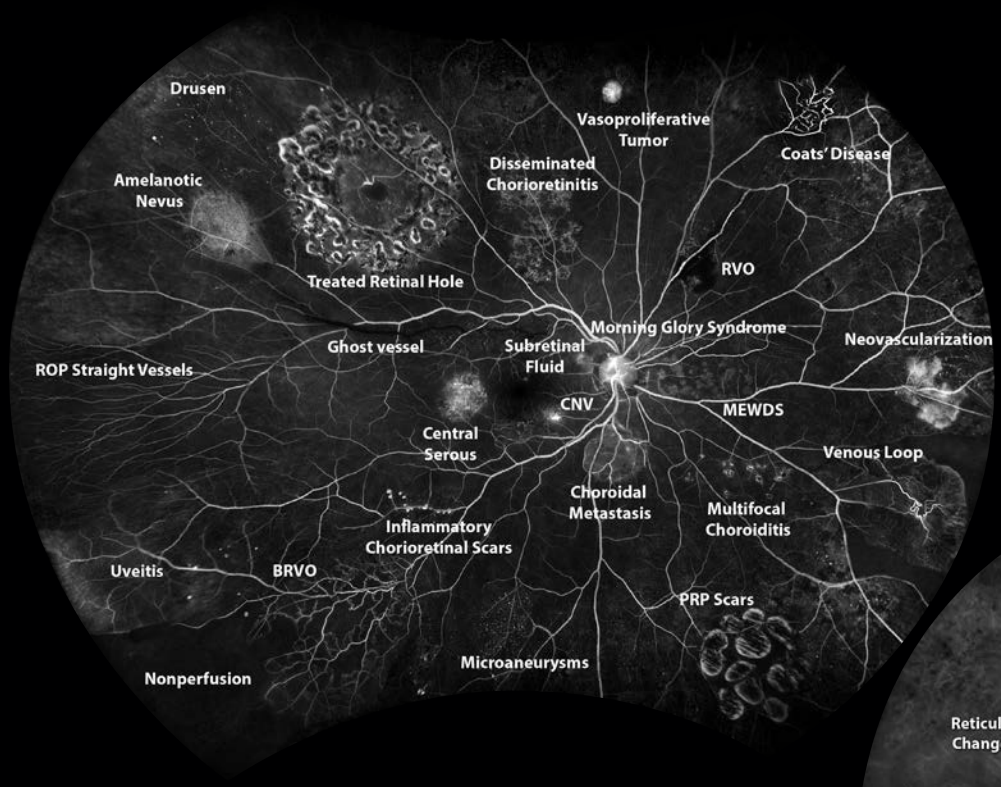
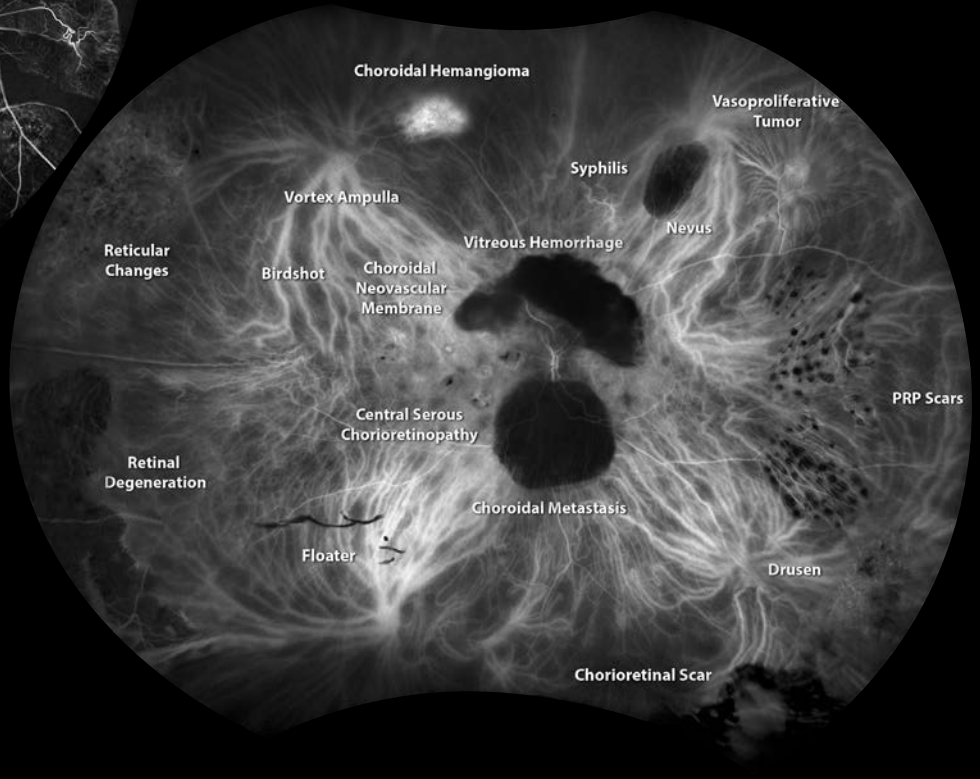
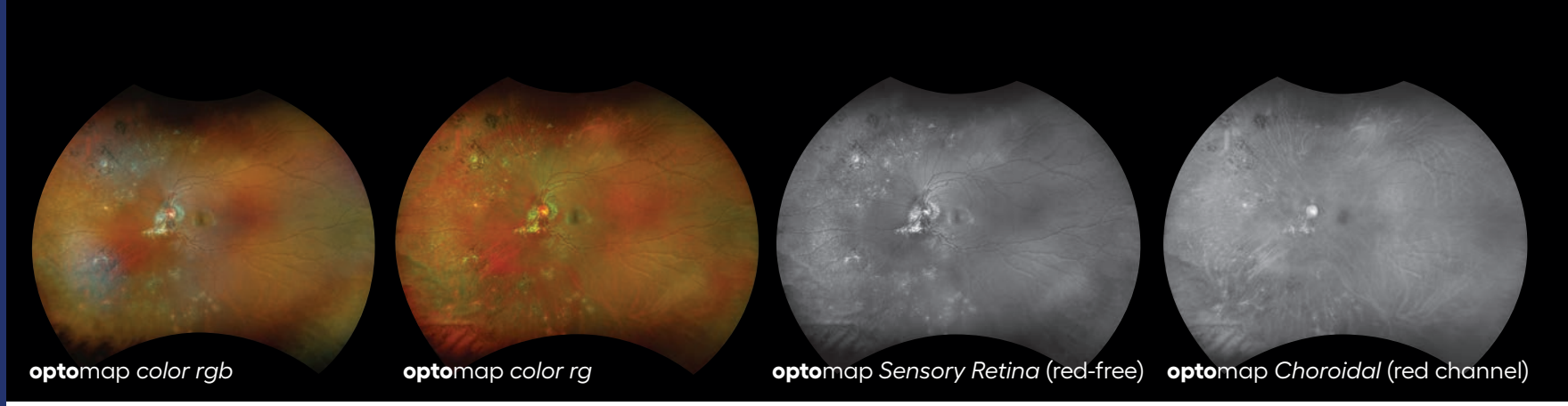

Drusen
Vasoproliferative Tumor
Amelanotic Nevus
Disseminated Chorioretinitis
Coats' Disease
Treated Retinal Hole
RVO
Morning Glory Syndrome
Ghost vessel
Subretinal Fluid
Neovascularization
ROP Straight Vessels
CNV
MEWDS
Central Serous
Venous Loop
Choroidal Metastasis
Multifocal Choroiditis
Inflammatory Chorioretinal Scars
Uveitis
BRVO
PRP Scars
Nonperfusion
Microaneurysms


Choroidal Hemangioma
Vasoproliferative Tumor
Syphilis
Vortex Ampulla
Nevus
Vitreous Hemorrhage
Reticular Changes
Birdshot
Choroidal Neovascular Membrane
PRP Scars
Central Serous Chorioretinopathy
Retinal Degeneration
Choroidal Metastasis
Floater
Drusen
Chorioretinal Scar



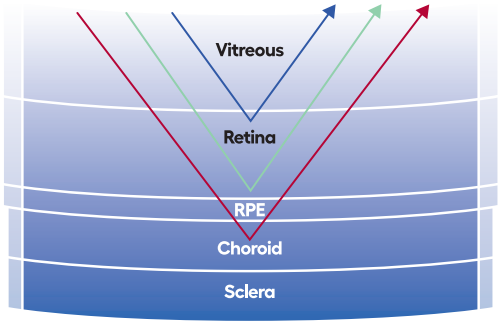
Optos devices produce ultra-widefield (UWF™), high resolution digital images (**opto**map®) of approximately 82% (200°) of the retina, documenting from the macula and beyond the vortex ampullae, something no other device is capable of capturing in a single shot. **opto**map images provide clinical information which facilitates the early detection, management and effective treatment of retinal and systemic diseases. In one capture some Optos devices provide four images: **opto**map *color rgb*, **opto**map *color rg*, **opto**map *Sensory Retina* and **opto**map *Choroidal*.

optomap *color rg* images consist of **opto**map *Sensory Retina* which is a red free image known as the green channel (532nm) visualizing the retinal pigment epithelium (RPE) and **opto**map *Choroidal* or red channel image (635nm) which visualizes the choroidal layer. **opto**map *color rgb* images include a third wavelength, blue (488nm), which provides additional information about vitreoretinal interface, structures anterior to the retina. The composite image consisting of all three wavelengths provides a more natural looking view of the retina.

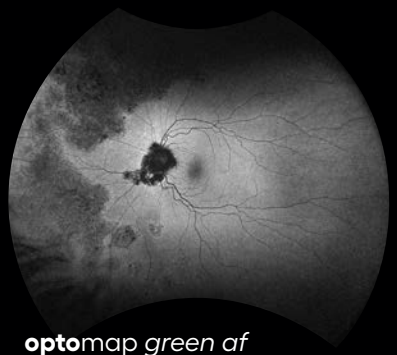
optomap *green af* images are captured using the green wavelength (532nm) and visualize the function of the RPE.

optomap *blue af* images are captured using the blue wavelength (488nm) and visualize the function of the RPE.

optomap Scanning Lasers

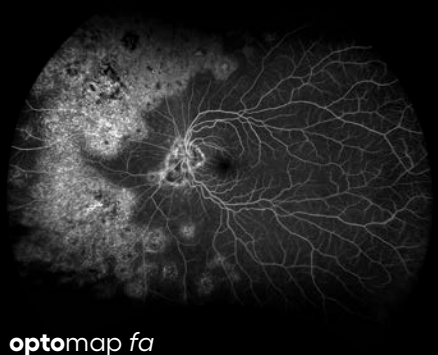


Blue laser (488nm) scans internal limiting membrane and vitreous interface.
Green laser (532nm) laser scans from sensory retina to RPE.
Red laser (635nm) scans from the RPE to the choroid.
Infrared laser (802nm) is used in indocyanine green angiography procedures. *(Not shown graphically)*



optomap *green af*

optomap *blue af*



optomap *fa*

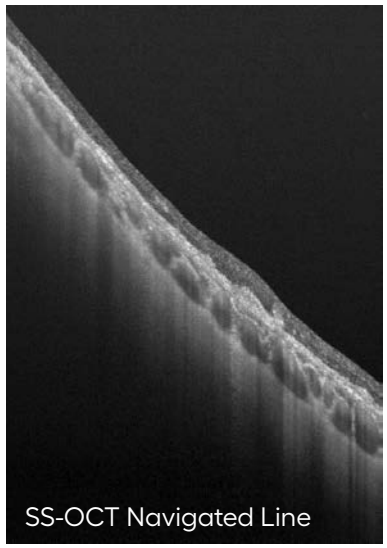
optomap *icg*

optomap *fa* images are captured using the blue wavelength (488nm) to visualize the circulation of the retina vasculature.

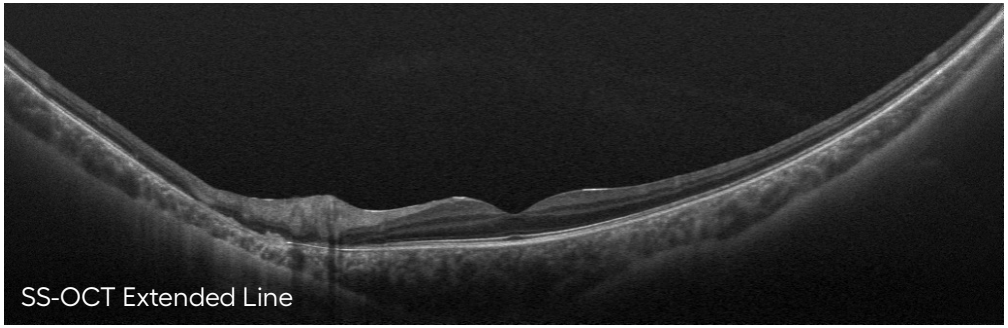
optomap *icg* images are captured using the infrared wavelength (802nm) to visualize the circulation of the choroidal vasculature. Interweave imaging is available to track circulation of the retina and the choroid in tandem.

optomap can be used for planning OCT scans which provide cross sectional views of the retina registered to the **opto**map where nearly all retinal layers can be visualized.

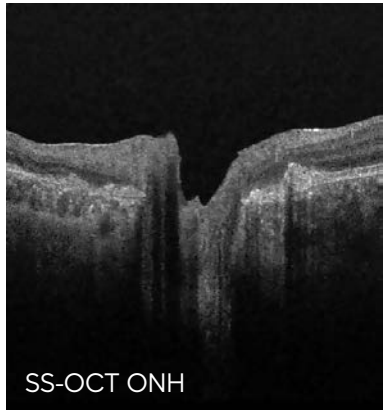
Optos provides two types of OCT technology: an SD-OCT for imaging the central pole in the *MonacoPro* device and an SS-OCT for imaging both the central pole and the peripheral retina, able to capture a scan anywhere within the **opto**map field of view in the *Silverstone RGB* device.



SS-OCT Navigated Line



SS-OCT Extended Line



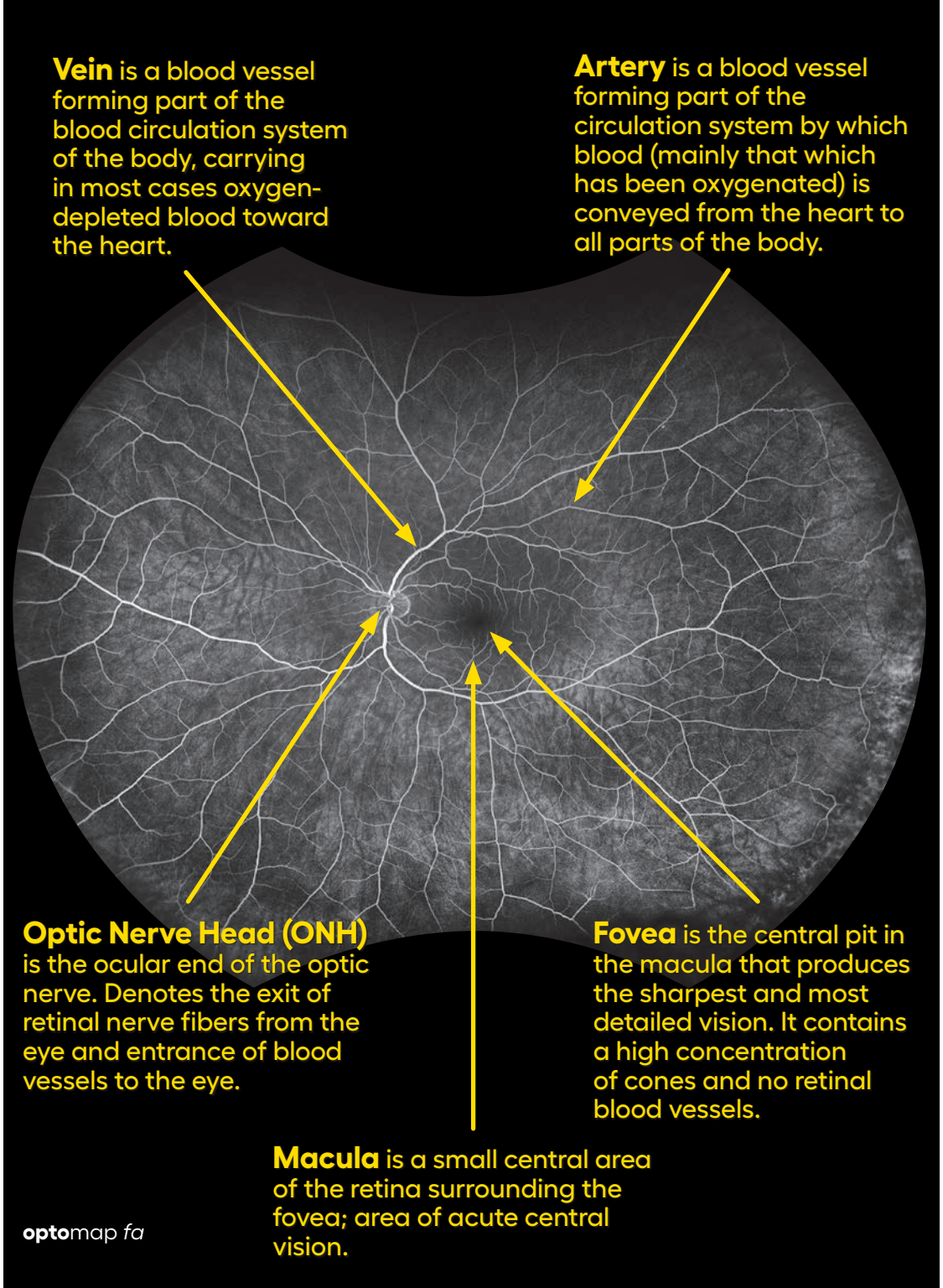
SS-OCT ONH

Retinal Anatomy

The **Retina** is the light-sensitive layer of tissue that lines the inside of the eye and sends visual information 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 providing nourishment to the retina. It can be visualized using the red channel of an **opto**map image or at the very bottom of an OCT scan.

The **Vitreous** is the clear 'jelly' like liquid that fills the eye from the lens to the Internal limiting membrane (ILM).



The **Internal Limiting Membrane (ILM)** is a thin membrane that covers the retinal surface in between the retina and vitreous.

The **Nerve Fiber Layer (NFL)** is made up of nerve fiber bundles which are axons of ganglion cells that carry the visual signal from the ganglion cell in the retina to the brain (forming the optic nerve). It appears as bright bands coming out from the optic nerve on **opto**map or a bright band on top of the retina in OCT.

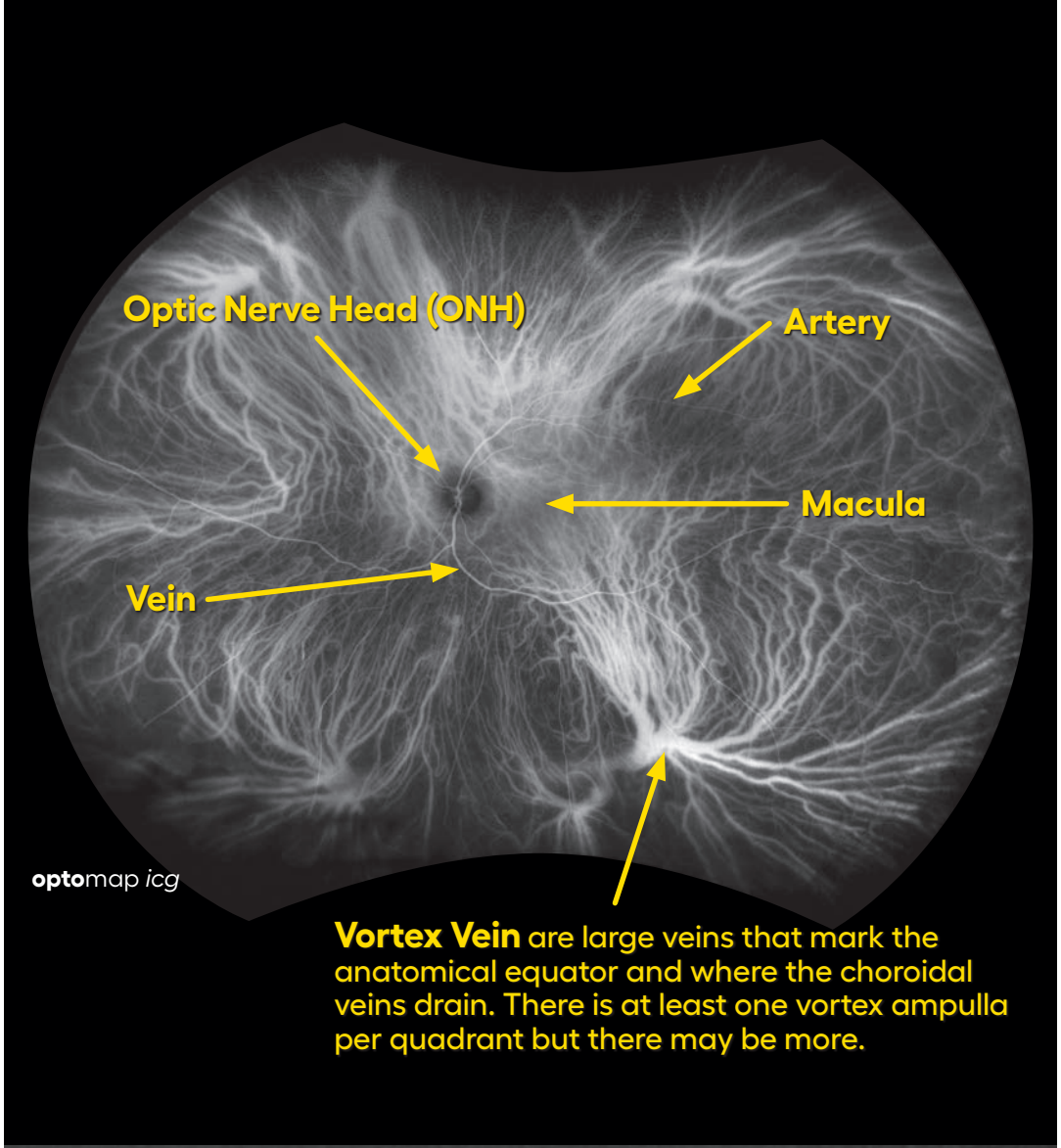
The **Ganglion Cell Layer** is made up of the ganglion cell bodies. It appears as a dark band on the OCT below the NFL.

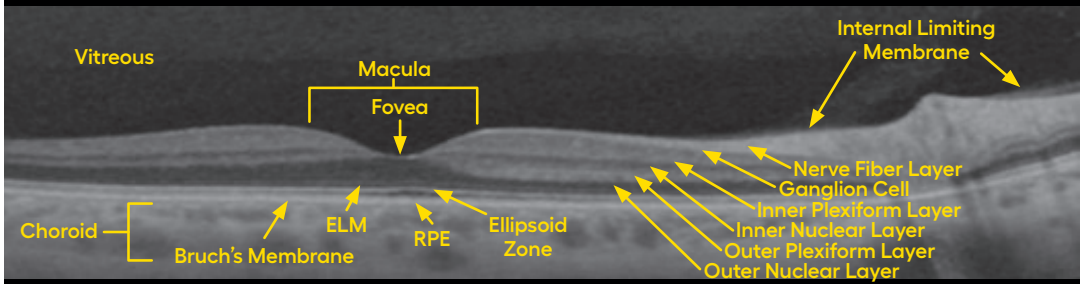
The **Inner Plexiform Layer** consists of ganglion cell dendrites where ganglion cells connect to bipolar cells and amacrine cells. It appears as a bright band on OCT.

The **Inner Nuclear Layer** is where bipolar, horizontal, and amacrine cell bodies are located. It appears as a dark band on OCT.

The **Outer Plexiform Layer** is where bipolar and horizontal cells connect to photoreceptors. It appears as a bright band on OCT.

The **Outer Nuclear Layer** is where photoreceptor cell bodies are located (rods and cones). It appears as a dark band on OCT.





SS-OCT

The **External Limiting Membrane** is a thin layer near the bottom of the retina separating the photoreceptor inner and outer areas from their cell bodies.

The **Ellipsoid Zone** is a bright band that separates the inner and outer areas of photoreceptors (sometimes referred to as the IS/OS border).

The **Retinal Pigment Epithelium (RPE)** is a thin pigmented layer that nourishes the photoreceptor layer. It is visualized on the green channel or red free **opto**map image or as a bright band at the bottom of an OCT just above the Bruch's membrane.

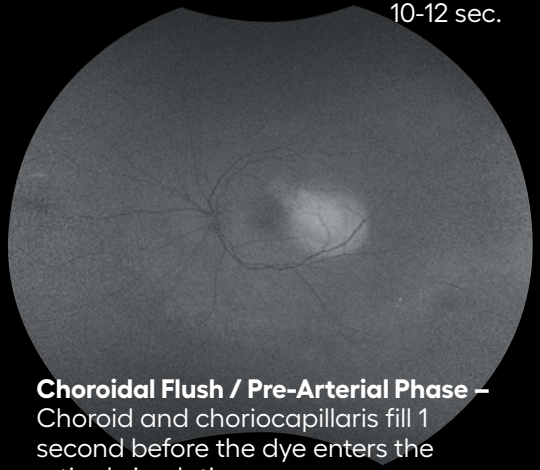
The **Bruch's Membrane** is a thin layer separating the RPE from the choriocapillaris.

Fluorescein Angiography (FA)

images are captured after fluorescein sodium ($C_{20}H_{10}Na_2O_5$), resorcinolphthalein sodium, is injected intravenously into a patient's arm. When the dye is injected and the retina is illuminated with blue light, the dye fluoresces, and exciter and barrier filters are put in place to allow only the fluorescent light to be imaged. The dye absorbs the blue light with an excitation at 465-490nm (blue) and the dye emits the yellow-green wavelength from 520-530nm (yellow-green).

Each image has a timestamp to track the circulation time of the retinal vessels.

10-12 sec.

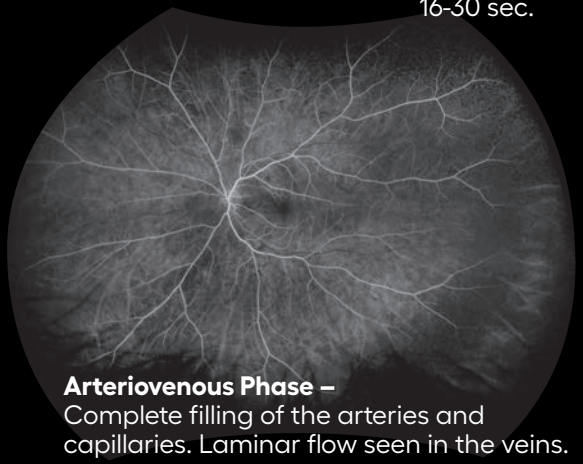


Choroidal Flush / Pre-Arterial Phase – Choroid and choriocapillaris fill 1 second before the dye enters the retinal circulation.

13-15 sec.

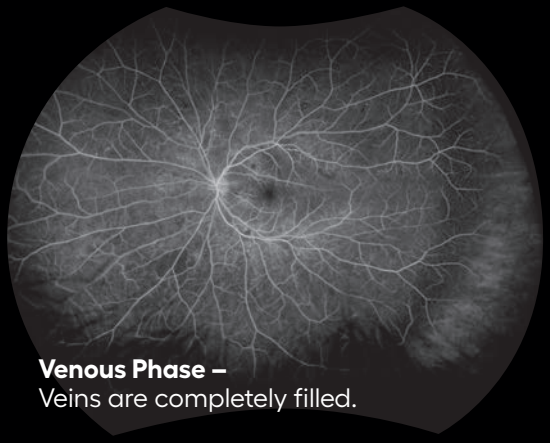
Arterial Phase – Arteries begin to fill.

16-30 sec.



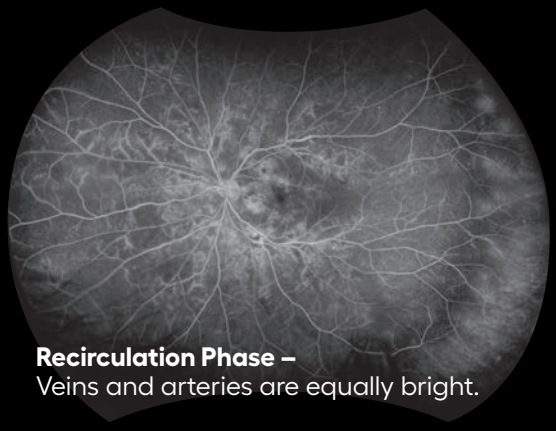
Arteriovenous Phase – Complete filling of the arteries and capillaries. Laminar flow seen in the veins.

30-35 sec.



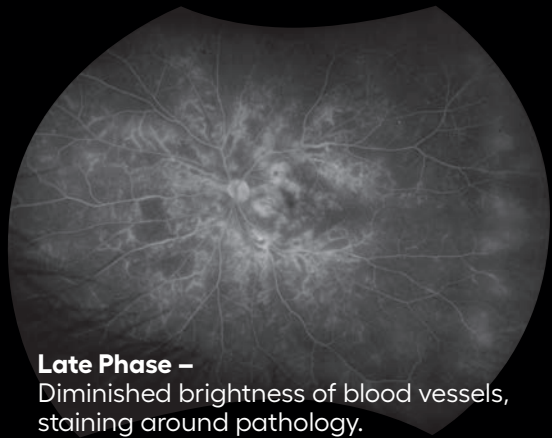
Venous Phase – Veins are completely filled.

2-4 min.



Recirculation Phase – Veins and arteries are equally bright.

5-7 min.



Late Phase – Diminished brightness of blood vessels, staining around pathology.

Image Features of FA

Hyperfluorescence – An increase in the level of fluorescence caused by an abnormality in the RPE which may allow either the dye to pass from the choroid into or under the retina or the fluorescent light from the dye to shine through the RPE.

Staining – Accumulation of dye in what is typically tissue space.

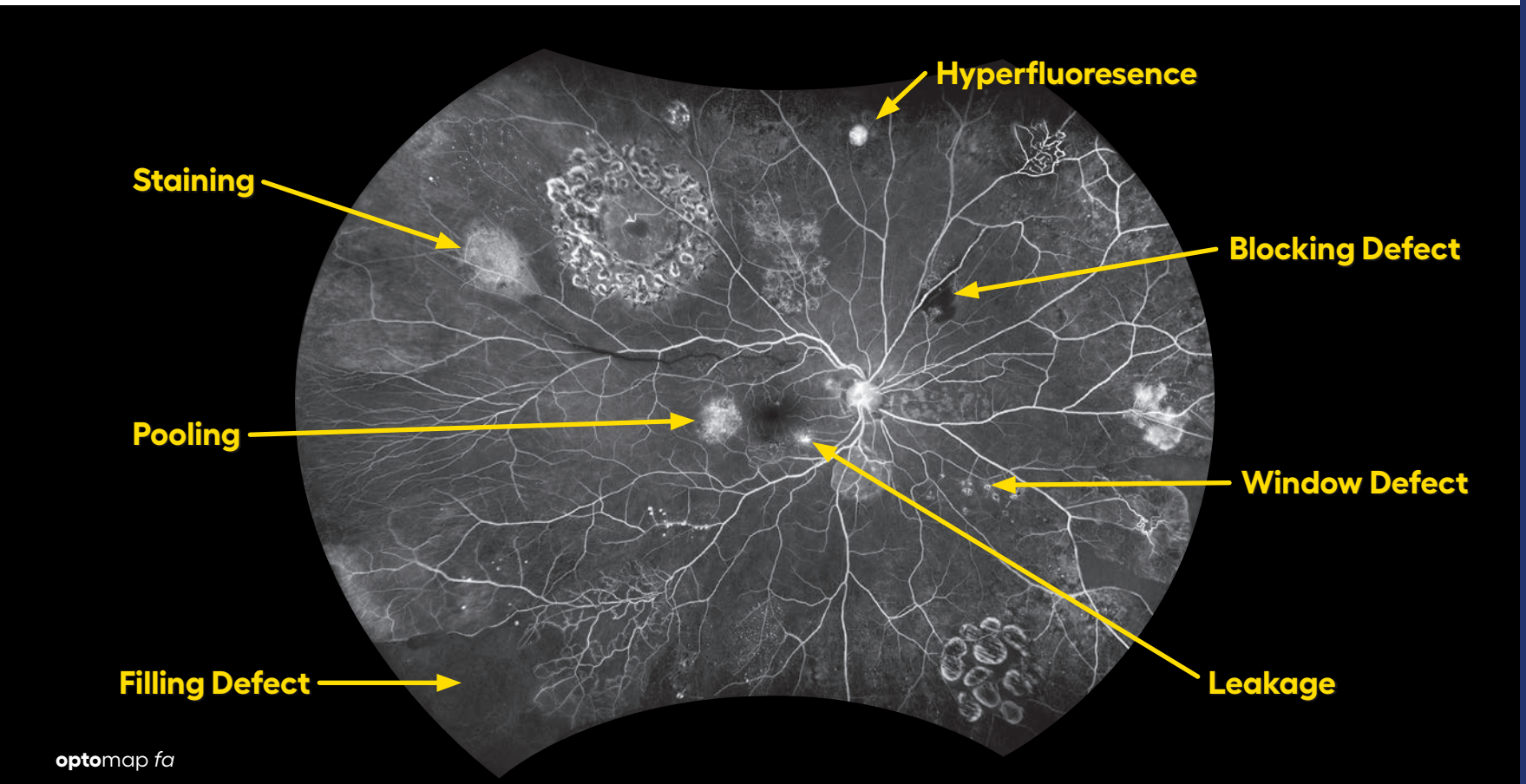
Filling Defect – Area of poor fluorescence caused by abnormal circulation.

Pooling – Accumulation of dye in a fluid-filled space.

Leakage – Passage of dye through a membrane that normally cannot be penetrated.

Blocking Defect – Absence or marked decrease of fluorescence observed in an area that would normally show fluorescence.

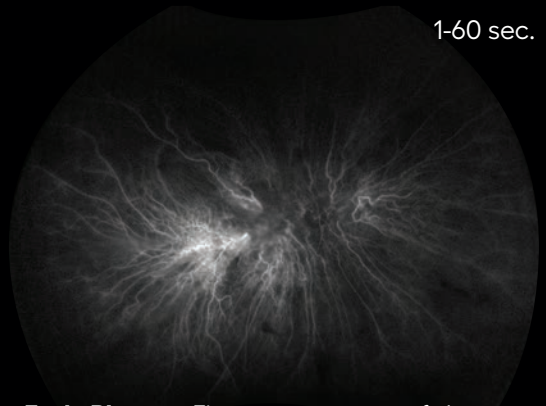
Window/Transmission – RPE that no longer has sufficient melanin to block fluorescence from the underlying choriocapillaris.



images are captured using the infrared wavelength (802nm) to visualize the circulation of the choroidal vasculature. Indocyanine green (ICG) fluoresces between 790-805nm, with a peak absorption around 800nm and emission around 830nm. The dye is injected intravenously and is comprised of a concentration of ICG and sodium iodide. Upon injection, images are captured and each image has a timestamp to track the circulation time of the choroidal vessels.

ICG Phases

1-60 sec.

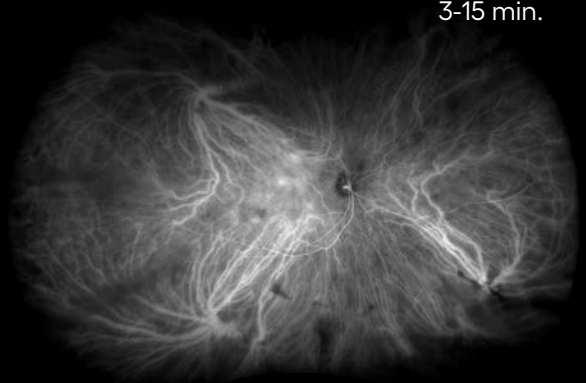


Early Phase – First appearance of dye in choroidal arteries, retinal arteries and veins are dark.

1-3 min.

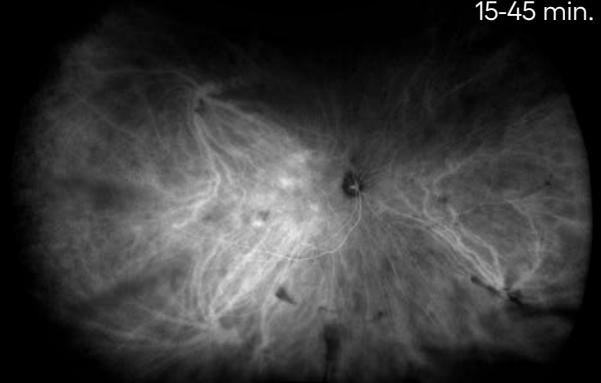
Early-Mid Phase – Dye filling in choroidal veins and retinal vessels.

3-15 min.



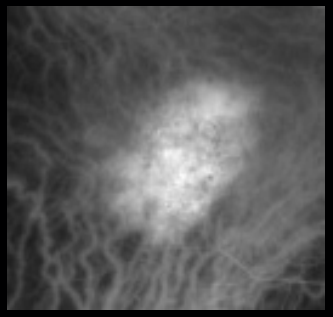
Late-Mid Phase – Choroidal vessels fading and retinal vessels still visible.

15-45 min.



Late Phase – Hypocyanescent choroidal vessels and gradual fading of hypercyanescence.

ICG Image Features



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

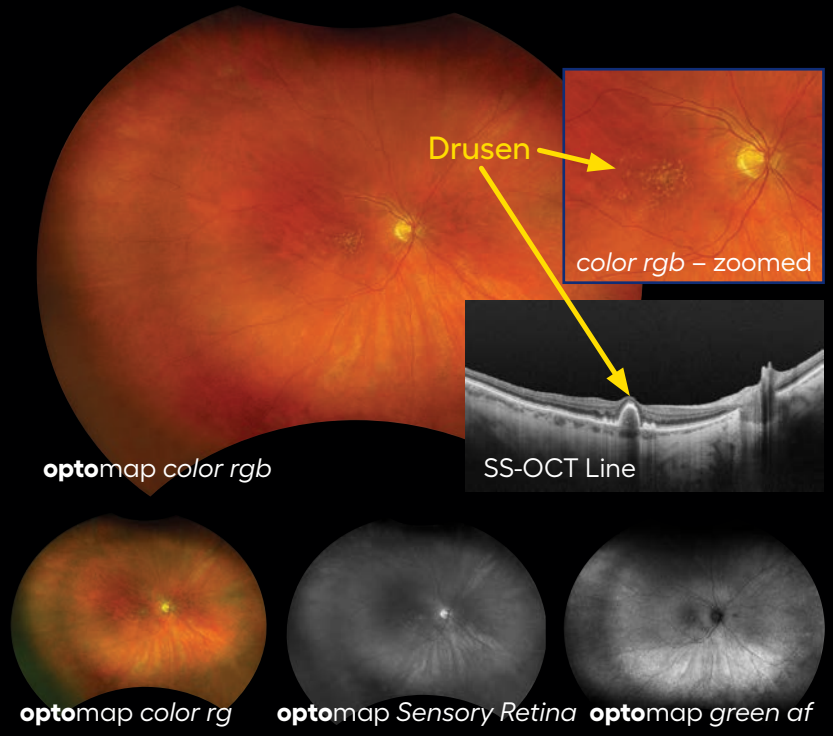
Hypocyanescence is the decreased fluorescence of indocyanine green dye in the choroidal circulation observed during ICG angiography.

Age-Related Macular Degeneration (AMD)

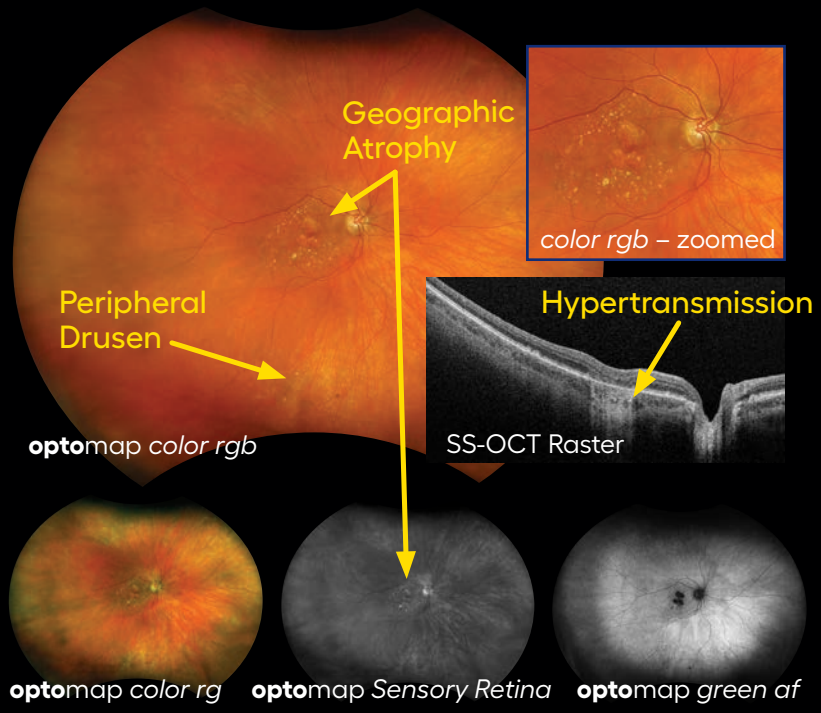
is a common eye disease in older individuals that involves deterioration of the macula, resulting in loss of sharp, central vision. Optos devices allow for UWF assessment of this condition which impacts the retina and choroid as research has found up to 97% of patients have AMD-associated pathology in the retinal periphery and may be more than a "macular" condition but one that involves the entire retina.[1]

Non-exudative or **Dry AMD** is when geographic atrophy (GA) or drusen are present on the RPE layer.

Drusen are small lipid deposits on Bruch's membrane or RPE. Multimodal imaging is critical for understanding structure-function relationship with drusen appearing as yellow spots on the **opto**map *color* images, hyperfluorescent on **opto**map *af* and white bumps on OCT.



GA occurs when the RPE is atrophic and no longer functioning. This causes the photoreceptors to die resulting in vision loss. GA appears on **opto**map *af* as hypofluorescence, and on OCT as a hyperreflective 'band' below the RPE layer. Angiography may also be used to rule out exudation.

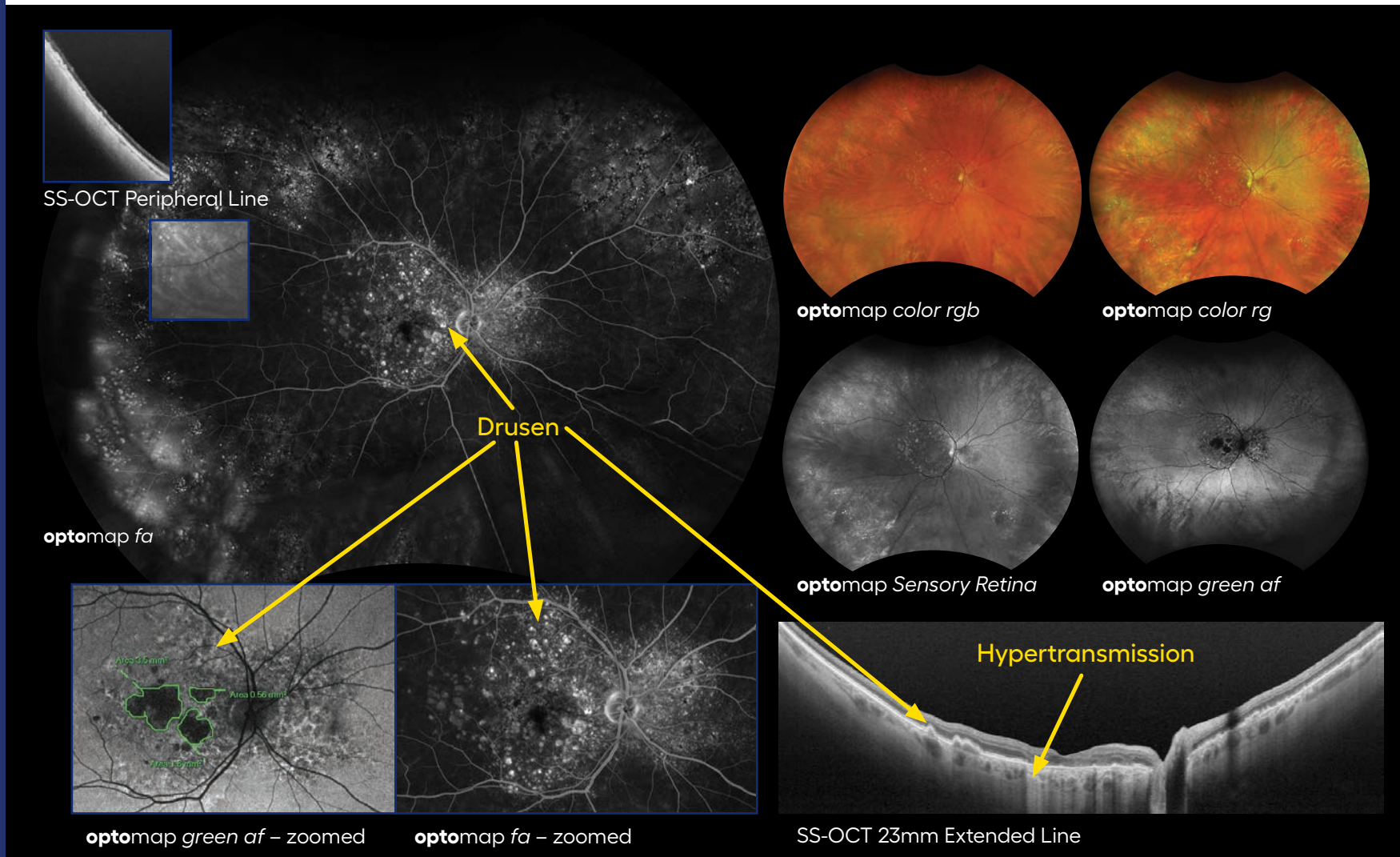


1. Friberg. Peripheral Retinal Changes Associated with Age-Related Macular Degeneration in the Age-Related Eye Disease Study 2. Ophthalmology, 2016.

Geographic Atrophy

is displayed in this case through the hyper-reflective band centrally present on the UWF SS-OCT line scan and drusen are captured superotemporally on the navigated line scan. **opto**map *fa* shows staining of drusen and RPE atrophy in the central pole as well as the peripheral retina.

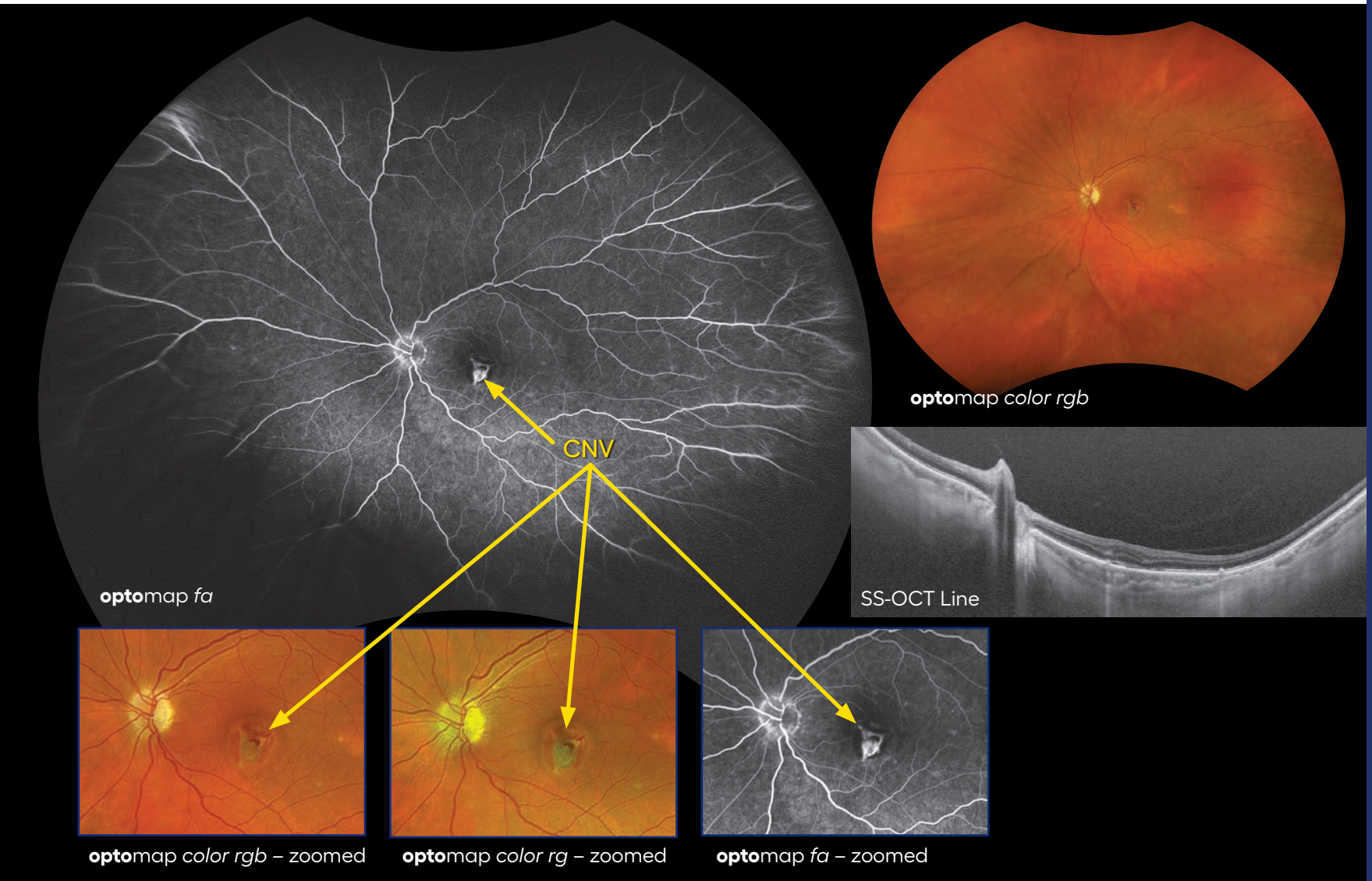
Optos*Advance*™ has validated measurement tools which allow for precise assessment of lesion size which easily demonstrates change over time.



Wet AMD

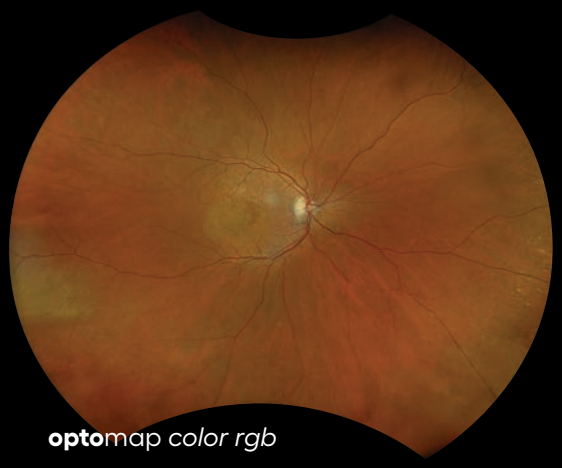
is when there is choroidal neovascularization (CNV) present in or below the retina. These new vessels leak fluid into the retina causing edema and can lead to vision loss. **opto**map *fa* can demonstrate neovascularization in the central pole and leakage peripherally.

Choroidal Neovascular Membrane (CNV, CNVM) is associated with AMD and has two types: classic and occult. In **opto**map *fa*, classic CNV will typically appear in the early phase with a well-defined area of hyperfluorescence. Occult CNV may be poorly defined, and areas of neovascularization are fuzzy, bright hyperfluorescent regions.

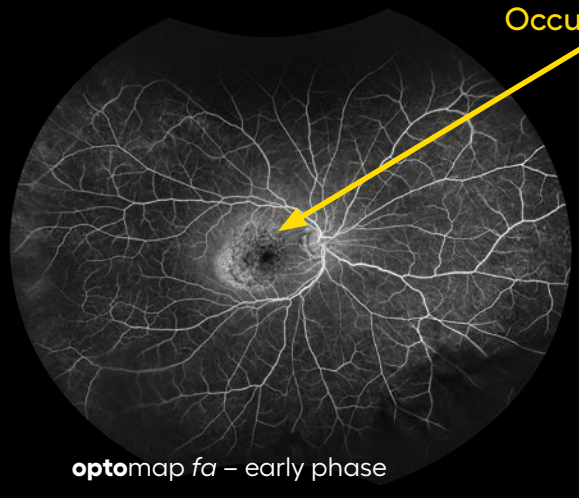


Wet AMD

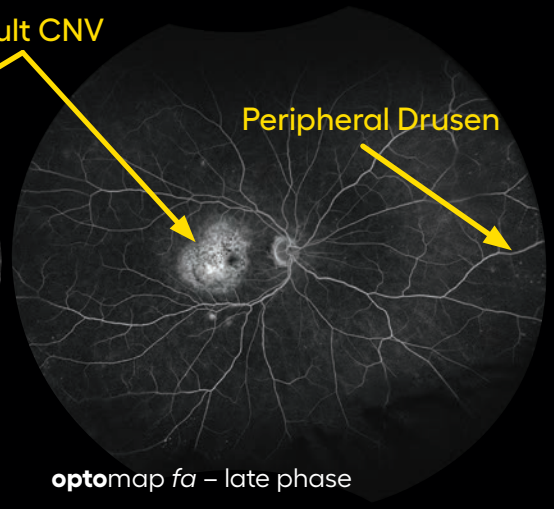
captured on **opto**map *color rgb* and **opto**map *color rg* can be used to document baseline pigmentary changes in the macula and monitor for progression over time. **opto**map *fa* supports differentiation and classification of exudative AMD by allowing for detection of neovascularization. SS-OCT can be used to visualize intraretinal and subretinal fluid as well as photoreceptor loss, and like UWF color imaging, monitor for progression over time.



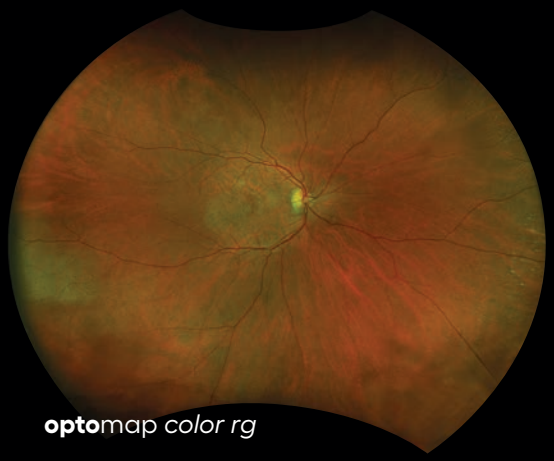
optomap *color rgb*



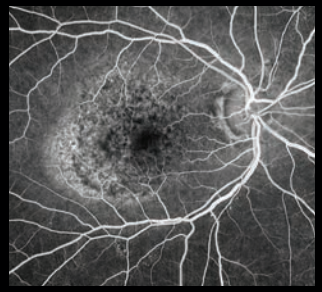
optomap *fa* – early phase



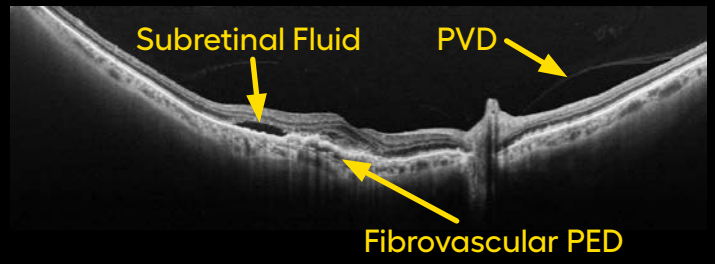
optomap *fa* – late phase



optomap *color rg*



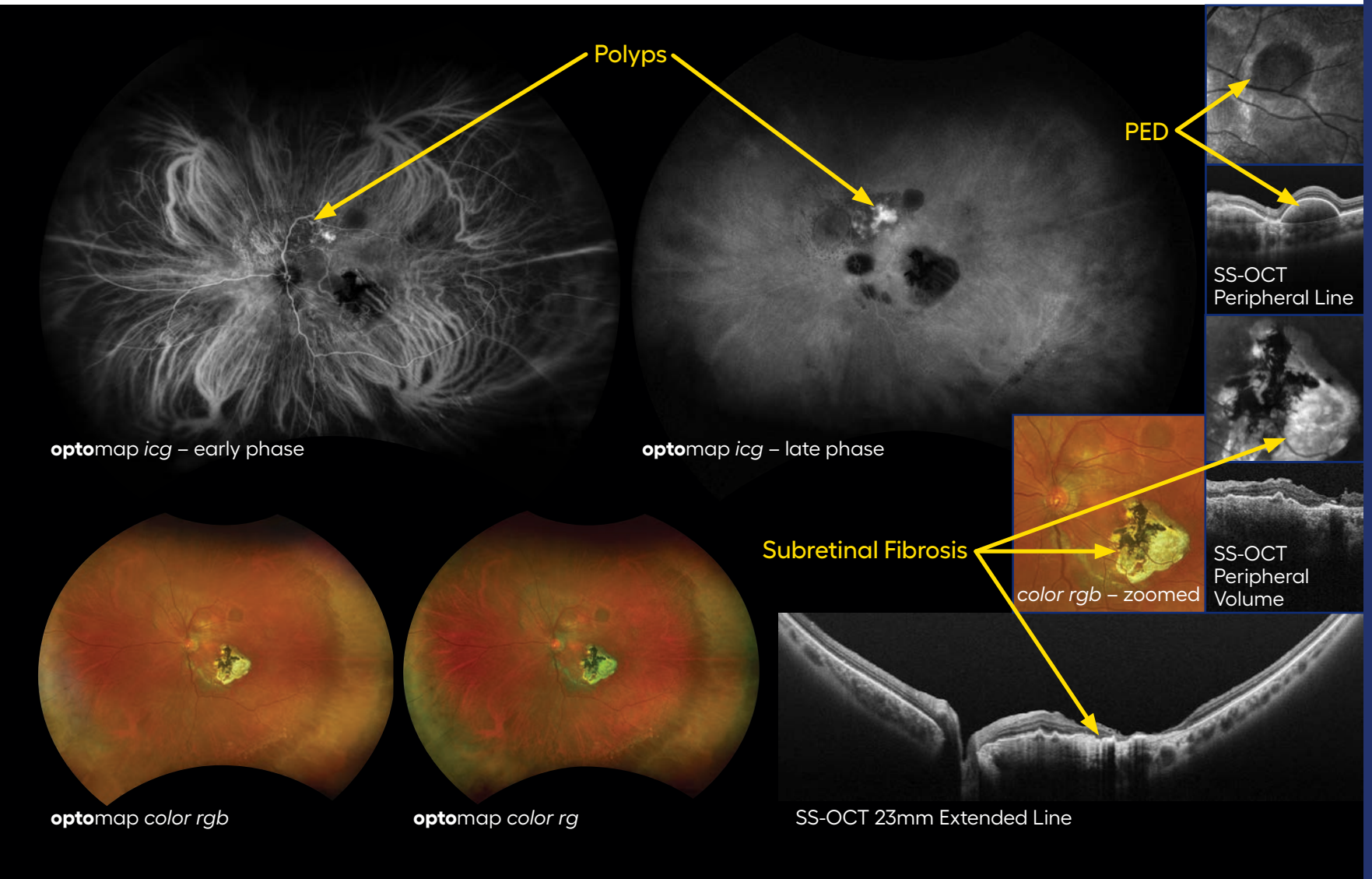
fa – early phase – zoomed



SS-OCT 23mm Extended Line

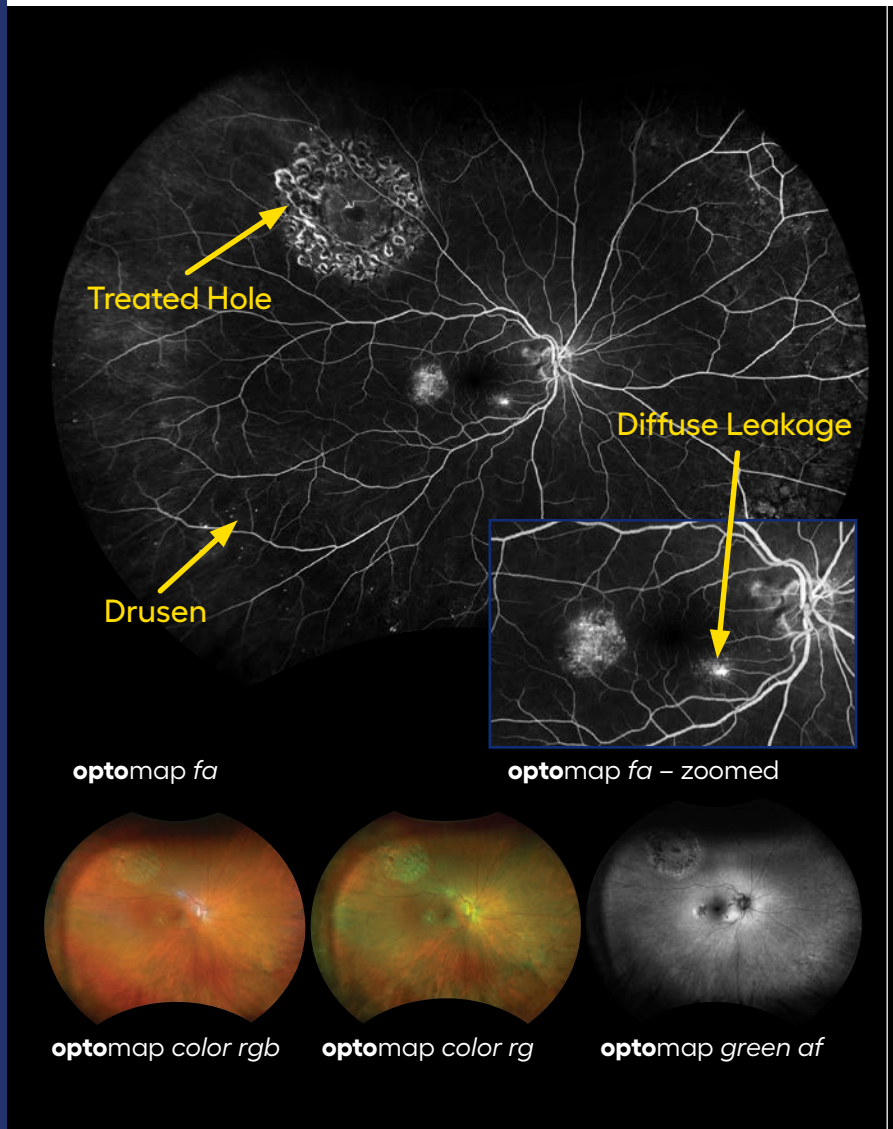
Polypoidal Choroidal Vasculopathy (PCV)

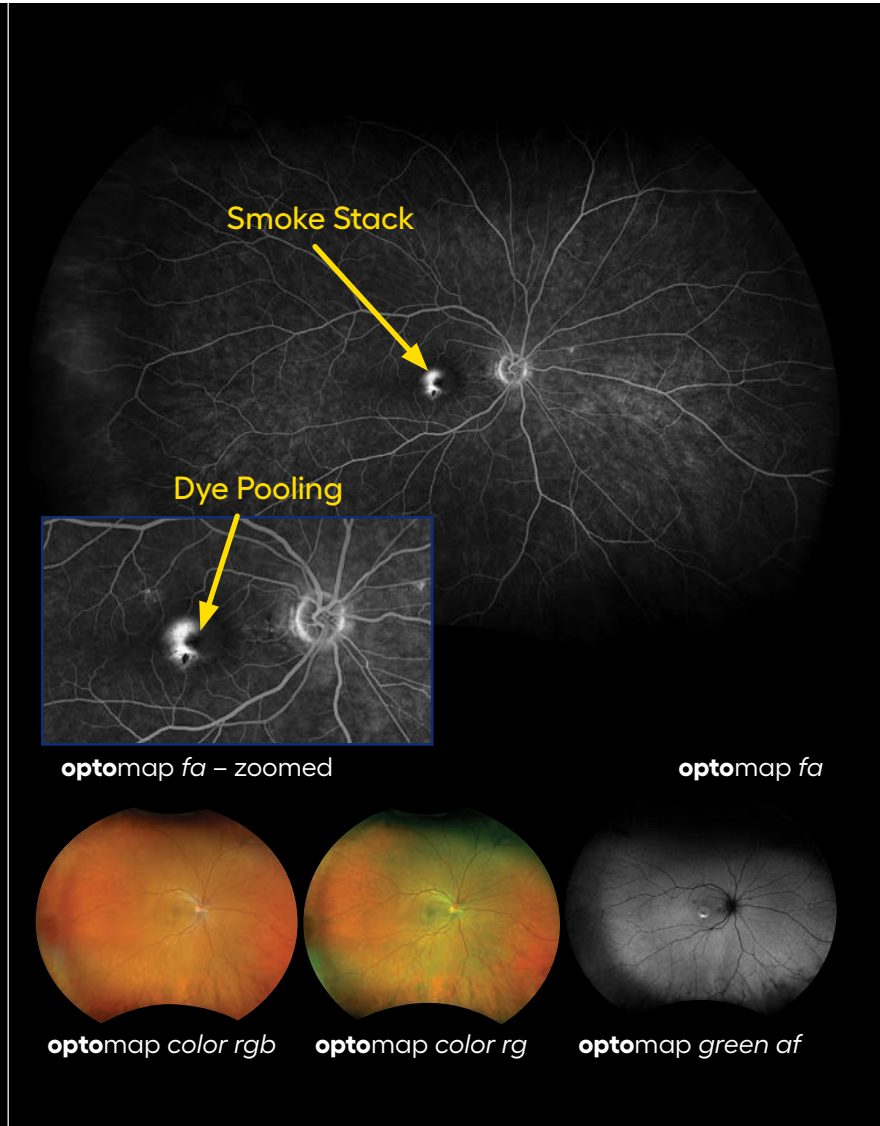
is a phenotype of AMD affecting the choroidal vasculature and is characterized by serosanguineous pigment epithelial detachments (PEDs) and exudative changes that typically lead to subretinal fibrosis. **opto**map *color rgb* and **opto**map *color rg* reveal lesions growing into the subretinal space from the choroid and can capture associated findings such as hemorrhagic and exudative detachments of the retina and RPE. **opto**map *icg* supports differentiation of PCV from other types of neovascularization with polyps presenting as focal hyperfluorescent spots. SS-OCT can be used to identify subretinal fluid and visualize polypoidal lesions appearing as dome-like elevations of the RPE with moderate internal reflectivity.



Central Serous Retinopathy, Serous Chorioretinopathy (CSR)

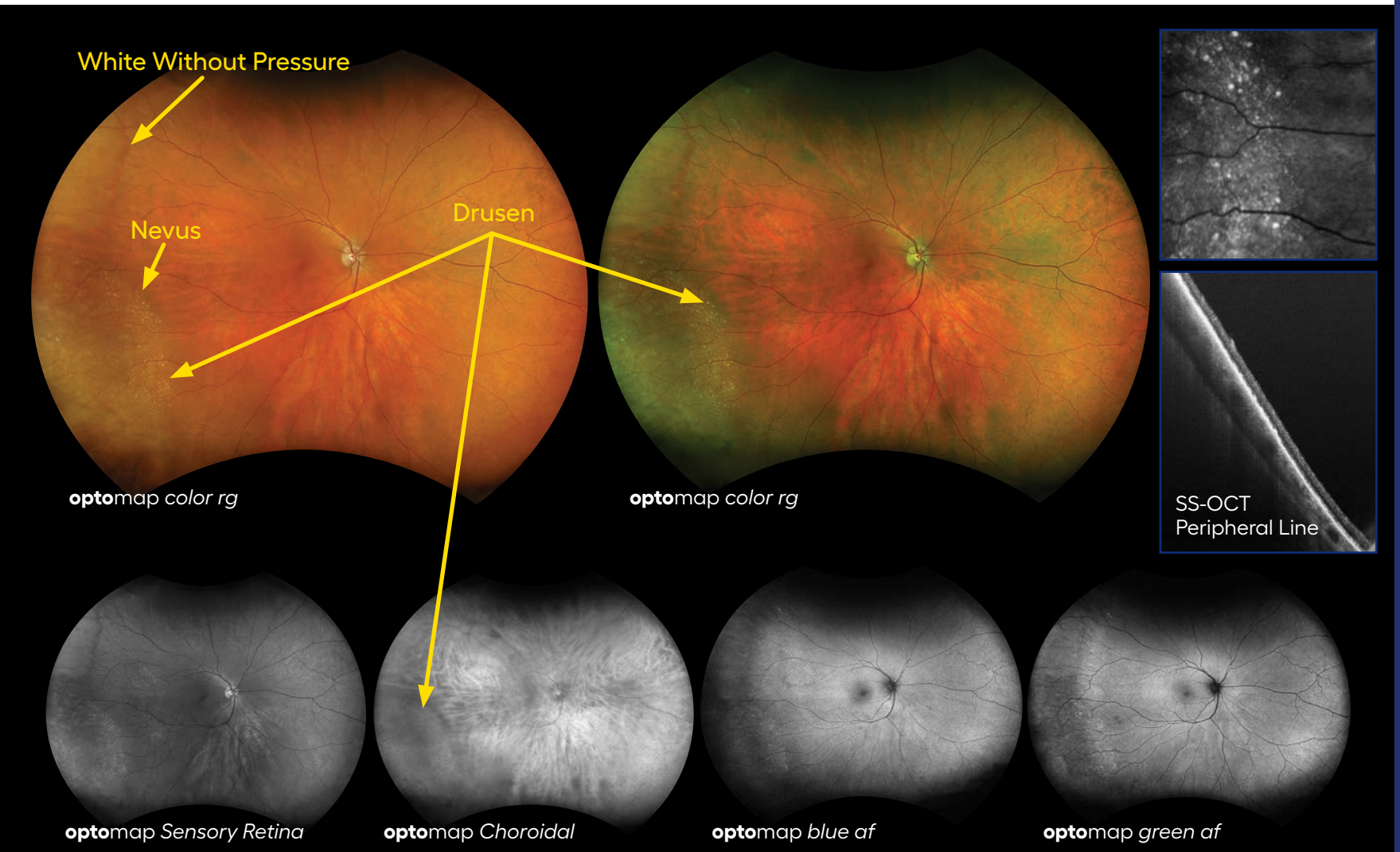
is a blister-like elevation of the sensory retina in the macula, with a localized detachment from the pigment epithelium, visualized below on **opto**map *color rgb*, **opto**map *color rg* and **opto**map *af*. **opto**map *fa* often shows an inkblot appearance and is used to rule out subretinal neovascularization. OCT may be helpful in cases that show equivocal signs on clinical examination.





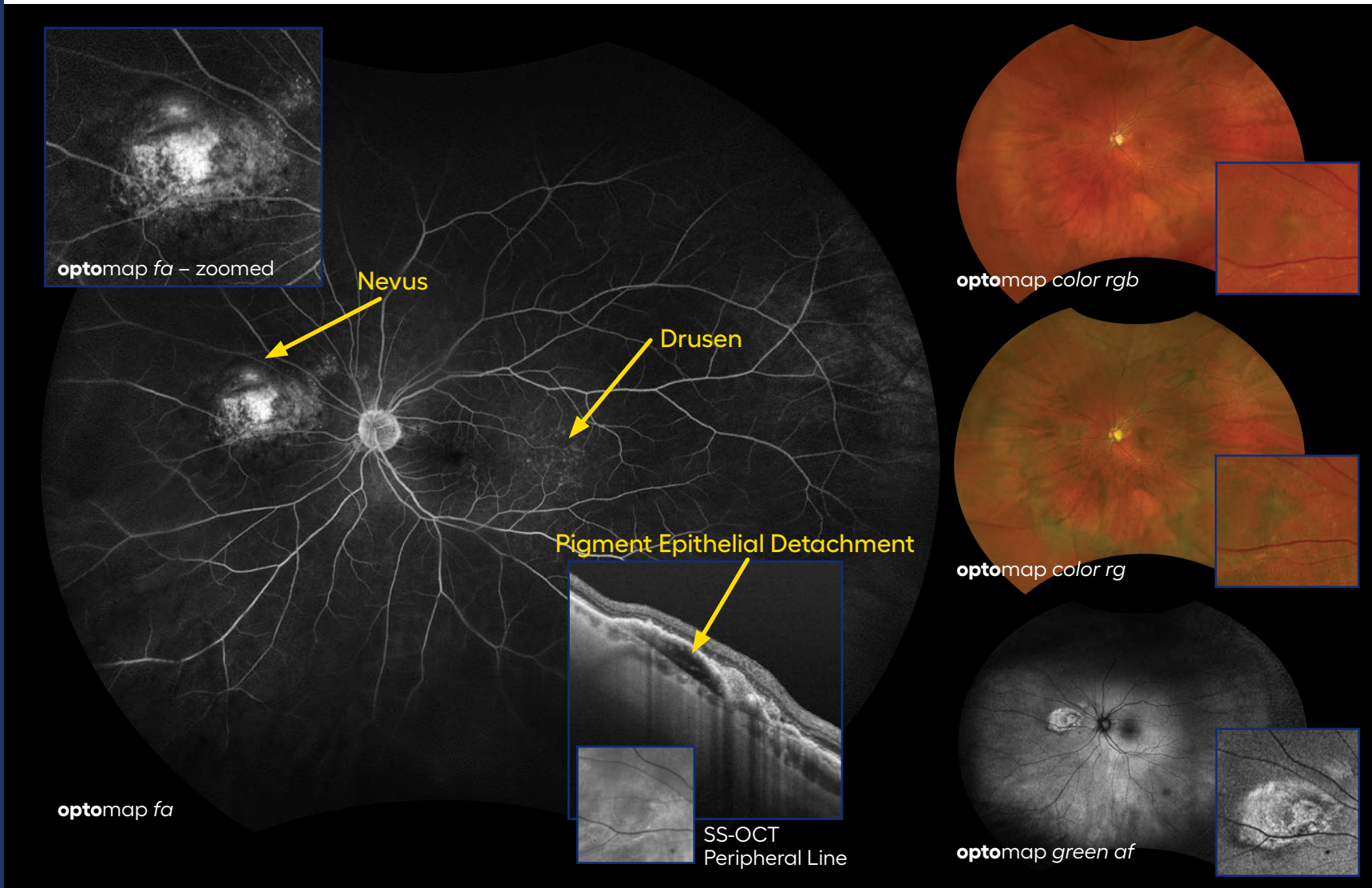
Choroidal Nevus

is a well-circumscribed, benign melanocytic tumor that is typically less than 2mm thick, asymptomatic and with overlying retinal pigment epithelial atrophy and drusen. **opto**map *color rgb*, **opto**map *color rg*, **opto**map *af* as well as SS-OCT can be used for the sequential monitoring of associated high risk characteristics including lesion size, thickness and internal circulation to rule out malignant transformation.



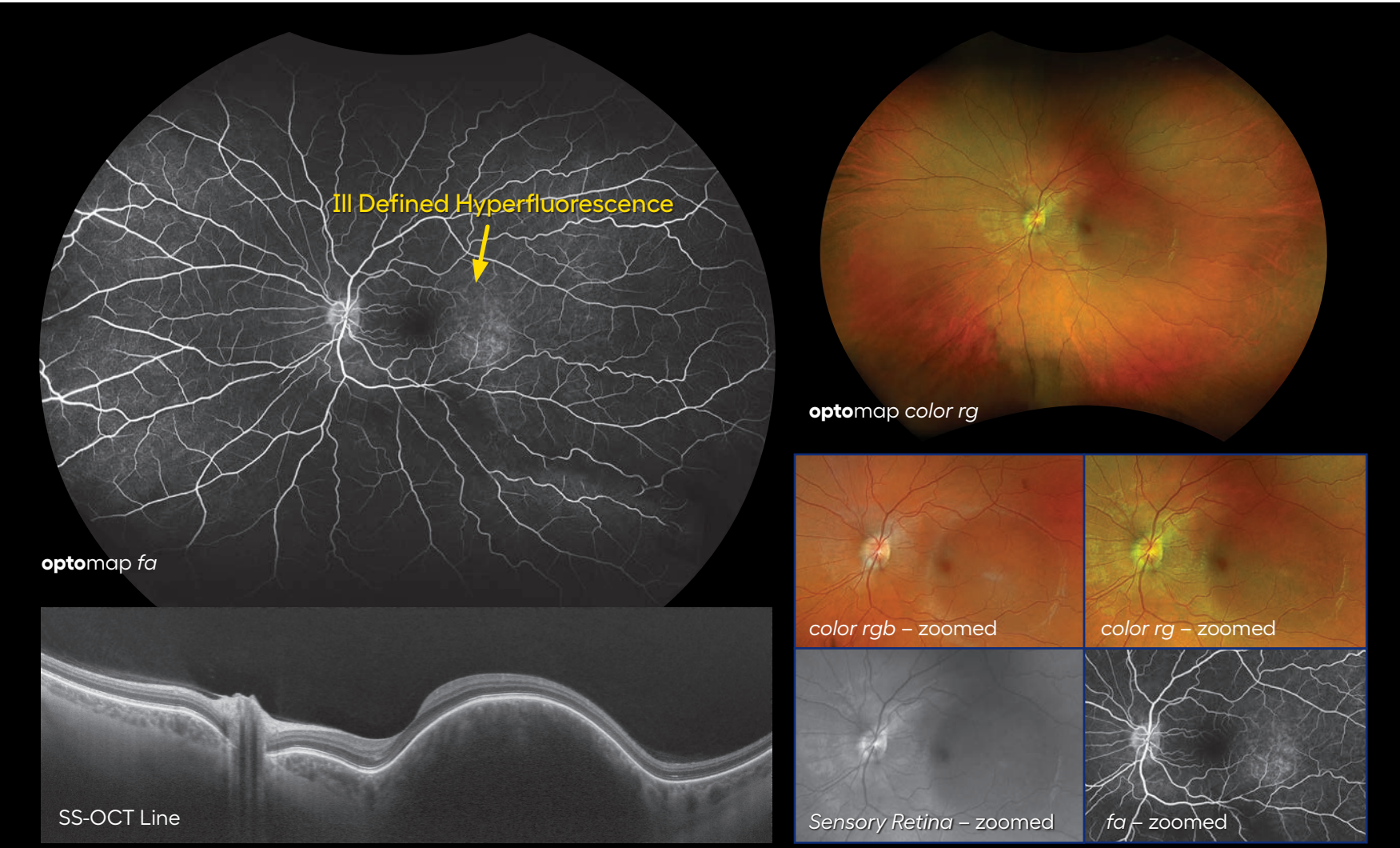
Ectopic Choroidal Neovascularization (CNV)

also known as peripheral exudative hemorrhagic chorioretinopathy, is an exudative process similar to that of wet AMD but occurring in the retinal periphery and can masquerade as a choroidal mass or uveal melanoma. **opto**map *color rgb*, **opto**map *color rg*, **opto**map *af* and **opto**map *fa* circumvent the challenges of visualizing these peripheral lesions with *Silverstone RGB* guided SS-OCT further supporting the evaluation of subretinal fluid in order to manage treatment planning.



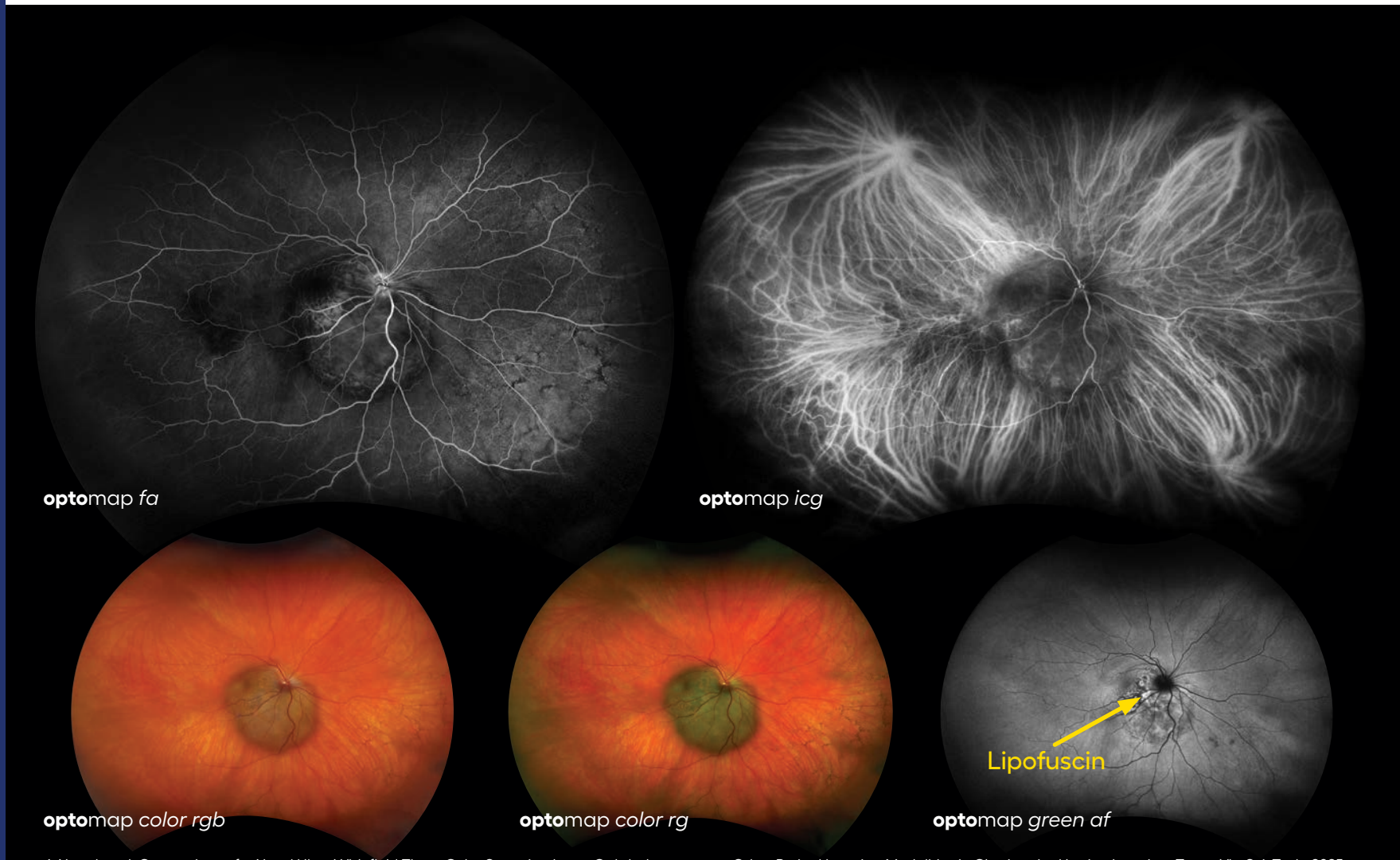
Choriodal Hemangioma

is a benign hamartomatous disorder that is usually first noted when it produces visual symptoms secondary to an accumulation of serous subretinal fluid and or degenerative changes in the macula. **opto**map *color rgb* and **opto**map *color rg* visualize this local dome-shaped orange-red choroidal mass. **opto**map *fa* typically shows early hyperfluorescence of larger-caliber choroidal blood vessels and stains the entire lesion and any subretinal fluid. SS-OCT can be used to evaluate for subretinal fluid, retinal edema and photoreceptor loss, as well as monitor pre and post treatment.



Choriodal Melanoma

arises from the pigmented cells of the choroid of the eye and is not a tumor that started somewhere else and spread to the eye. **opto**map *color rgb* captures the true color information of the tumor with **opto**map *color rg* improving visualization of the lesion's borders.[1] **opto**map *af* provides information about metabolic activity. **opto**map *fa* and **opto**map *icg* can aid in determining the characteristics of the retinal and choroidal circulation around the mass.

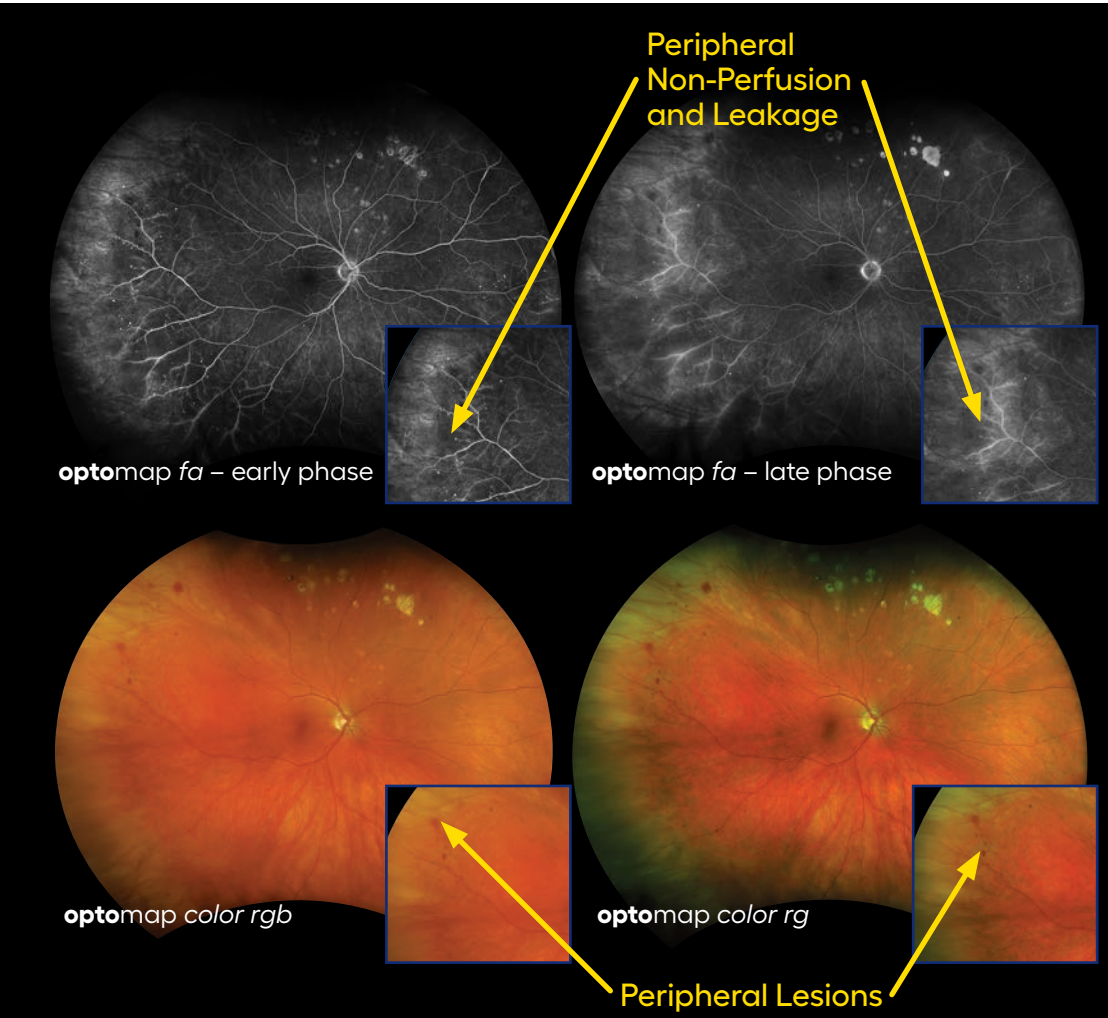


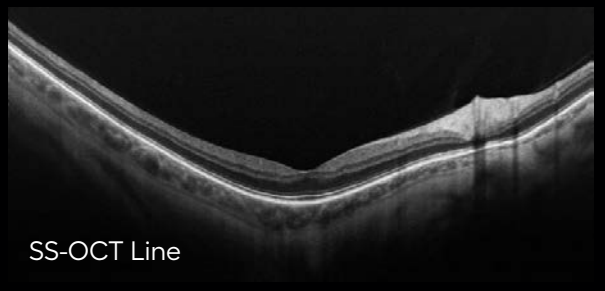
1. Nagel et al. Comparison of a Novel Ultra-Widefield Three-Color Scanning Laser Ophthalmoscope to Other Retinal Imaging Modalities in Chorioretinal Lesion Imaging. Trans. Vis. Sci. Tech. 2025.

Diabetic Retinopathy (DR)

is an ocular disease caused by diabetes mellitus with stages ranging from mild to severe, which can lead to vision loss. **Non-Proliferative Diabetic Retinopathy (NPDR)** is the early stage of diabetic retinopathy where there is no neovascularization (NVE), but there are other lesions such as hemorrhages and microaneurysms.

In this case, peripheral non-perfusion and leakage on **opto**map *fa* correspond with the peripheral lesions seen on the color images. While the posterior pole does not show clinically significant diabetic retinopathy findings, these multimodal peripheral findings suggest high risk of progression.[1]



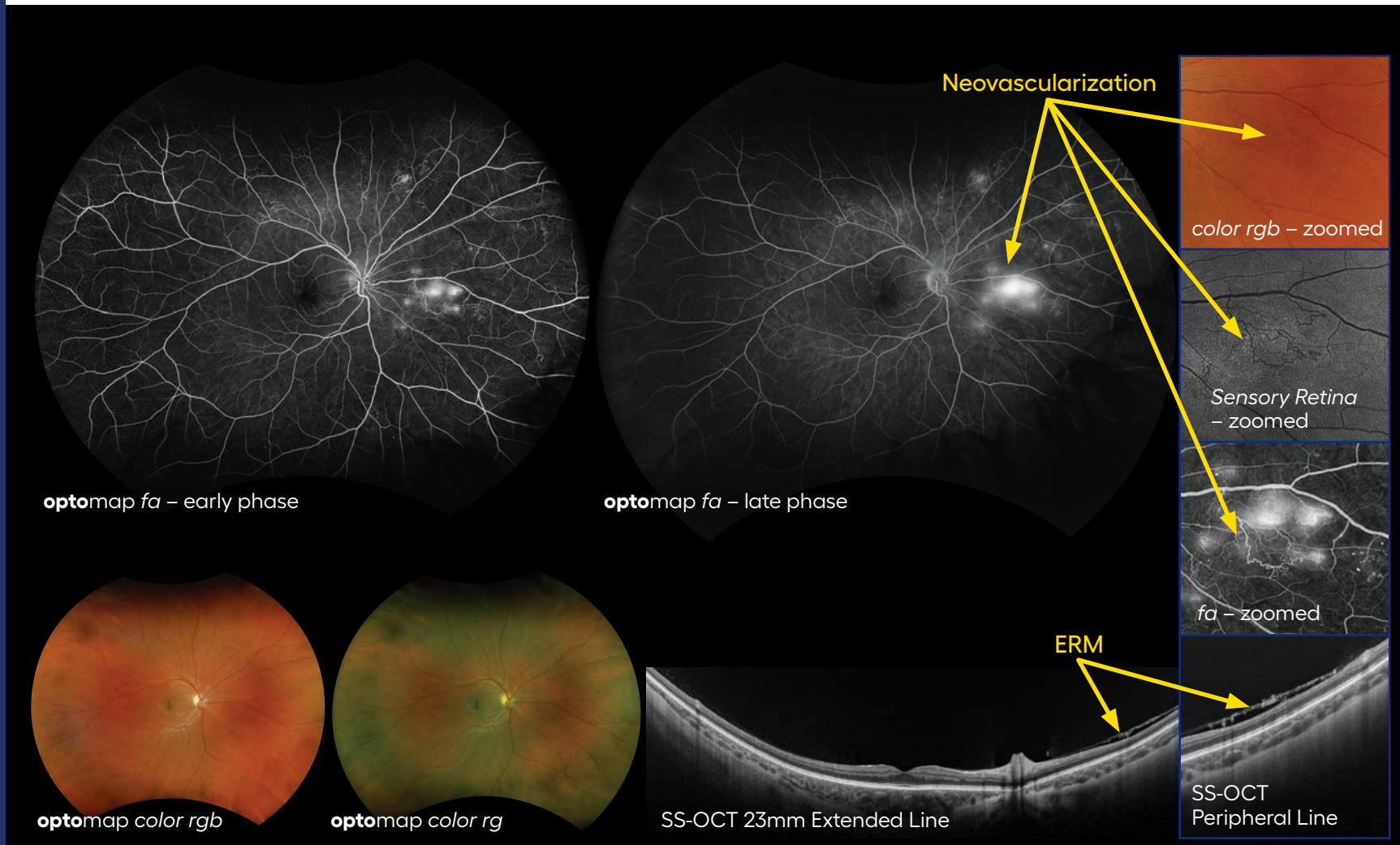


Detection of lesions across the retina beyond the field captured by ETDRS is supported by **opto**map *color rgb* and **opto**map *color rg*. Research has found that peripheral lesions should be assessed for accurate classification of diabetic retinopathy severity and risk of progression.[1] **opto**map *fa* can visualize the macular detail as well as capture the full extent of peripheral nonperfusion and microaneurysms present in one image.
SS-OCT can be conducted to evaluate for diabetic macular edema and may be used to differentiate NVE from IRMA.

1. Marcus et al. Association of Predominantly Peripheral Lesions on Ultra-Widefield Imaging and the Risk of Diabetic Retinopathy Worsening Over Time. JAMA Ophthalmol. 2022 Oct 1;140(10):946-954

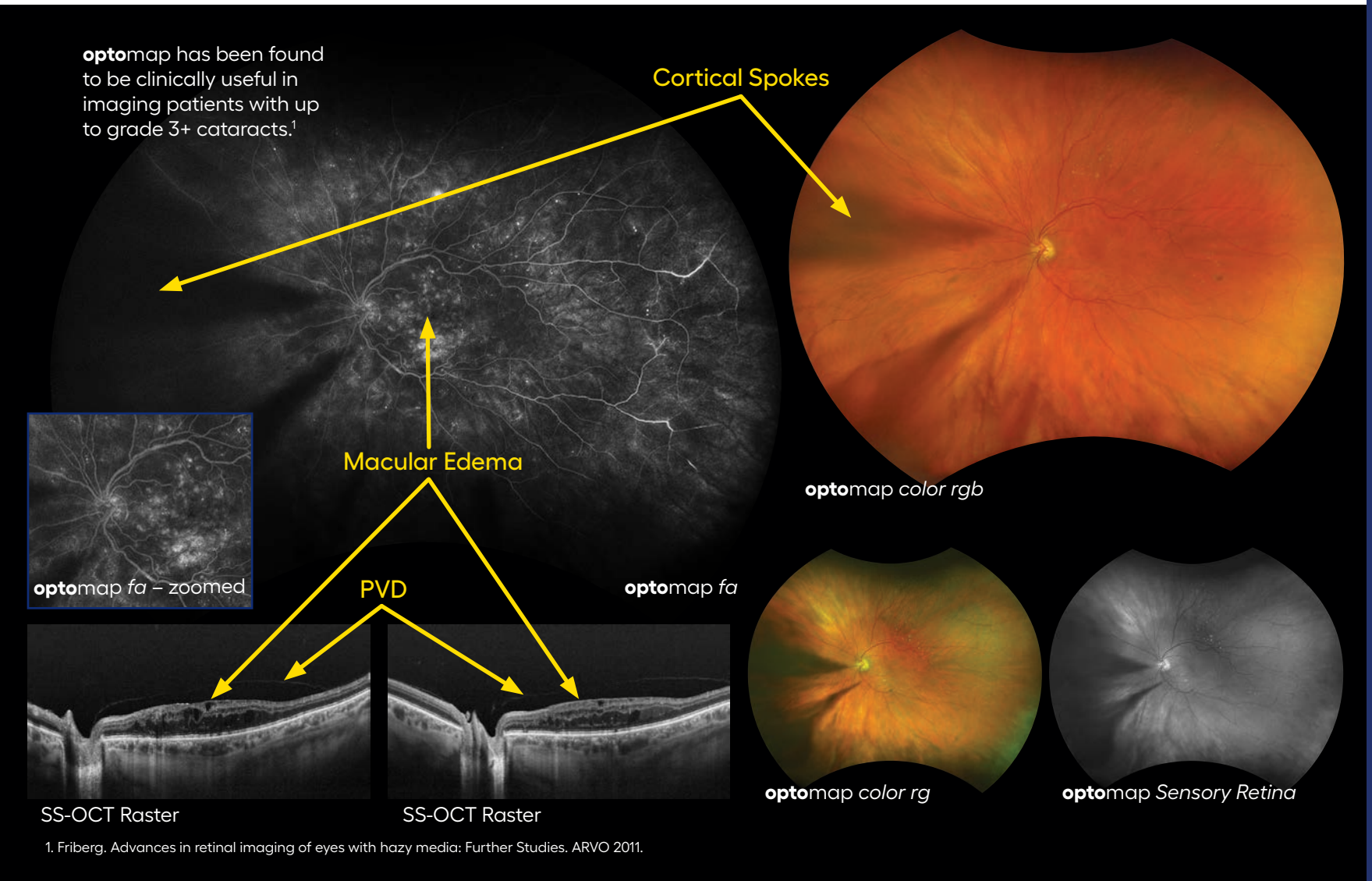
Proliferative Diabetic Retinopathy

demonstrates in this case how multimodal UWF imaging is critical for management. **opto**map *color rgb*, **opto**map *color rg* and **opto**map *Sensory Retina* (red-free) show neovascularization. **opto**map *fa* shows leakage in both early and later frames with SS-OCT showing the macula free of edema.



Severe Proliferative Diabetic Retinopathy

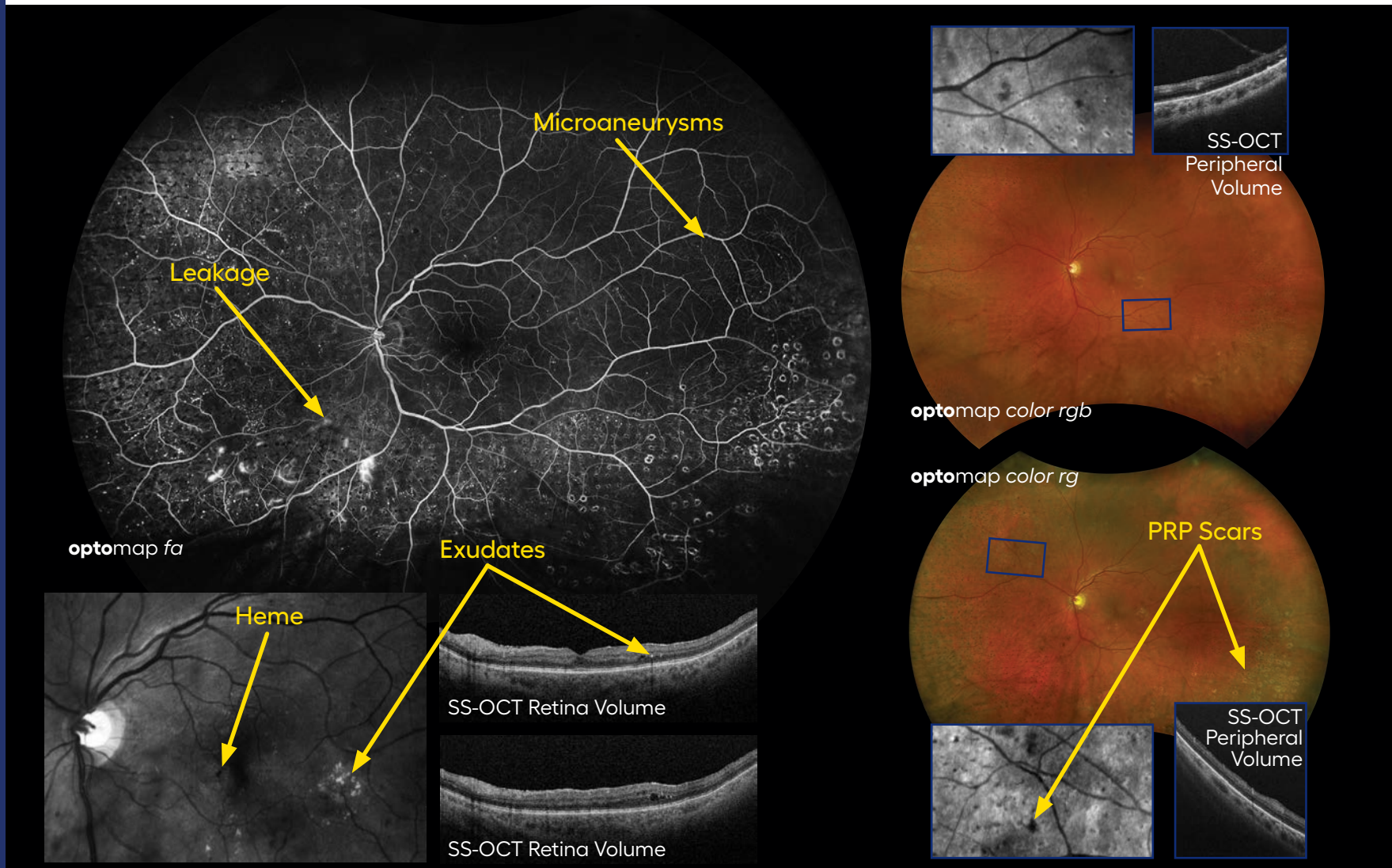
imaged with **opto**map *color rgb*, **opto**map *color rg*, **opto**map *fa* and SS-OCT is supportive for management. In this case, **opto**map *color rgb* and **opto**map *color rg* support visualization of exudates and hemorrhages. **opto**map *fa* shows leakage across the retina with SS-OCT capturing cystic changes consistent with macular edema.



1. Friberg. Advances in retinal imaging of eyes with hazy media: Further Studies. ARVO 2011.

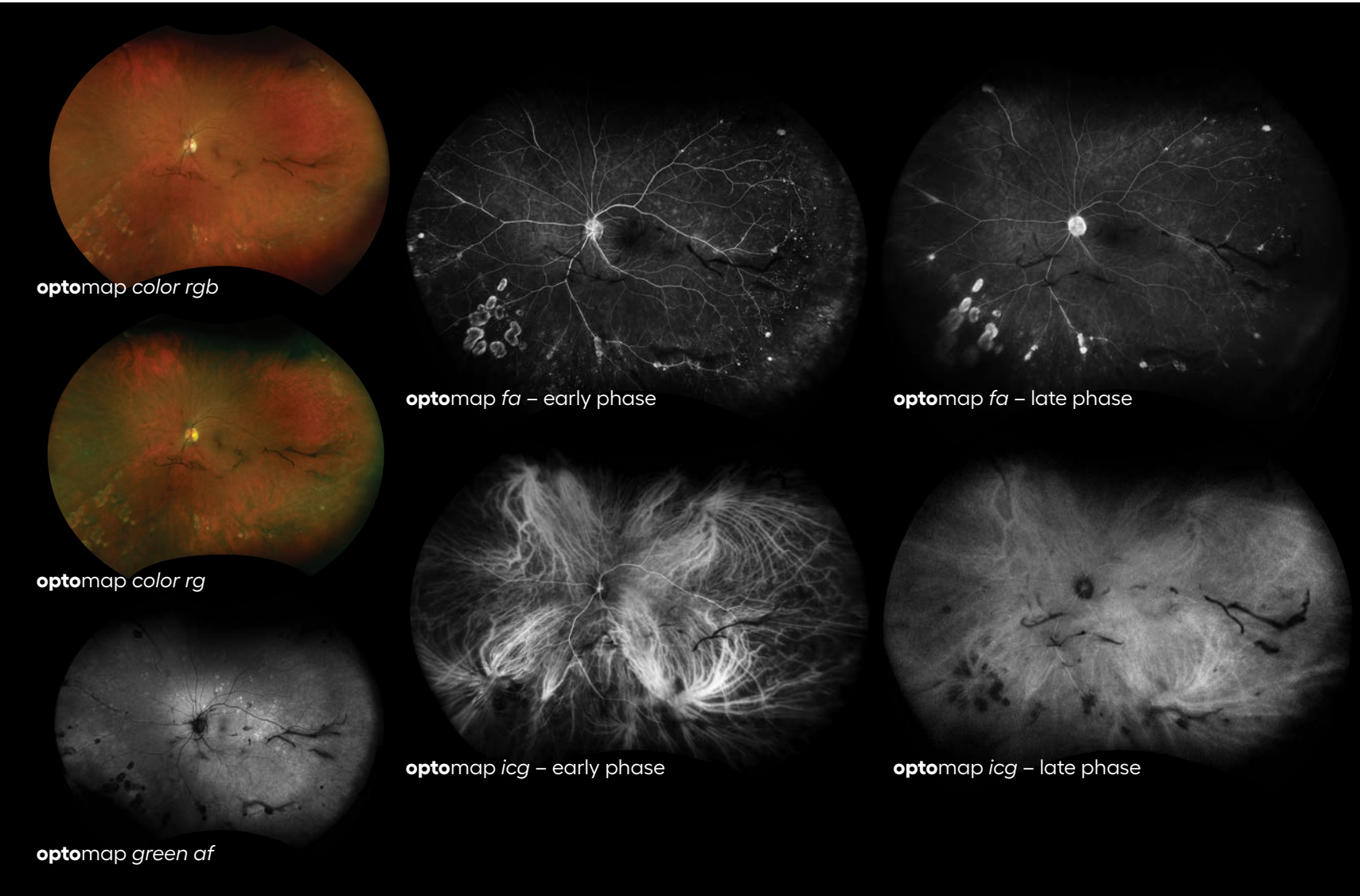
Proliferative Diabetic Retinopathy

in this case of proliferative diabetic retinopathy, multimodal UWF imaging reveals despite extensive pan-retinal photocoagulation (PRP) there is leakage in the inferior periphery on **opto**map *fa*. Guided SS-OCT reveals subtle vascular changes. Central OCT shows there are some cystic changes in the central pole while the central macula and fovea are fluid-free.



Uveitis

is inflammation of any of the structures of the uvea: iris, ciliary body or choroid. **opto**map *color rgb* and **opto**map *color rg* can document the appearance of retinal lesions and capture associated peripheral pathologies such as snowbanking, retinoschisis and peripheral traction membranes. **opto**map *fa* is used to detect localized and diffuse leakage throughout the retina to show the activity of retinal vascular inflammation. **opto**map *icg* can be captured to evaluate for signs of choroidal inflammation.



optomap *color rgb*

optomap *color rg*

optomap *green af*

optomap *fa* – early phase

optomap *fa* – late phase

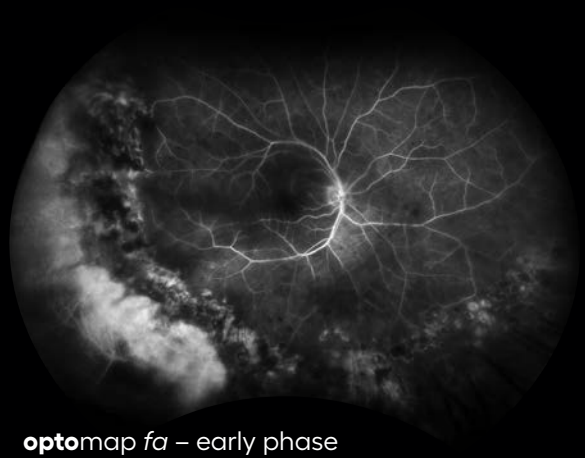
optomap *icg* – early phase

optomap *icg* – late phase

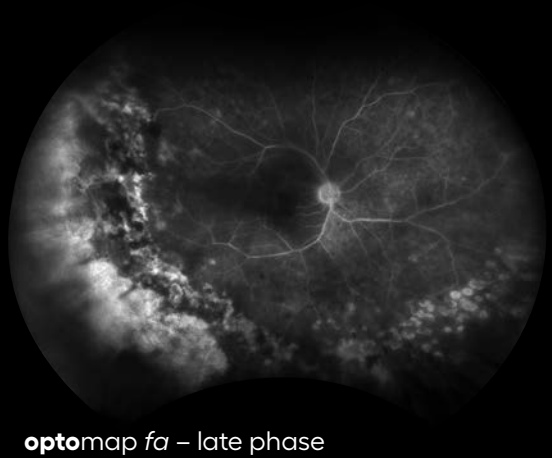
Acute Retinal Necrosis (ARN)

is an inflammatory condition which may present as panuveitis with principal causative viral agents of Varicella Zoster Virus (VZV) and Herpes Simplex Virus. Patchy retinitis usually starts peripherally, underscoring the value of **opto**map *color rgb* and **opto**map *color rg*, then progresses to become increasingly confluent and advancing within the posterior pole. **opto**map *fa* is used to investigate for occlusive retinitis. Choroidal vasculature is typically affected with **opto**map *icg* showing ischemia-induced inflammatory changes.

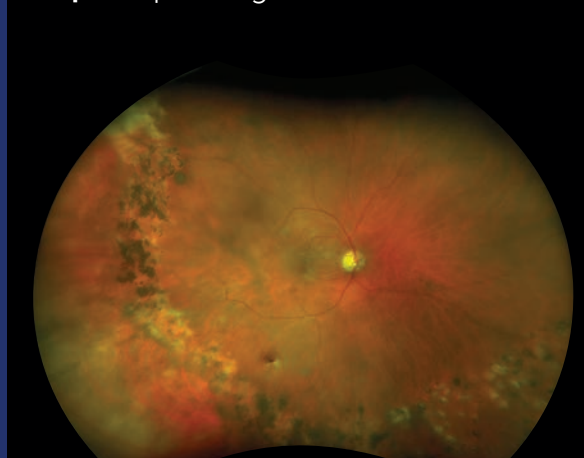
optomap *color rgb*



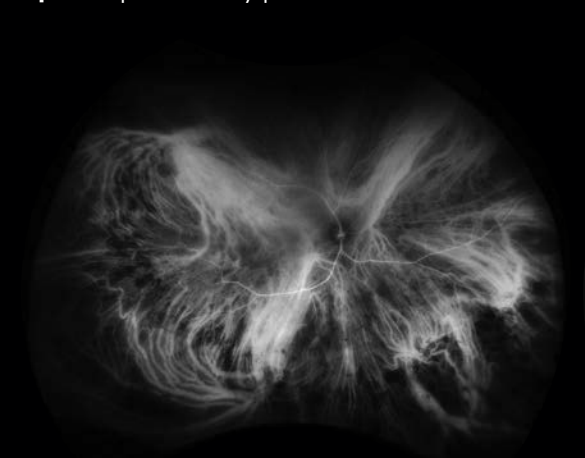
optomap *fa* – early phase



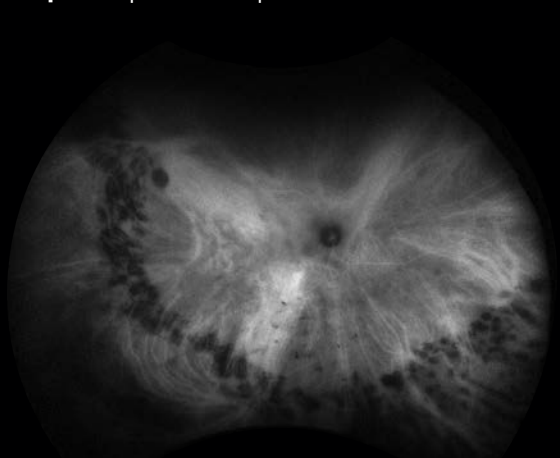
optomap *fa* – late phase



optomap *color rg*



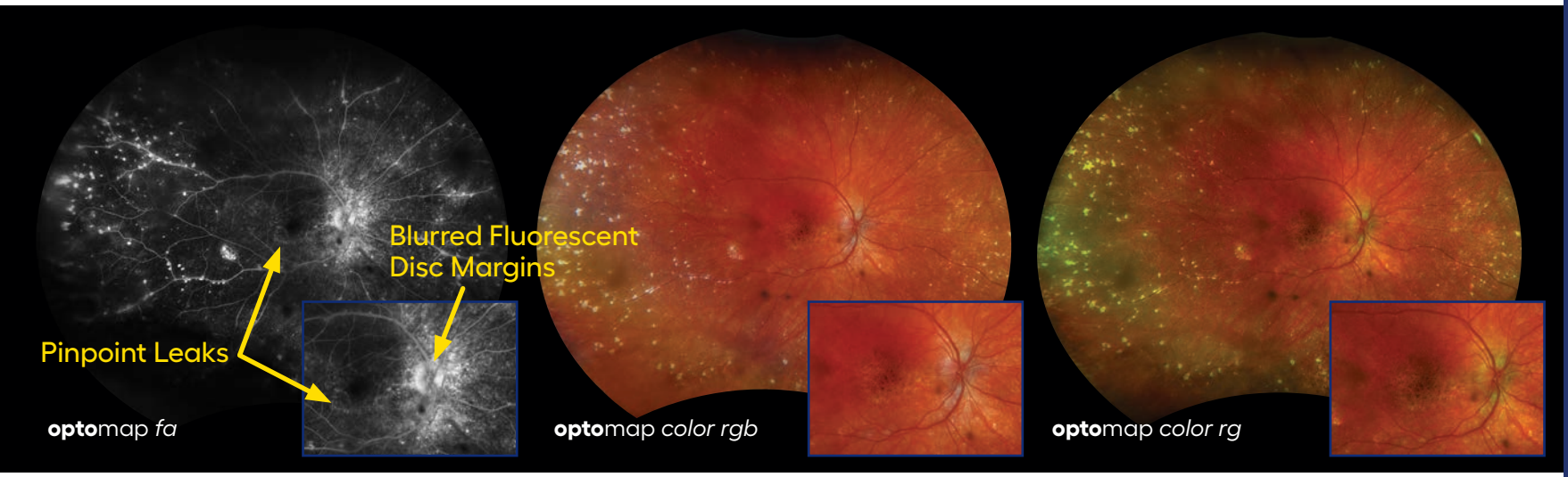
optomap *icg* – early phase



optomap *icg* – late phase

Vogt–Koyanagi–Harada disease (VKH)

is an idiopathic multisystem immune disease featuring bilateral granulomatous panuveitis. **opto**map *color rgb* and **opto**map *color rg* can capture disease progression as optic nerve edema and exudative retinal detachments resolve and develop into optic and chorioretinal atrophy with a sunset-glow fundus. **opto**map *fa* shows how lesions and inflammatory areas found in VKH correspond across multimodal imaging. In all images shown, hyperfluorescence is due to staining of inflammatory foci.



Multifocal Evanescent White Dot Syndrome (MEWDS) is a condition in which white dots, as captured on **opto**map *color rgb* and **opto**map *color rg* appear in the deep layers of the retina caused by inflammation. **opto**map *fa* shows early punctate hyperfluorescence in a wreath-like pattern and late staining in areas corresponding to the white dots.

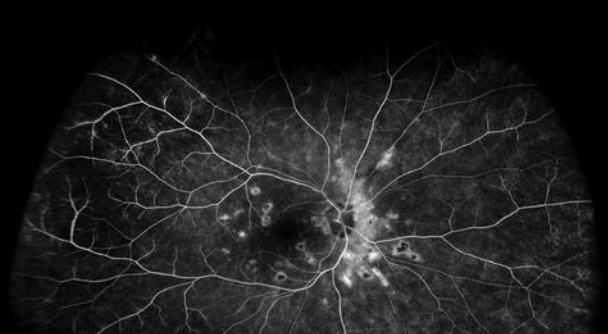
Birdshot Chorioretinitis

is an inflammatory disease of the choroid, characterized by small, yellowish choroidal spots. The lesions as captured on **opto**map *color rgb* and **opto**map *color rg* are often clustered around the optic nerve and posterior pole, radiating towards the periphery in a pattern like the gunshot spatter from birdshot. **opto**map *af*, **opto**map *fa* and **opto**map *icg* can improve visualization and monitoring of these choroidal lesions.

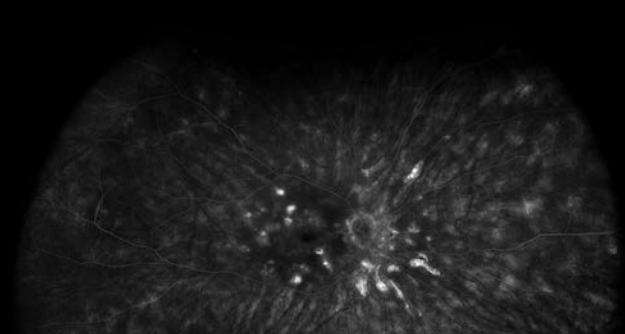
optomap *color rgb*

optomap *color rg*

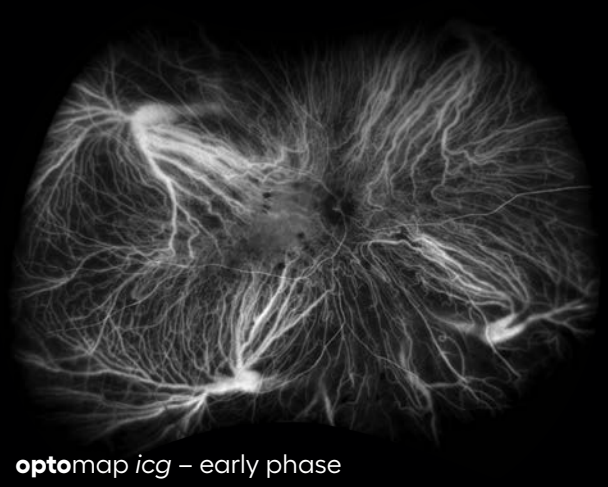
optomap *green af*



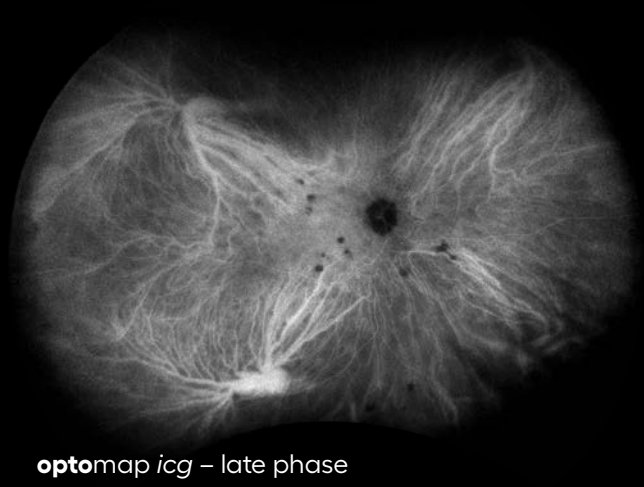
optomap *fa* – early phase



optomap *fa* – late phase



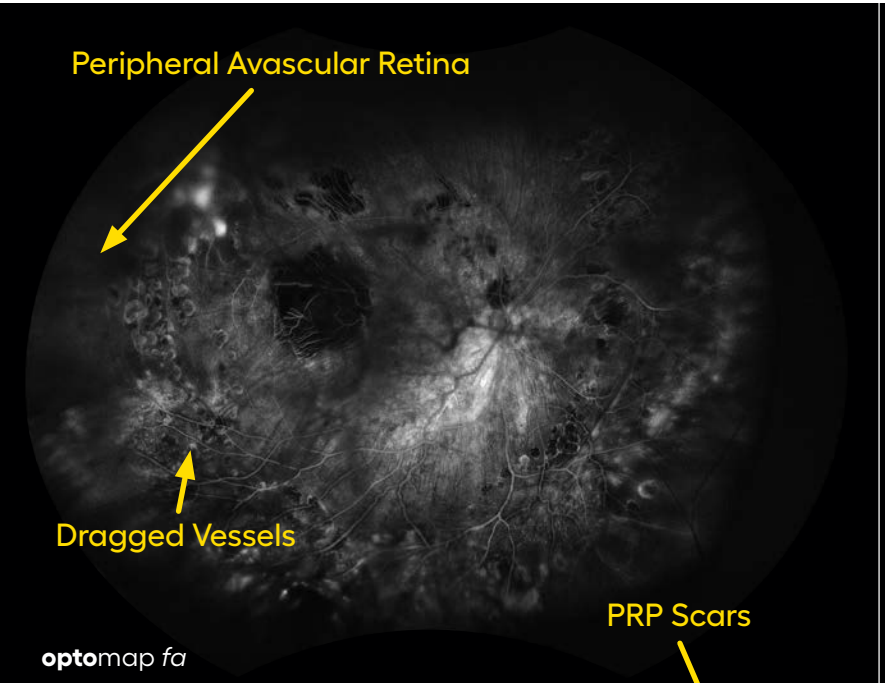
optomap *icg* – early phase



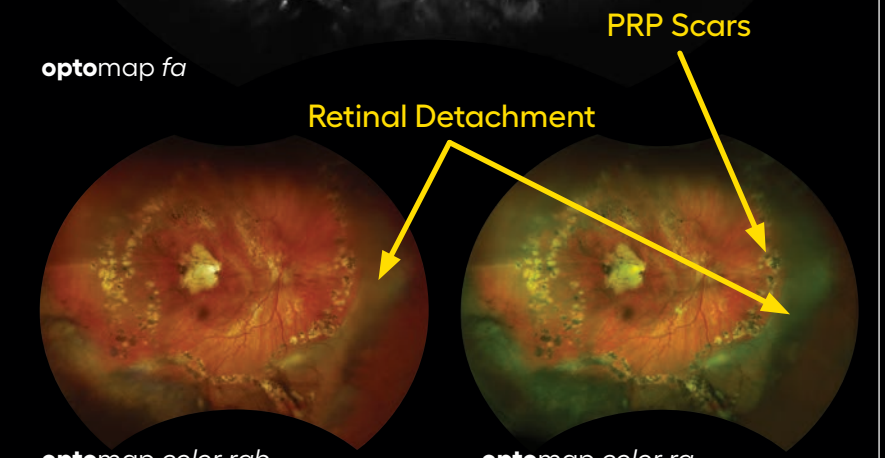
optomap *icg* – late phase

Familial Exudative Vitreoretinopathy (FEVR)

is a hereditary condition characterized by abnormal retinal growth leading to incomplete vascularization of the peripheral retina causing subretinal exudation and hemorrhages, tractional retinal detachment and foveal displacement. **opto**map *color rgb* and **opto**map *color rg* can capture these features with **opto**map *fa* demonstrating peripheral avascular retina.



optomap *fa*

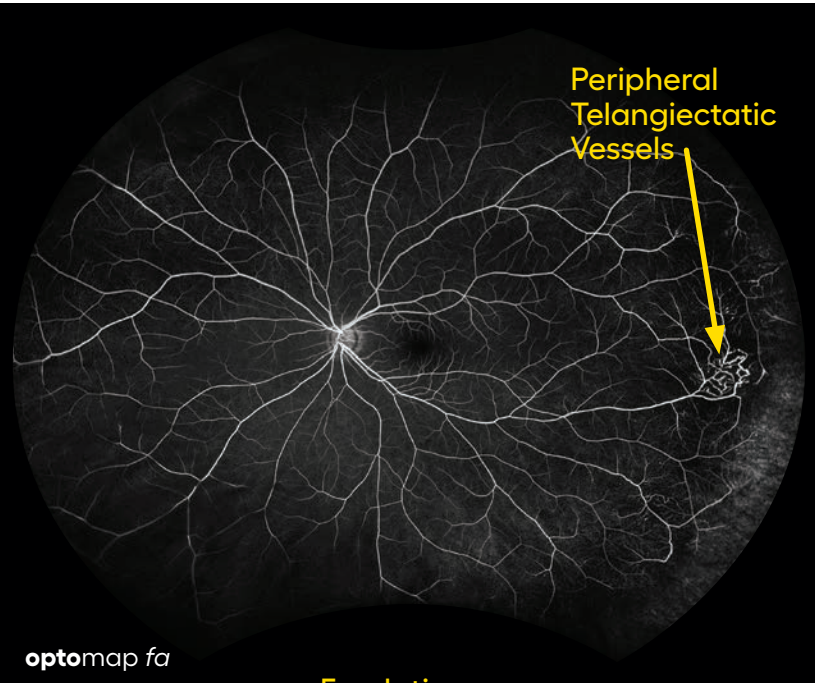


optomap *color rgb*

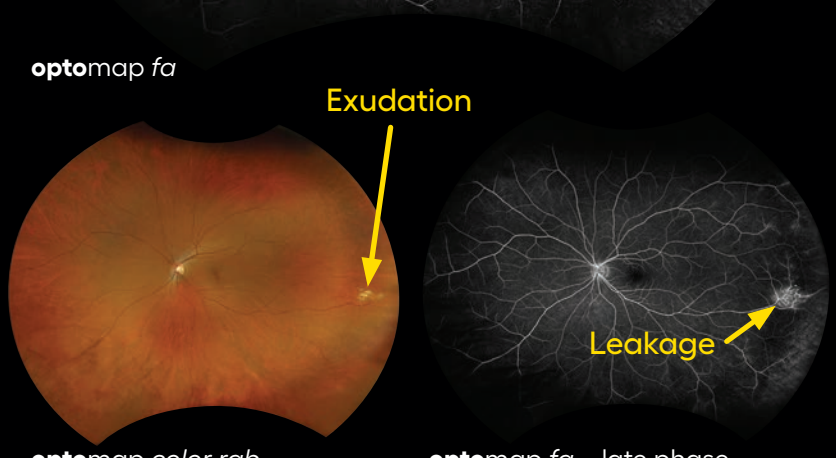
optomap *color rg*

Coats' Disease

is a rare, genetic retinal vascular disease characterized by massive white exudates and malformed, tortuous retinal blood vessels with aneurysmal dilations. **opto**map *color rgb* and **opto**map *color rg* capture exudation with **opto**map *fa* showing telangiectatic vessels and peripheral capillary nonperfusion.



optomap *fa*

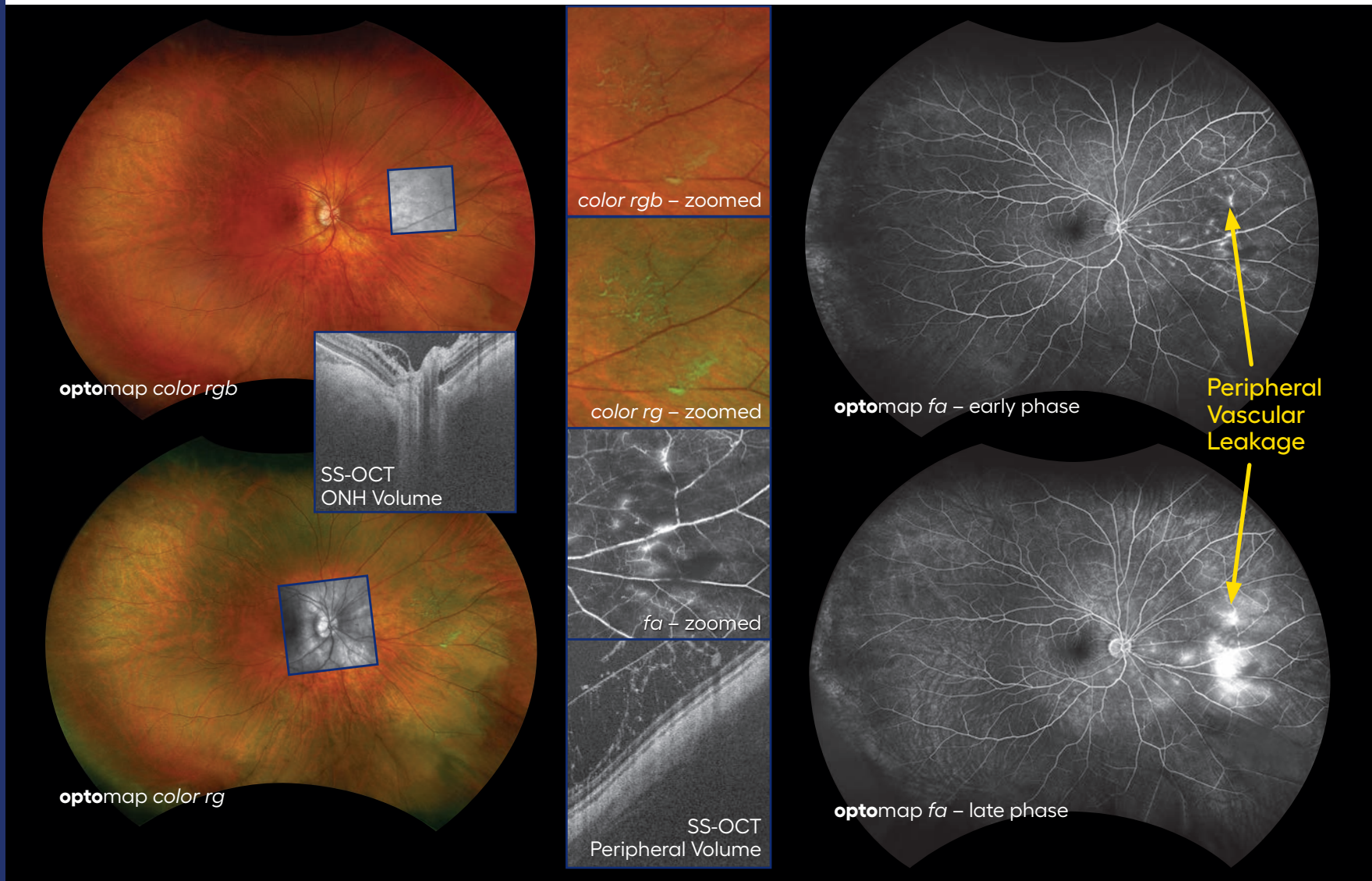


optomap *color rgb*

optomap *fa* – late phase

Myopic Foveoschisis

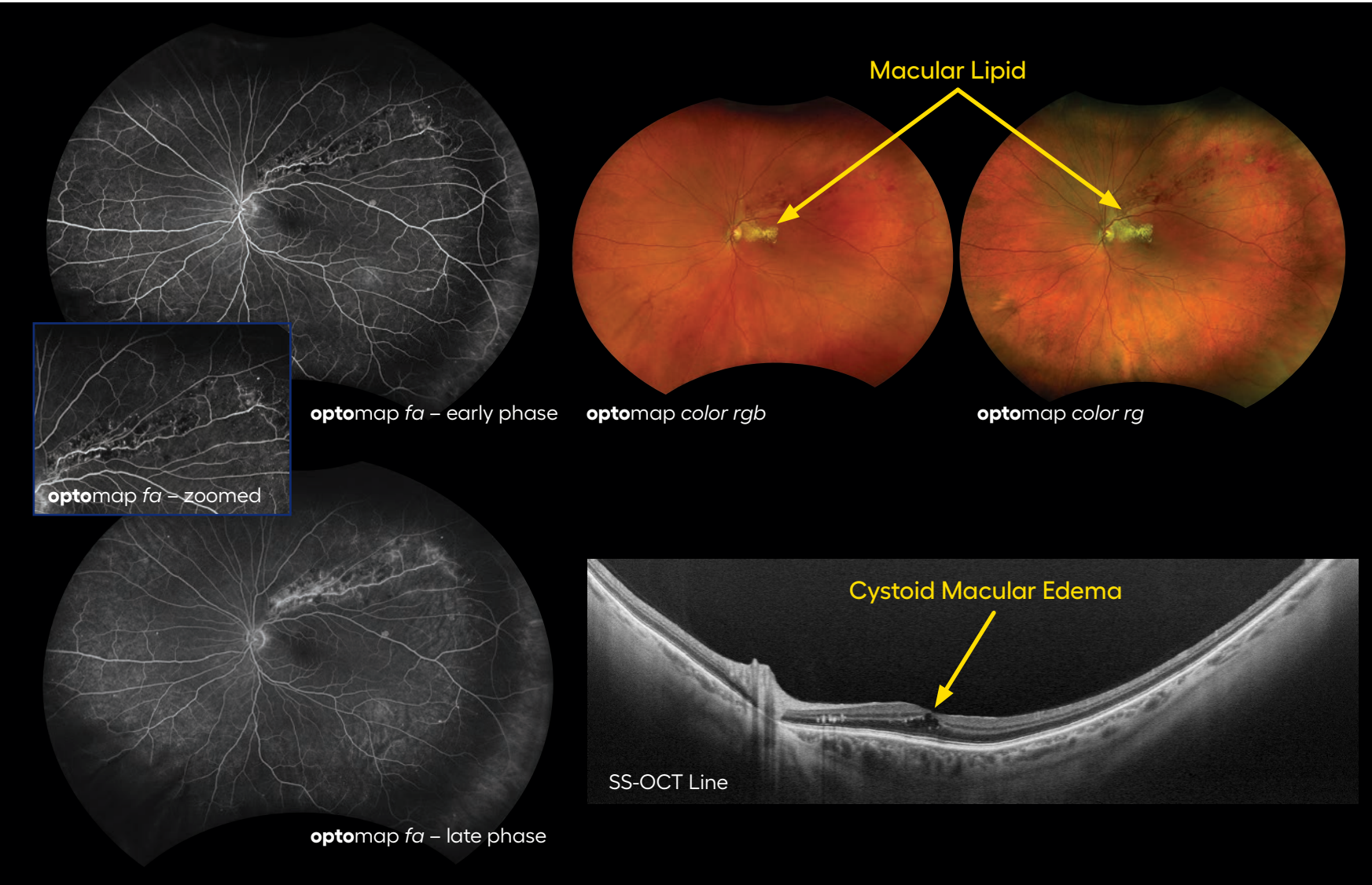
is a complication of pathologic myopia where the retinal layers split leading to potential visual impairment. Associated diagnostic testing includes **opto**map *color rgb* and **opto**map *color rg* to document subtle elevation and traction, and **opto**map *fa* to evaluate for the development of central neovascularization with late frames showing more severe leakage and delayed staining of peripheral vessels. SS-OCT is used to identify areas of retinal schisis both centrally and peripherally.



Retinal Vein Occlusion (RVO)

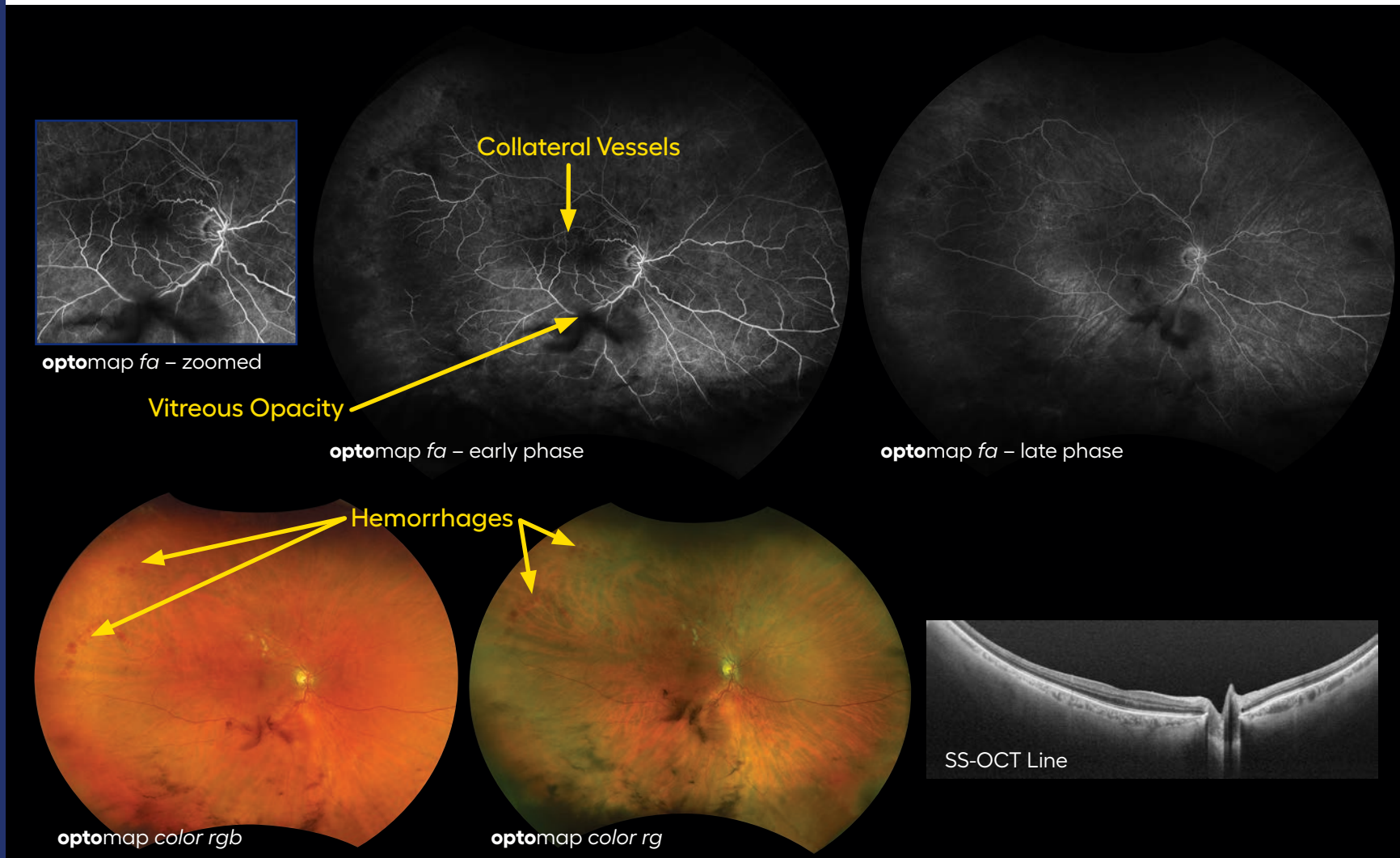
is a retinal vascular disorder in which a blockage occurs that can involve the central retinal vein (CRVO) or a major branch of the central vein (BRVO). These blockages occur where retinal arteries that have been thickened or hardened by atherosclerosis cross over and place pressure on a retinal vein. When a retinal vein is blocked, it cannot drain blood from the retina leading to widespread hemorrhages and leakage of fluid.

In this case, **opto**map *color rgb* and **opto**map *color rg* capture hemorrhaging superior to the macula with macular lipid present. **opto**map *fa* also shows the extensive hemorrhaging and is useful for determining the degree of ischemia. SS-OCT offers supplemental information and shows cystoid macular edema.



Retinal Vein Occlusion

with secondary peripheral retina and vitreous hemorrhaging is documented by **opto**map *color rgb* and **opto**map *color rg*. **opto**map *fa* helps to characterize the retinal vasculature, including the extent of nonperfusion, macular ischemia, macular edema, and leakage. SS-OCT can also visualize intraretinal hemorrhages and macular edema.



optomap *fa* – zoomed

optomap *fa* – early phase

optomap *fa* – late phase

optomap *color rgb*

optomap *color rg*

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Reference for Definitions

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The Retinal Atlas. Second Edition. 2017

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Joel Schuman MD
Slack Incorporated

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optos®

Optos UK/Europe
+44 (0)1383 843350
ics@optos.com

Optos North America
800 854 3039
usinfo@optos.com

Optos DACH
DE: 0800 72 36 805
AT: 0800 24 48 86
CH: 0800 55 87 39
ics@optos.com

Optos Australia
+61 8 8444 6500
auinfo@optos.com

Contact us: