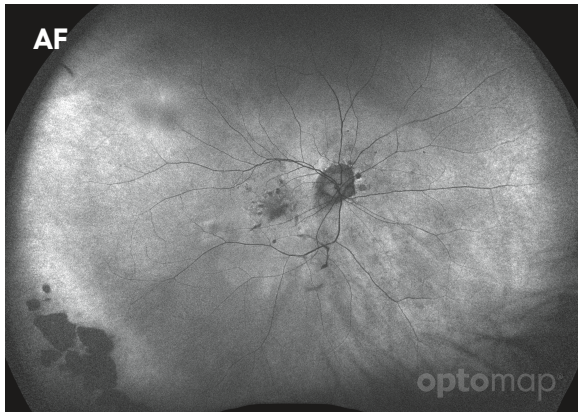
Vasculitis

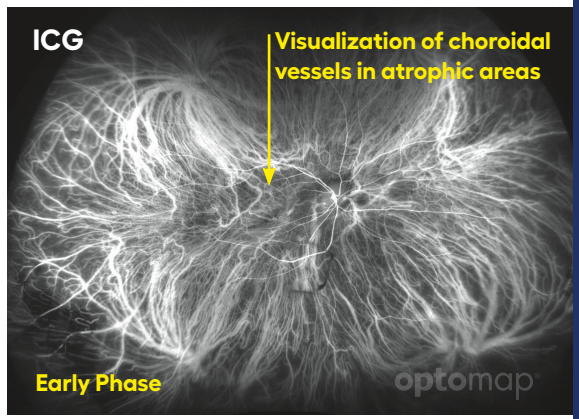
is inflammation of blood or lymph vessels.

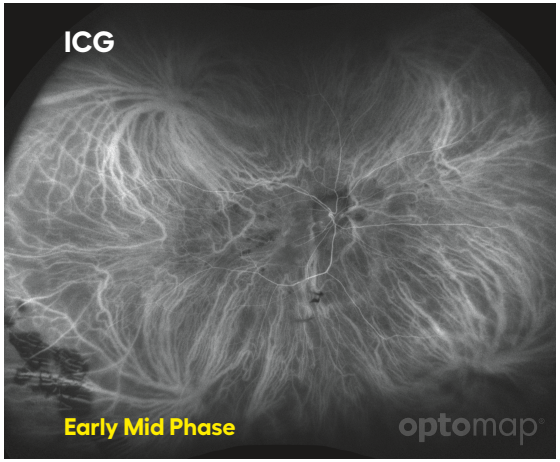
optomap *color* shows atrophy, vessel sheathing, ischemia and inflammation. Due to the atrophic changes that are present, **opto**map *icg* shows vasculitic changes within the choroidal tissues. Vessel hypercyanescence is present due to vessel staining and leakage.

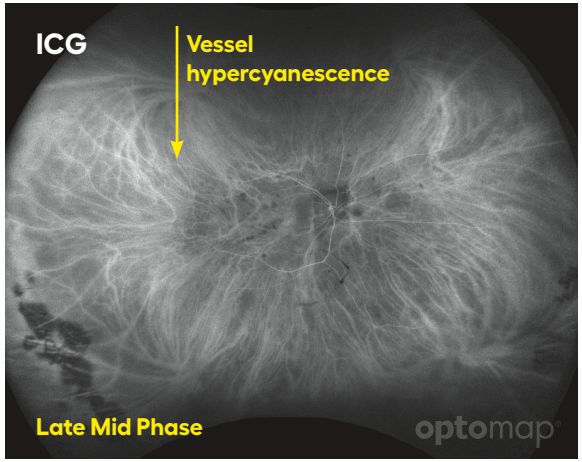


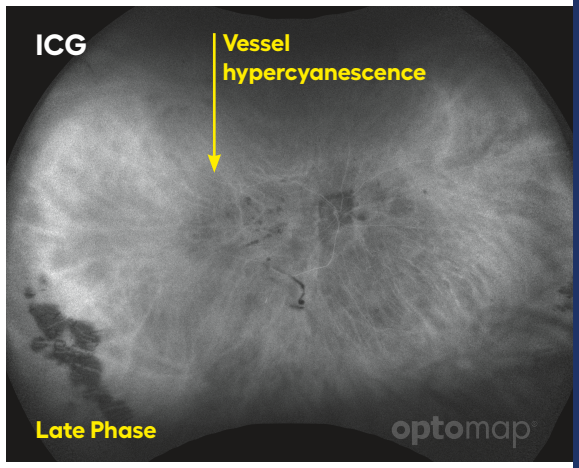








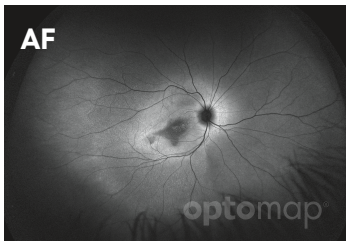


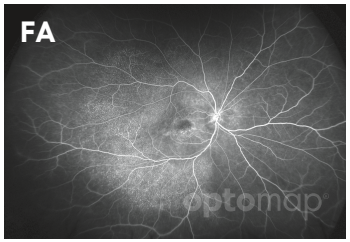


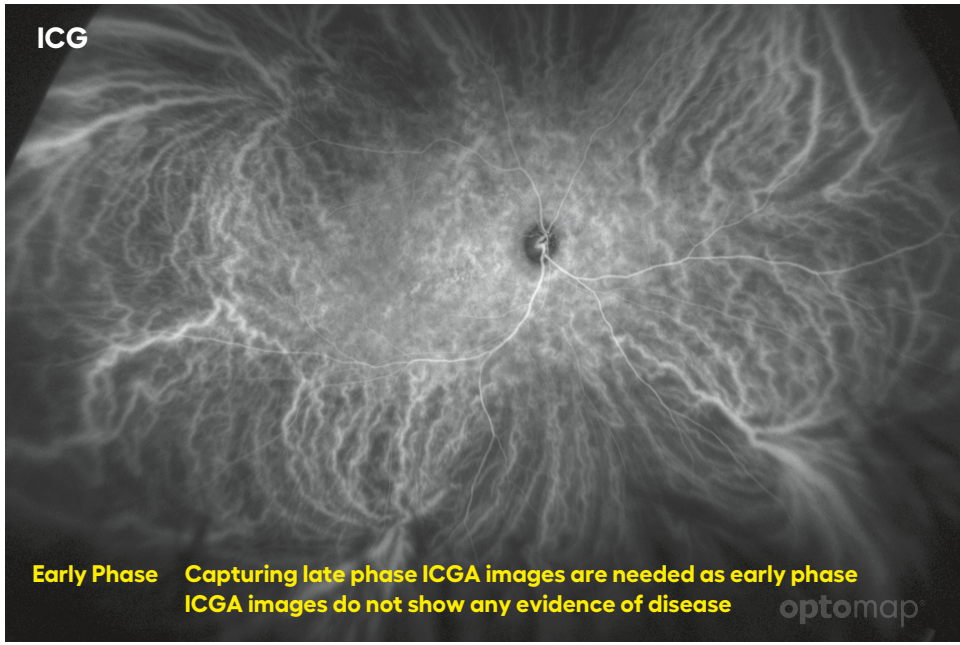
The late phase of the **opto**map *icg* shows persistence of hypercyanescence in the choroidal vessels confirmatory of inflammatory disease.

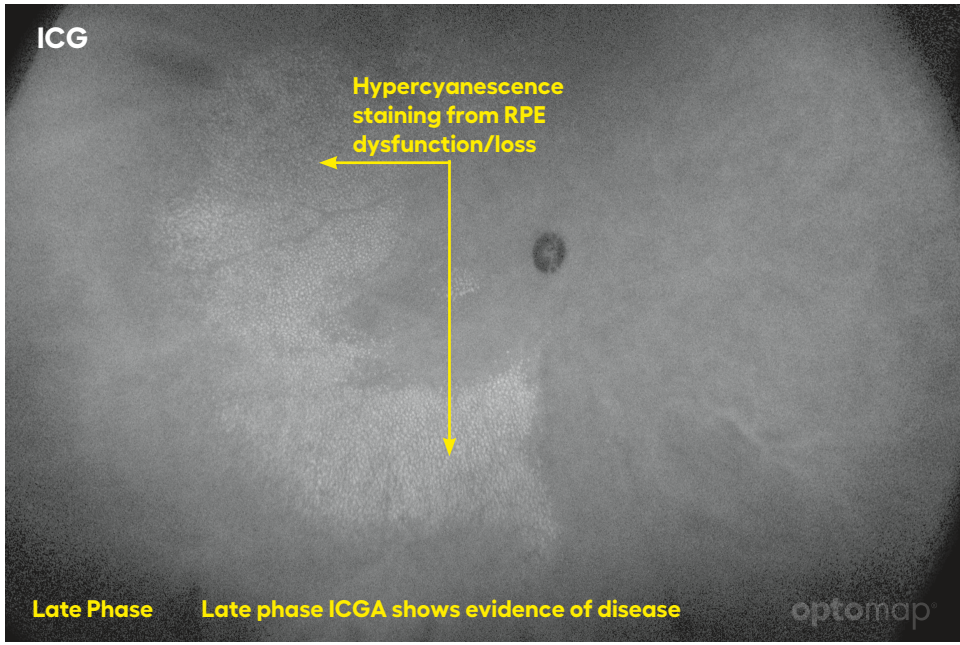
Retinal Dystrophy

is a term given to a range of genetic conditions with varying pathologic manifestations including, Leber Congenital Amaurosis and Rod-Cone Dystrophies such as, Retinitis Pigmentosa, Stargardt's disease, Best's disease, Usher Syndrome, Batten Disease and Bardet-Biedl. **opto**map *color* shows hypopigmented pathologic changes from the central pole to the peripheral retina. **opto**map *af* shows hyperautofluorescence around an area of hypoautofluorescence of the RPE from photoreceptor loss and dysfunction, which indicates disease progression. **opto**map *fa* shows window defect from RPE dysfunction or degeneration in those areas. **opto**map *icg* shows consistency with RPE disturbances as seen in the other imaging modalities and increase visualization of the choroid.



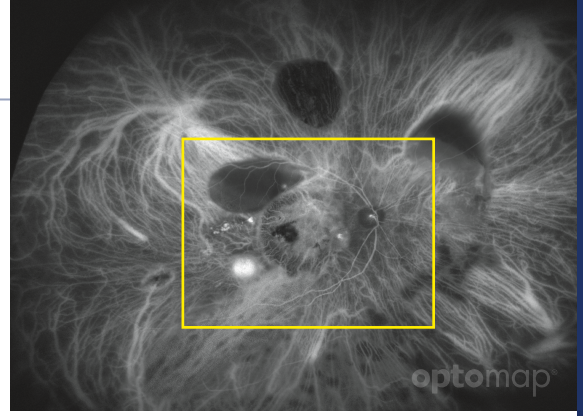


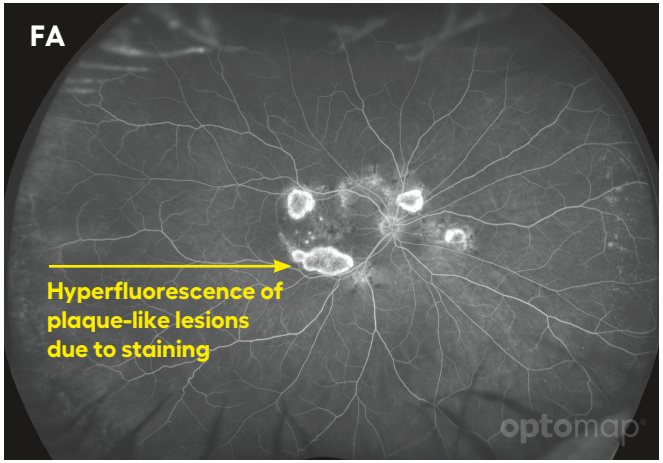


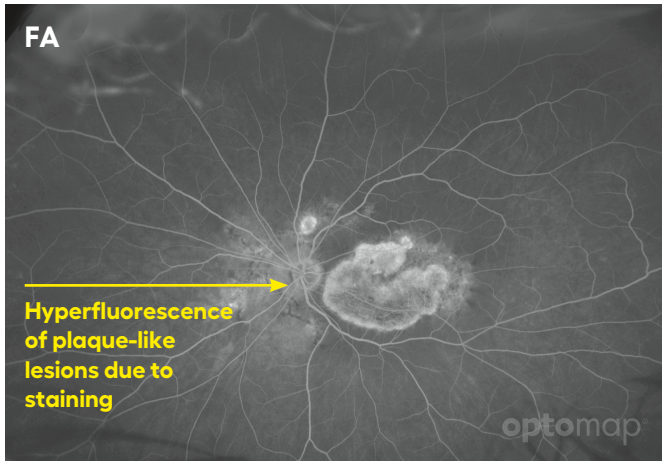


Choroidal Dystrophy

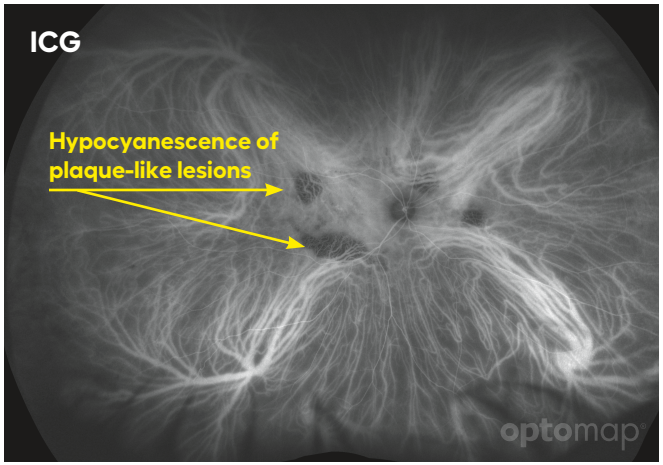
is a genetic eye disorder that involves the choroid, often resulting in areas of atrophy in the retinal pigment epithelium and the choriocapillaris.

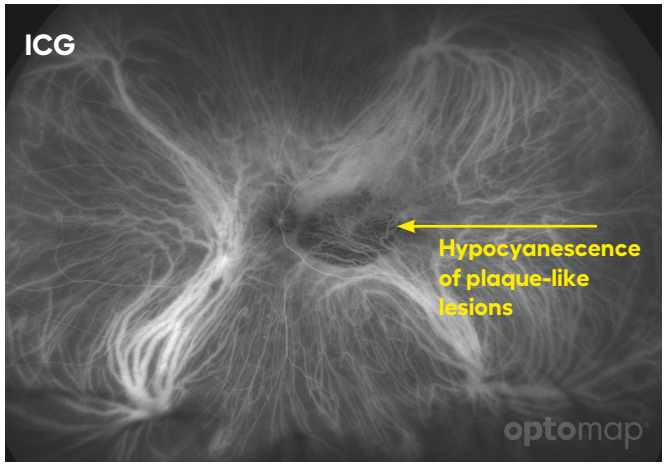






optomap *fa* shows plaque-like lesions which can occur in choroidal and retinal dystrophy.



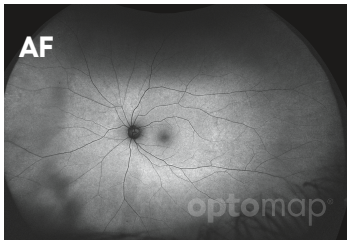


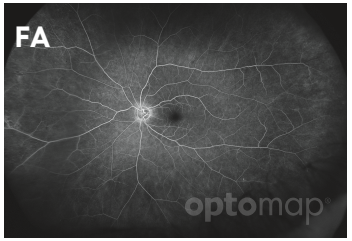
optomap *icg* of choroidal dystrophy corresponds to the plaque-like lesions as seen in **optomap** *fa*. The lesions in both ICGA and FA show the depth of the dystrophy in the retina and choroidal layers.

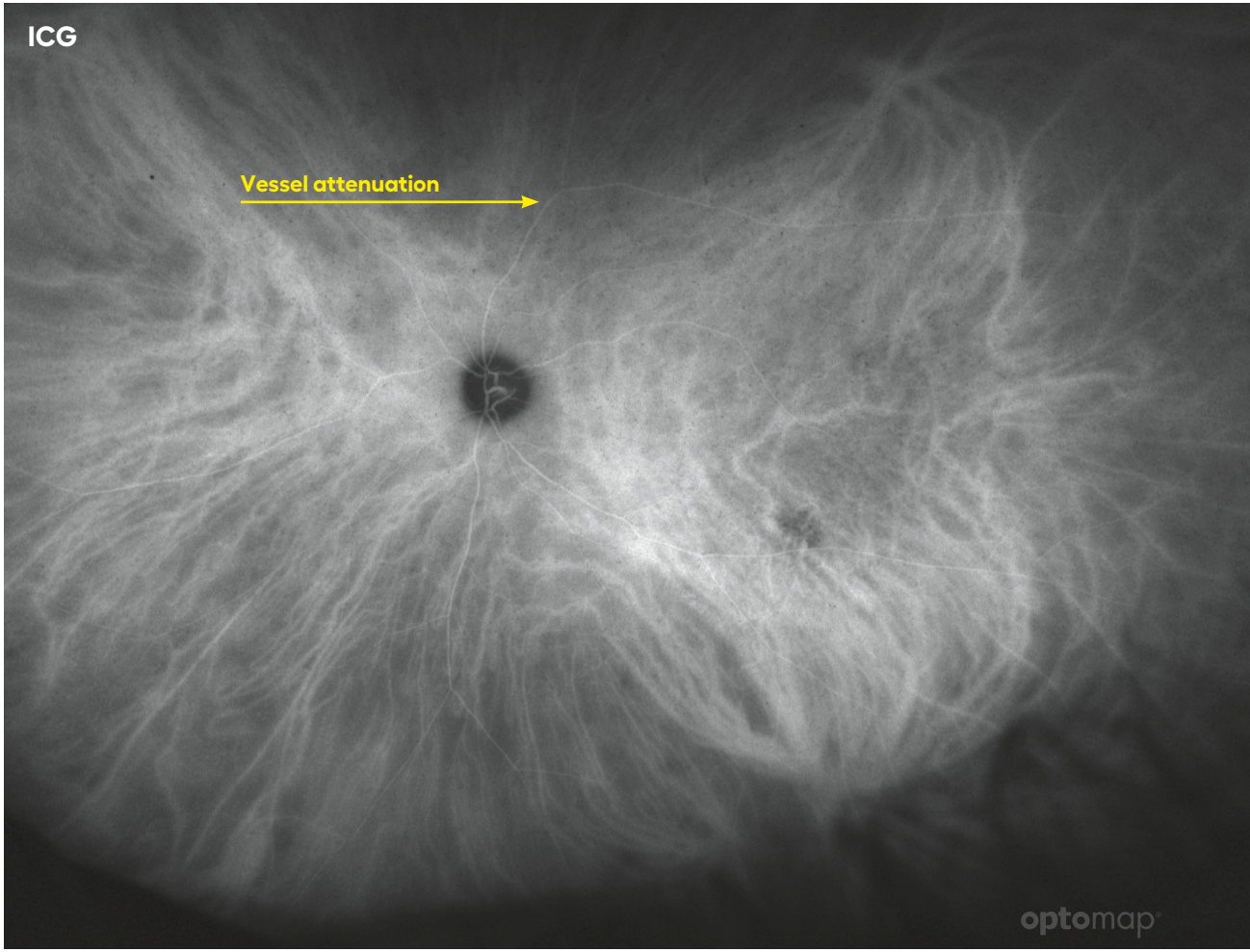
Autoimmune Retinopathy (AIR)

is a rare immune-mediated disease that may cause inflammation from circulating autoantibodies against the retina. It may be related to history of autoimmune disease in the patient or in a family member or the presence of neoplastic disease in the individual.

In autoimmune retinopathy, arteries and veins can appear attenuated as seen on the **opto**map images. ICG angiography is used to rule out inflammatory/vasculitic disease.



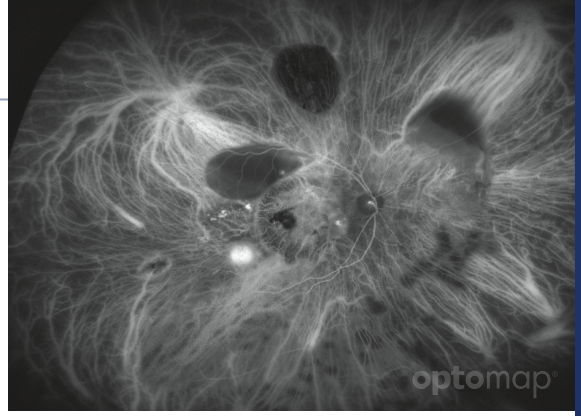


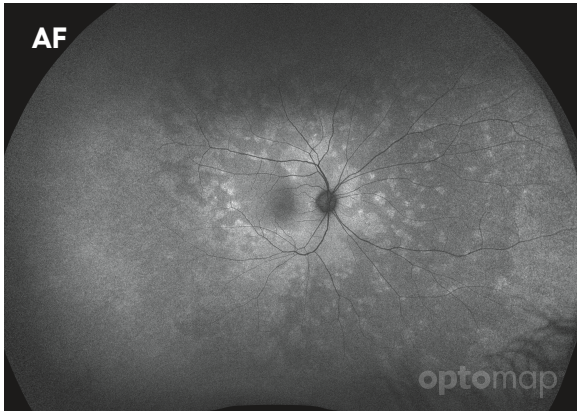


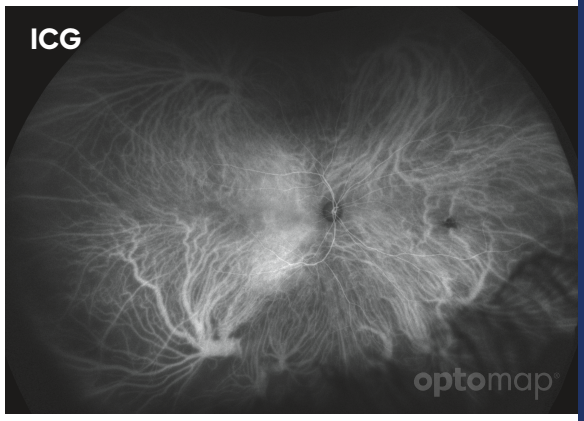
Acute Zonal Occult Outer Retinopathy (AZOOR)

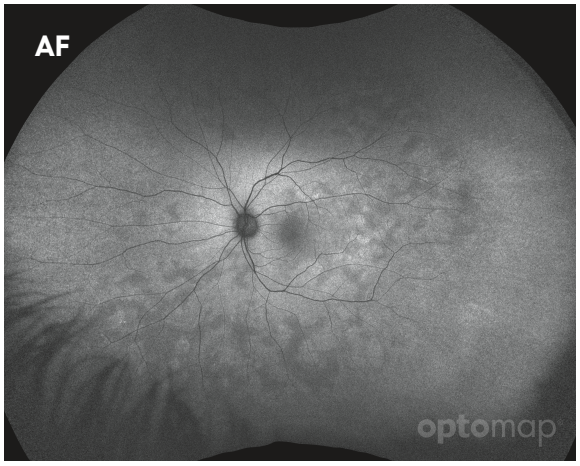
is characterized by a rapid loss of one or more large zones of outer retinal function, and permanent visual field loss that is associated with delayed development of visible atrophic changes in the RPE.

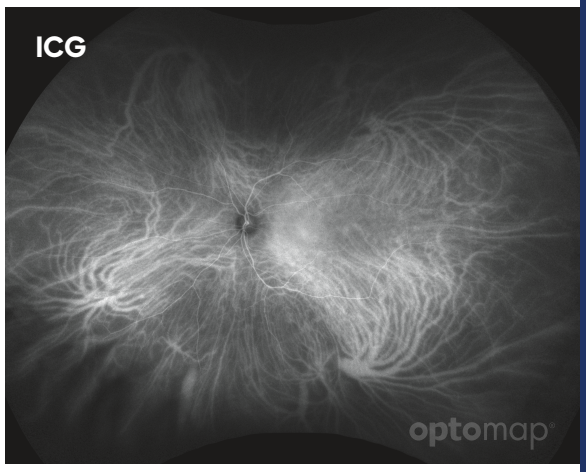
optomap *color* shows hypopigmentation consistent with an inflammatory or infectious process. **opto**map *af* shows hyperautofluorescent lesions that correspond to hypopigmentation on the **opto**map *color* that extend from the posterior pole to the periphery. **opto**map *icg* shows the location of the lesions and may help to rule out vasculitis or inflammatory diseases.





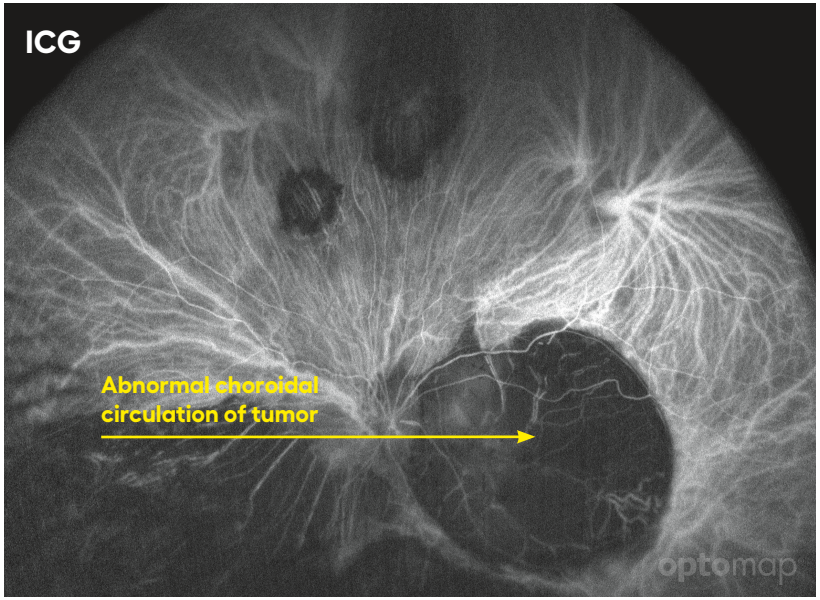


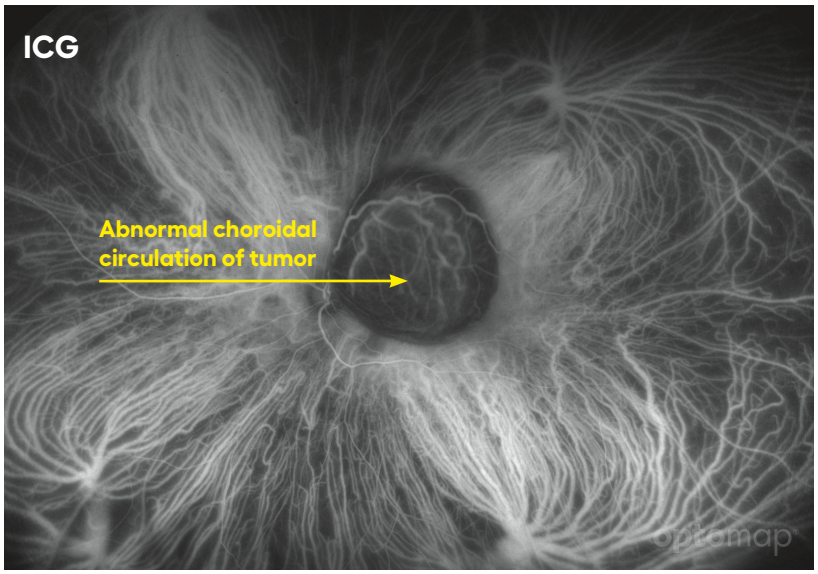




Choroidal Melanoma

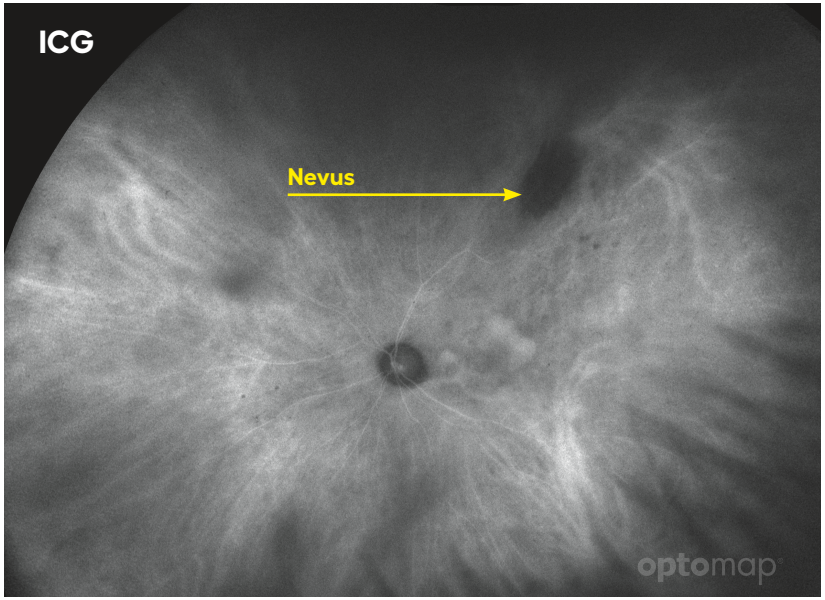
is a malignant tumor derived from pigment cells initiated in the choroid. Fluorescein and ICG angiography can aid in determining the characteristics of the retinal and choroidal circulation around the tumor mass and can confirm the diagnosis.





Choroidal Nevus

is a benign pigmented and nonpigmented lesion (freckle) in the choroid. **opto**map *icg* may be used with multimodal imaging to determine if a suspicious lesion is a nevus or melanoma.



ICG angiography is used to determine if a nevus has a vascular involvement that would indicate it is a melanoma. If it is a melanoma, ICG angiography is used to determine if there is vascular involvement.

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The **opto**map *icg* Diagnostic Atlas: A Retinal Reference Guide
was created by the Optos Clinical Team and reviewed by Rishi Singh, MD

Contact clinical@optos.com for any additional educational questions.

Optos, part of Nikon Healthcare is the leading retinal imaging company committed to saving sight and saving lives worldwide. The company was founded by a father determined to find a better way to detect eye disorders and diseases, following his son`s loss of sight in one eye despite regular eye examinations. Optos has led the field with its high resolution ultra-widefield (UWF) **opto**map imaging, which captures approximately 82% and 200˚ of the retina, something no other device can do in a single image.

Optos has since expanded its unrivaled UWF devices to offer integrated multimodal imaging solutions including Optical Coherence Tomography (OCT), data management software and other offerings to facilitate accessibility in any healthcare setting.

Thousands of published clinical studies have demonstrated the long-term value of **opto**map multimodal imaging in early detection, management and effective treatment of disorders and diseases such as retinal detachments and tears, glaucoma, diabetic retinopathy, and age-related macular degeneration.

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