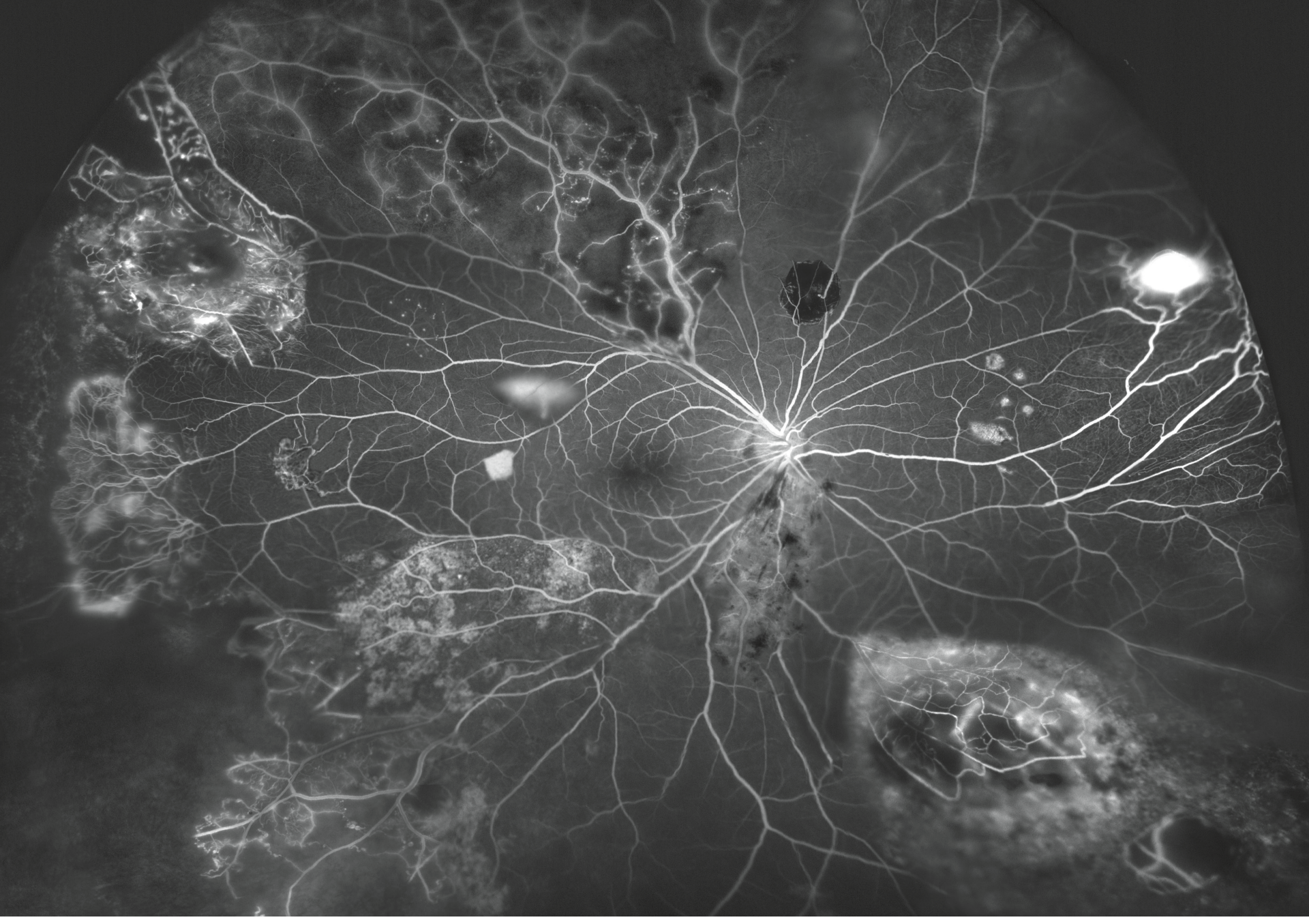


Nikon

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

optos®

Optos devices produce ultra-widefield (UWF™), high resolution images (**opto**map) of approximately 82% (200°) of the retina. A single **opto**map can document the retina from the central pole through the vortex vessels; no other technology can capture this view in a single image. **opto**map images provide more clinical information which facilitates early detection and more effective management of retinal diseases. Retinal imaging can also uncover 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.

optomap *fa* images uses the blue wavelength (488nm) to capture the circulation of the retina. A fluorescein angiogram is used to analyze the integrity of the retinal vascular system, looking for leakages, blockages, neovascularization and vascular abnormalities. The **opto**map *fa* Diagnostic Atlas: A Retinal Reference Guide is designed to illustrate how different pathologies are visualized on UWF fluorescein angiogram.

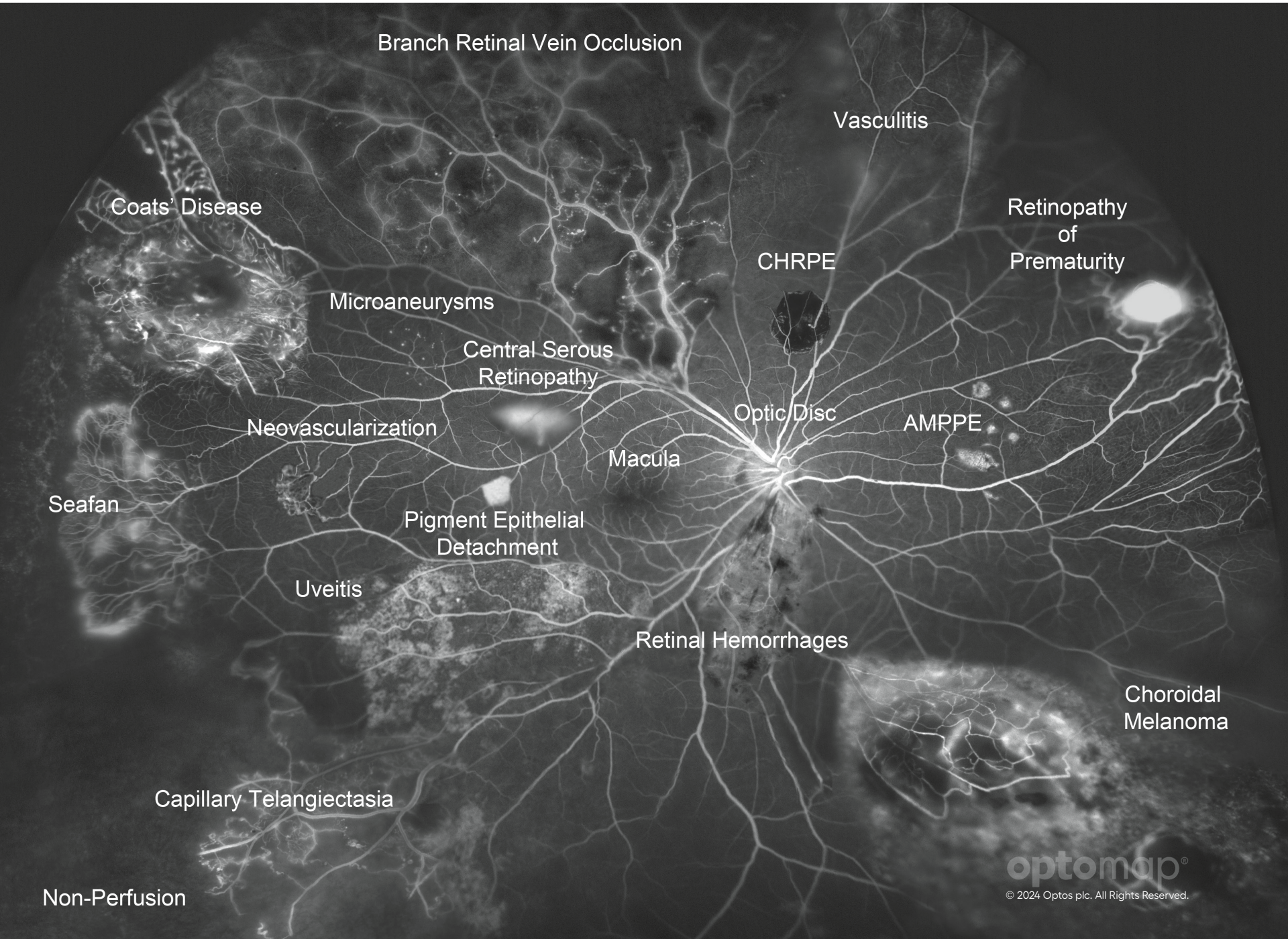
Reference for Definitions

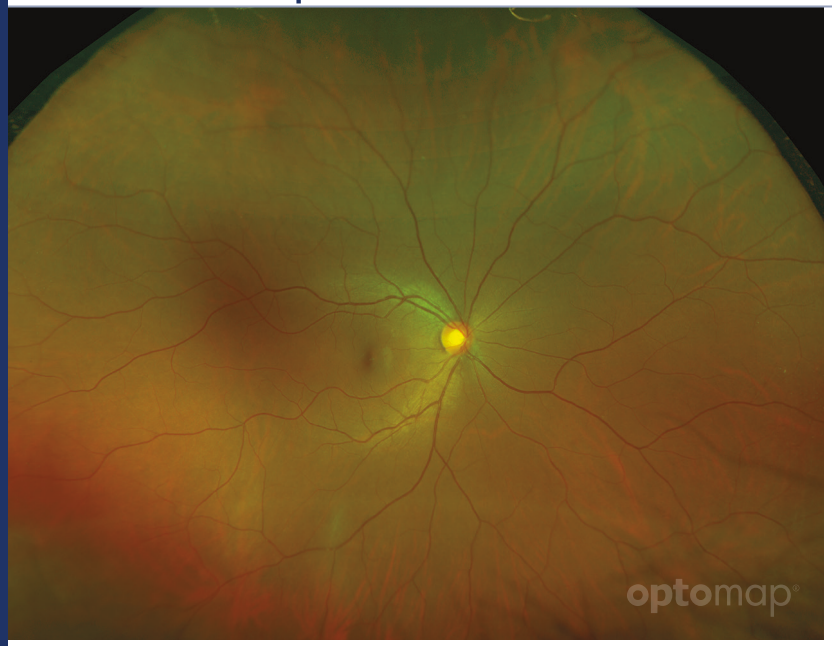
Dictionary of Eye Terminology. Sixth Edition. 2012.
Barbara Cassin and Melvin L. Rubin, MD.
Triad Communications, Inc.

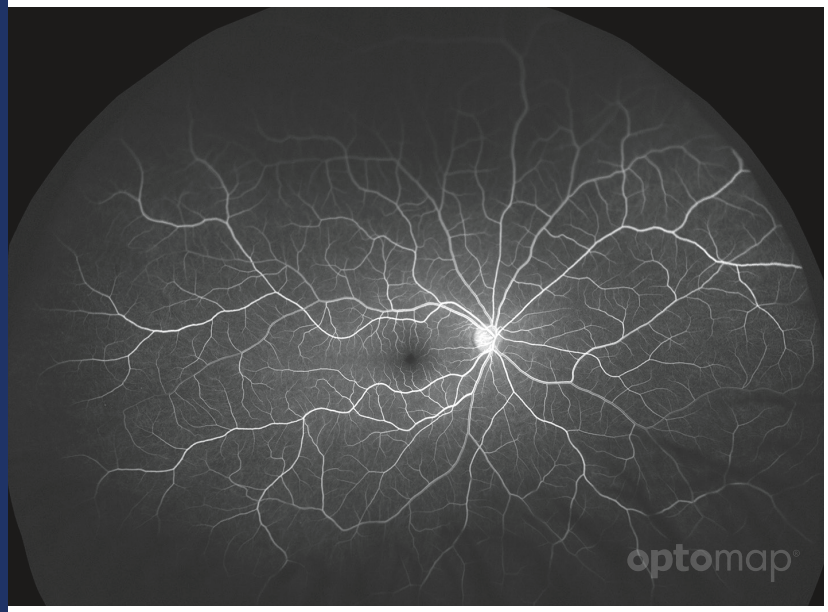
Fluorescein and Indocyanine Green Angiography: Technique and Interpretation. Second Edition. 1997
Joseph W. Berkow, MD; Robert W. Flower; David H. Orth, MD; James S. Kelley, MD
American Academy of Ophthalmology

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

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







optomap *color* composite images provide a structural image of the retina.

optomap 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).

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

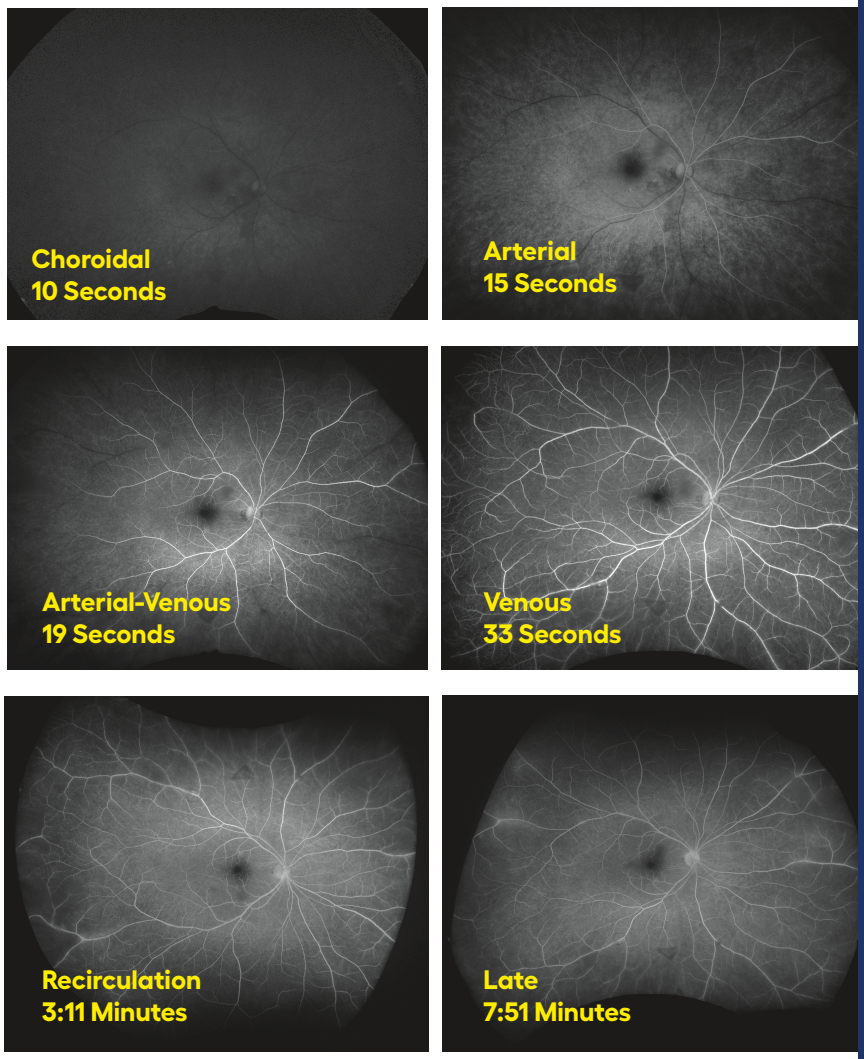
optomap *fa* images are captured using the blue wavelength (488nm) to visualize the circulation of the retina vasculature.

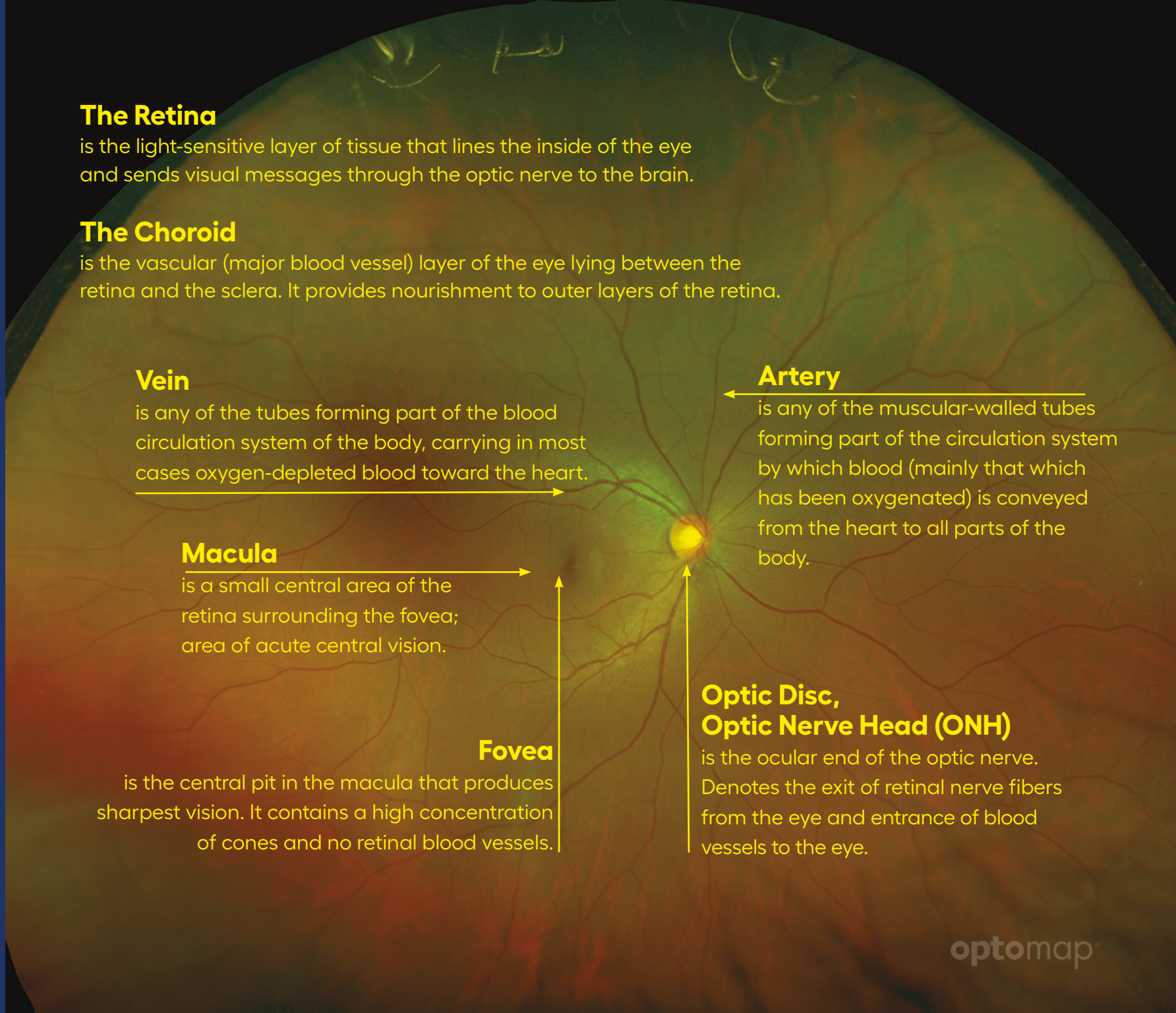
Fluorescein sodium ($C_{20}H_{10}Na_2O_5$), resorcinolphthalein sodium, is injected intravenously into a patient's arm. When the dye is injected and the retina is illuminated with blue light, the dye fluoresces and exciter and barrier filters are put in place to allow only the fluorescent light to be 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).

Upon injection, images are captured and each image has a timestamp to track the circulation time of the retinal vessels.

Fluorescein Angiography Phases

Phase	Timing	Description
Choroidal Flush/ Pre-Arterial Phase	10-12 seconds choroid fills 1 second before the dye enters the retinal circulation.	Choroid and choriocapillaris fill. Choroidal retinal arteries fill with the choroid at the same time.
Arterial	13-15 second	Arteries begin to fill.
Arterial-Venous Phase		Complete filling of the arteries and capillaries. Laminar flow seen in the veins.
Venous Phase	30-35 seconds	Veins are completely filled.
Recirculation Phase	2-4 minutes	Veins and arteries are equally bright.
Late Phase	5-10 minutes	Staining around the optic disc.





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.

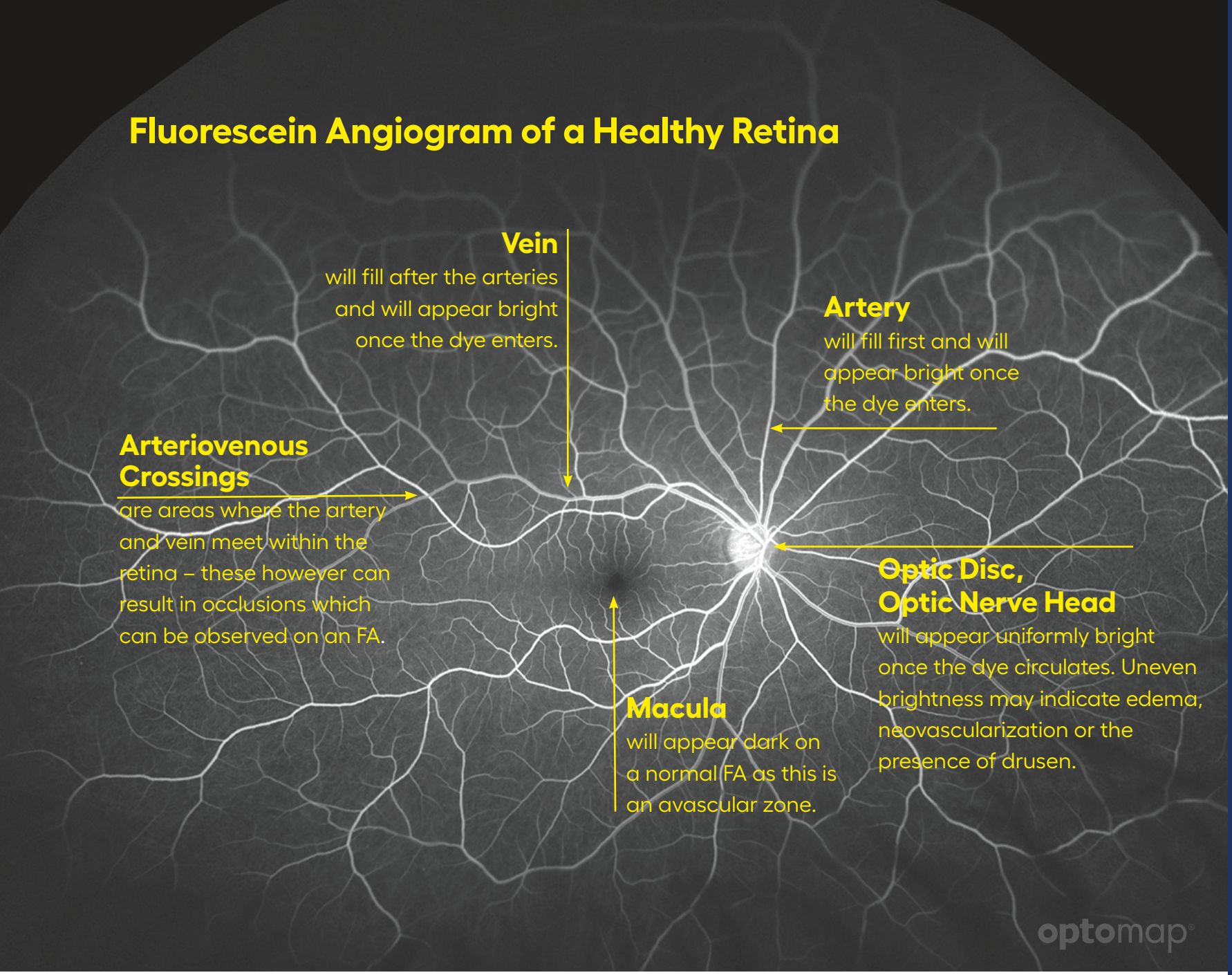
Artery
is any of the muscular-walled tubes forming part of the circulation system by which blood (mainly that which has been oxygenated) is conveyed from the heart to all parts of the body.

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 Disc, 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.

Fluorescein Angiogram of a Healthy Retina



Hyperfluorescence

is an increase in the level of fluorescence caused by an abnormality in the RPE. A structural abnormality may allow either the fluorescein dye to pass from the choroid into or under the retina or the fluorescent light from the dye to shine through the pigment epithelium.

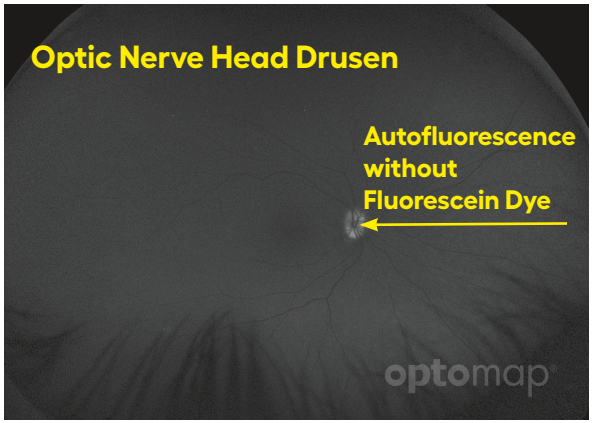
Autofluorescence – Occurs when tissue fluoresces without the assistance of a fluorescent dye.

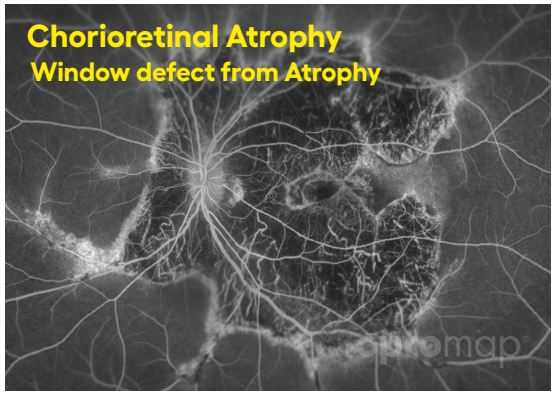
Window/Transmission - An area of the RPE that no longer has sufficient melanin to block fluorescence from the underlying choriocapillaris (ie. pigment epithelial window defect, atrophy or drusen).

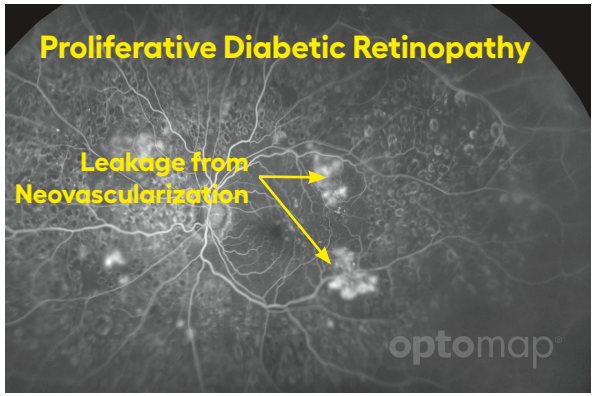
Leakage - The passage of fluorescein dye through a membrane that normally cannot be penetrated (ie capillary leakage, aneurysm or neovascularization).

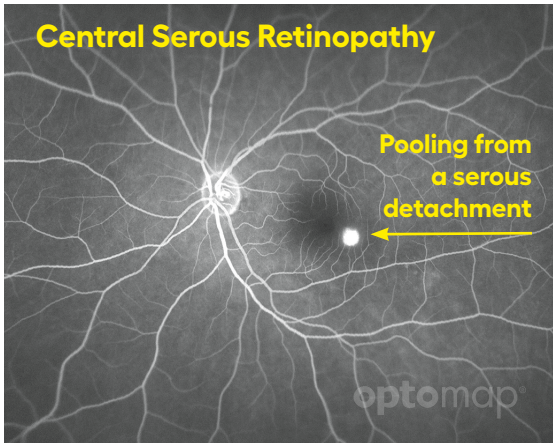
Pooling - The accumulation of fluorescein dye in what is typically tissue space (ie. cystoid macular edema, sensory retinal detachment or pigment epithelial detachment).

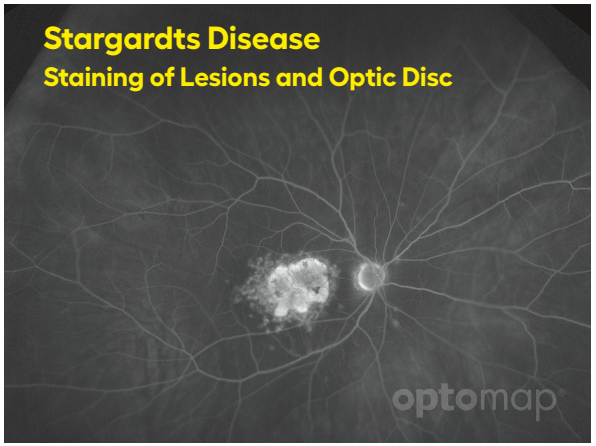
Staining - The accumulation of fluorescein within tissue substance.







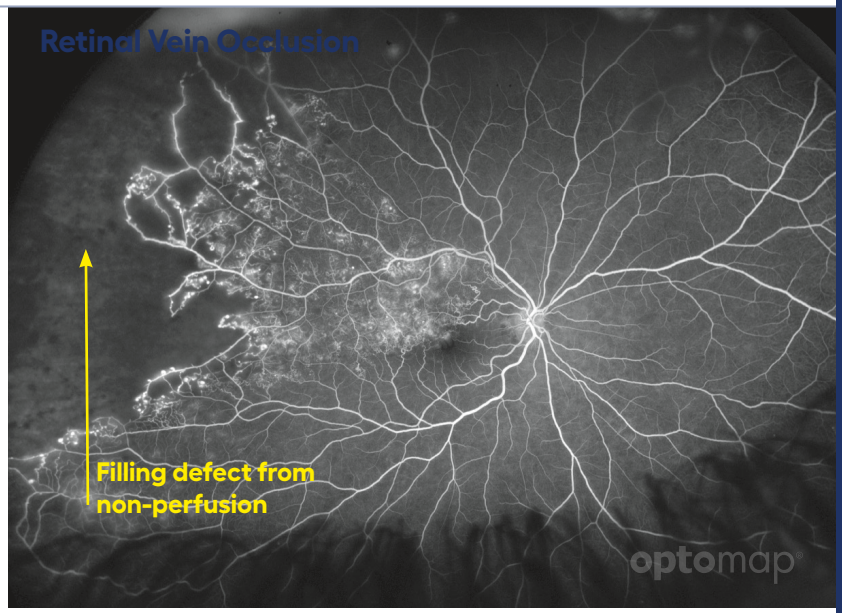




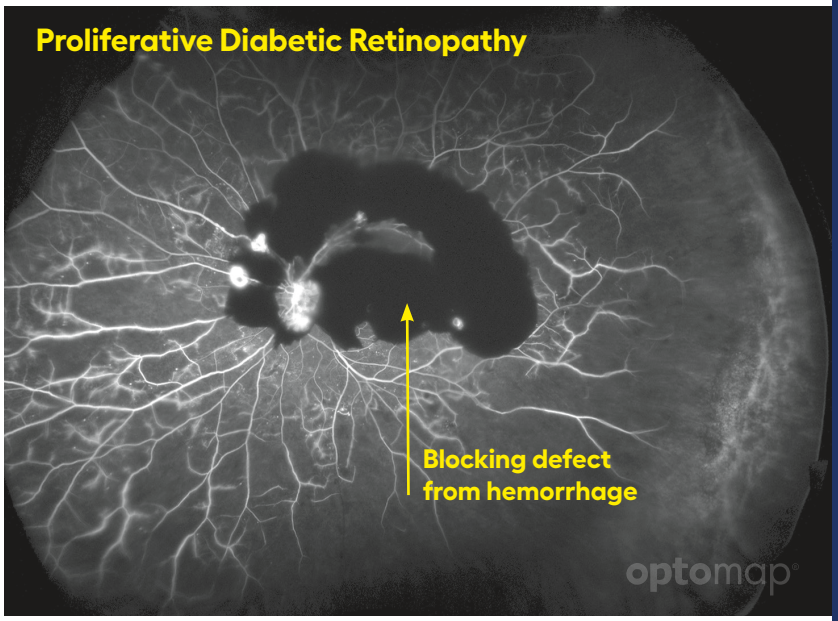
Hypofluorescence

is a lower level of fluorescence (seen as darker patches) caused by either the blockage of light from normally fluorescing structures or inadequate circulation in an area of the retina or choroid.

Filling defect – An area of poor fluorescence caused by a abnormal circulation. This can be non-perfusion or ischemia.

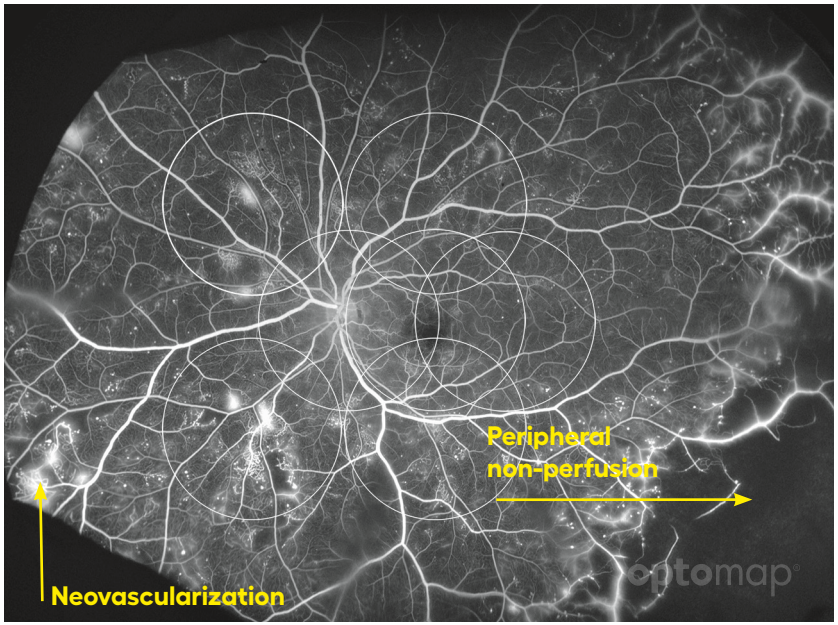


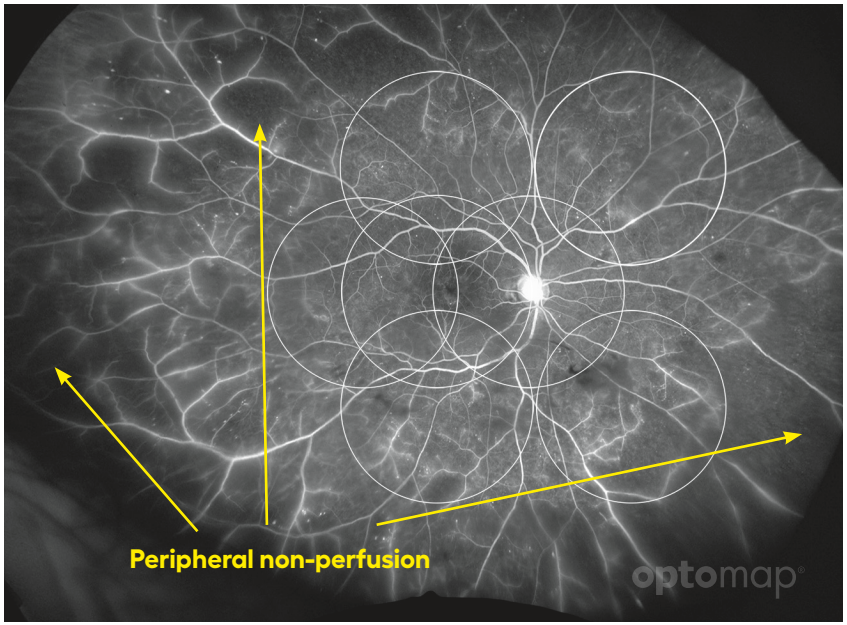
Blocking defect – An absence or marked decrease of fluorescence observed in an area that would normally show fluorescence. This can be caused by the presence of opaque material such as blood or pigment in a nevus.



Diabetic Retinopathy (DR)

is a series of progressive retinal changes that can result from long-standing diabetes mellitus. Early stage DR is non-proliferative (NPDR). It may advance to proliferative diabetic retinopathy (PDR), which includes neovascularization and fibrous tissue which can be visualized on FA.





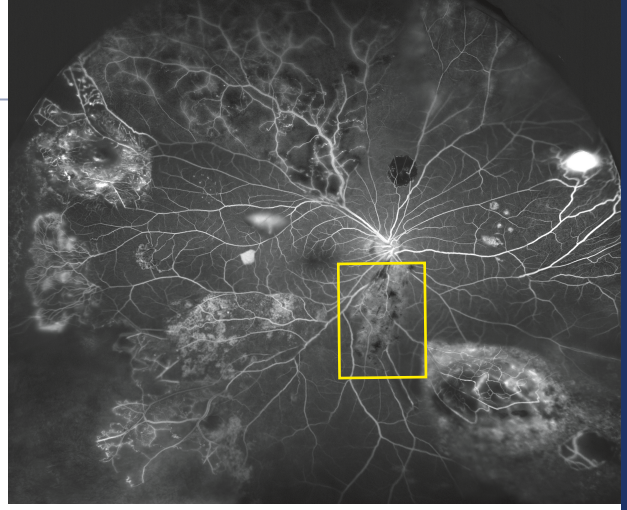
Recent research has established the importance of monitoring the retinal periphery (area outside of ETDRS) for early signs of DR.
optomap imaging has demonstrated that diabetic lesions occur in the retinal periphery in up to 50% of eyes and these lesions result in a more severe grade of retinopathy in 10% of eyes and a 4.7 fold increased risk of progression to PDR.[1]

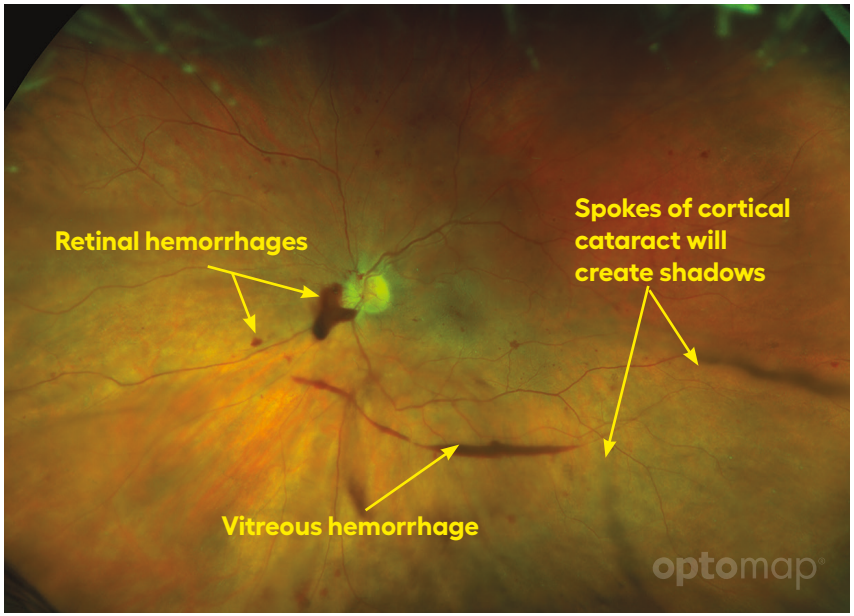
The gold standard for classification of diabetic retinopathy is stereoscopic color fundus photographs in 7 standard fields, as defined by the Early Treatment Diabetic Retinopathy Study (ETDRS) group (area captured shown in circles above). **opto**map images have been found equivalent in quality and may be used in place of ETDRS in managing DR.[2]

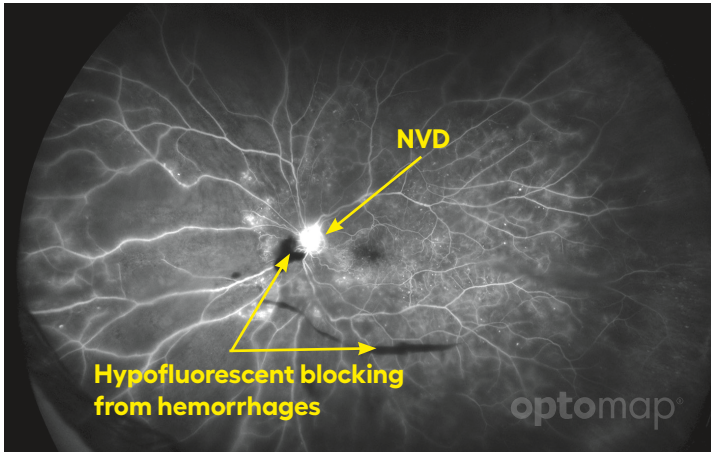
1. Silva et al Peripheral Lesions Identified on Ultrawide Field Imaging Predict Increased Risk of Diabetic Retinopathy Progression over 4 Years. Ophthalmology, 2015
2. Silva et al. Nonmydriatic Ultrawide Field Retinal Imaging Compared with Dilated Standard 7-Field 35-mm Photography and Retinal Specialist Examination for Evaluation of Diabetic Retinopathy. American Journal Of Ophthalmology, 2012

Retinal Hemorrhage

is the abnormal bleeding or leakage of the blood vessels in the retina often seen in conditions such as diabetic retinopathy. Retinal hemorrhage can be caused by injury or disease resulting in temporary or permanent loss of vision. Dot and blot hemorrhages are tiny round hemorrhages in the retina, usually in the outer plexiform layer.

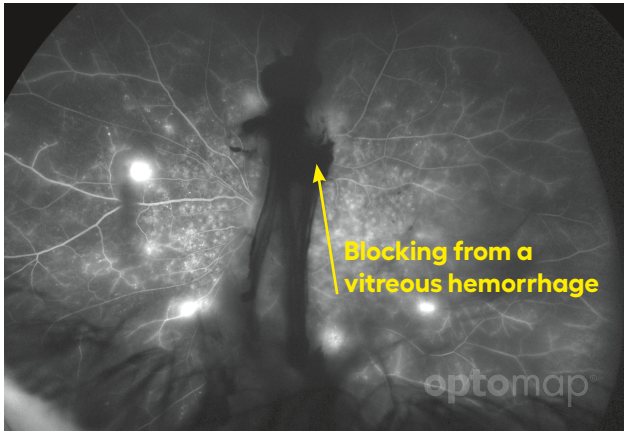






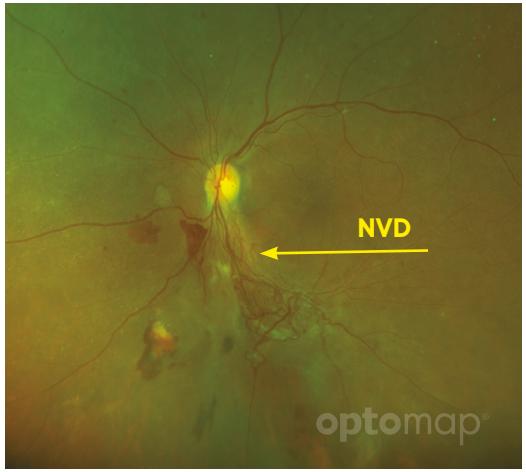
Vitreous Hemorrhage is blood in the vitreous that may result from blunt eye trauma, blood leakage from neovascularization, vitreous detachment or a retinal tear. It is also called a vitreal bleed and typically associated with diabetes.

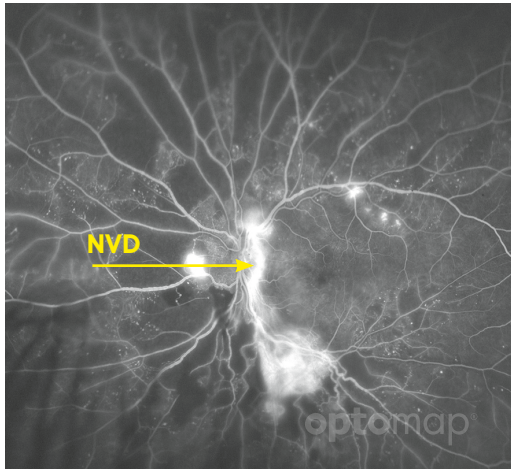
A vitreous hemorrhage will hypofluoresce on a fluorescein angiogram and will appear as blockage.

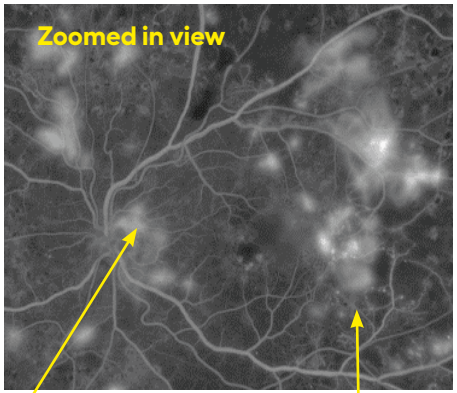


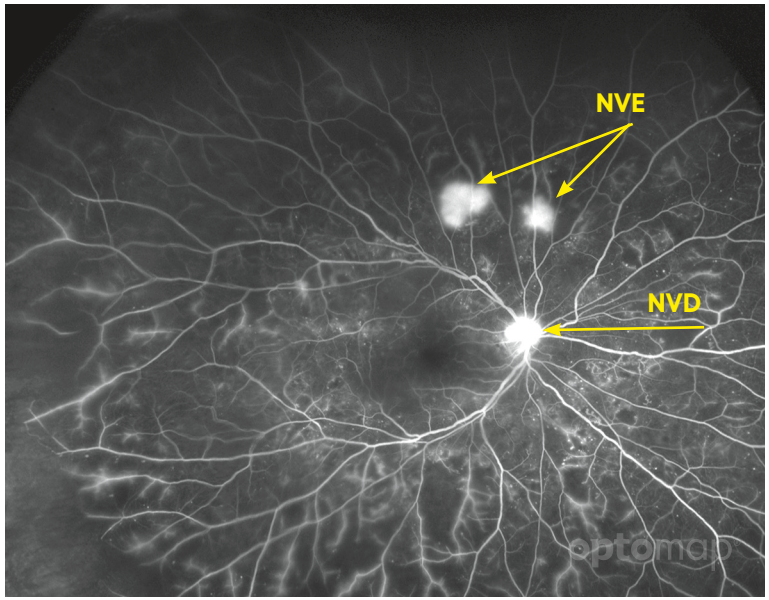
Neovascularization

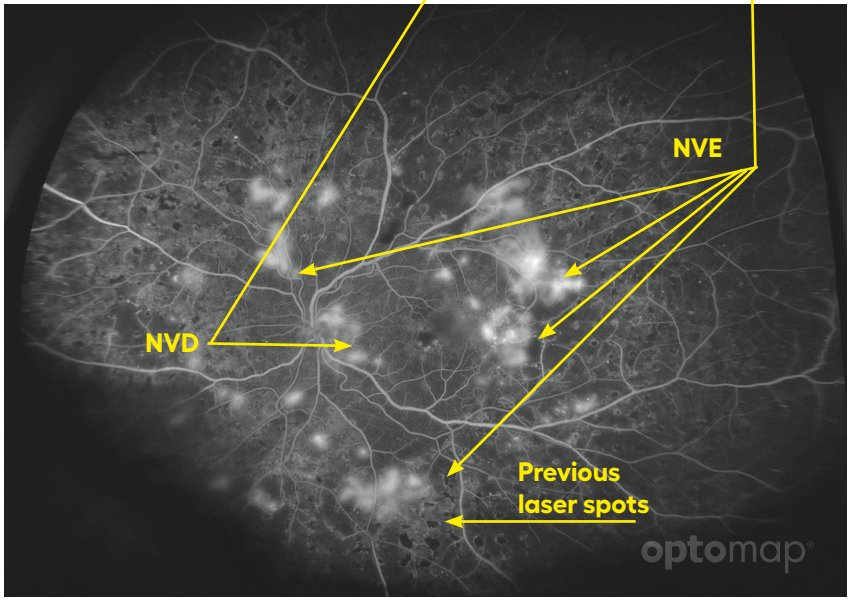
is the abnormal formation of new blood vessels, usually in or under the retina or on the iris surface. Neovascularization of the optic disc (NVD) are new vessels growths at the optic disc and neovascularization elsewhere (NVE) occurs outside of the optic disc. Neovascularization will hyperfluoresce on a **opto**map *fa* and will appear similar to leakage.





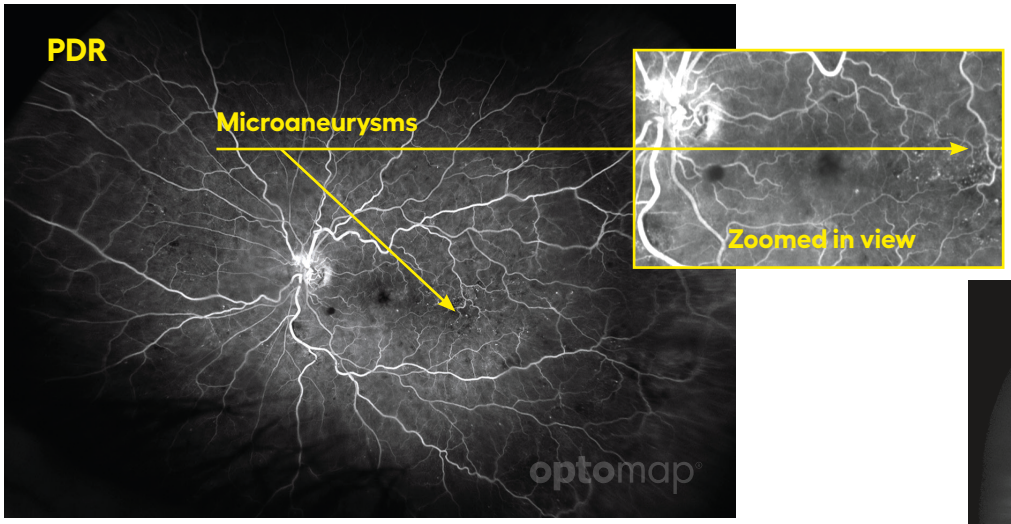


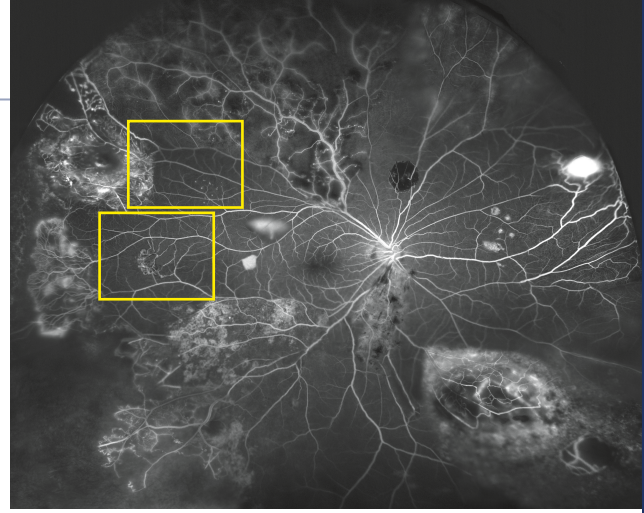


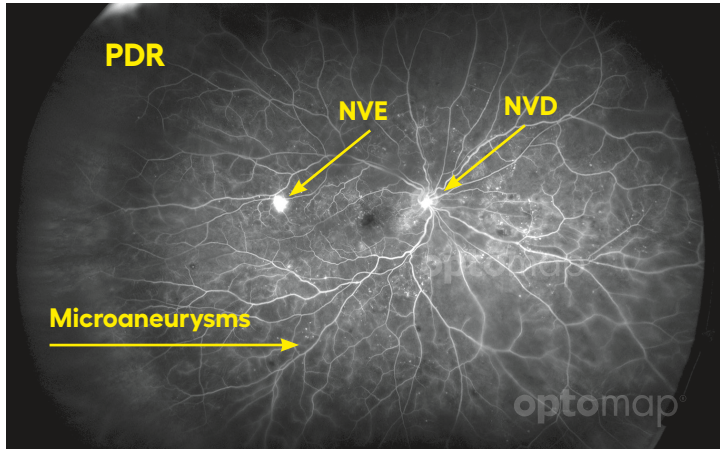


Microaneurysms

are focal dilation of the venous end of retinal capillaries. These appear in the retinal vessels as a small round red spot resembling a tiny, deep hemorrhage.

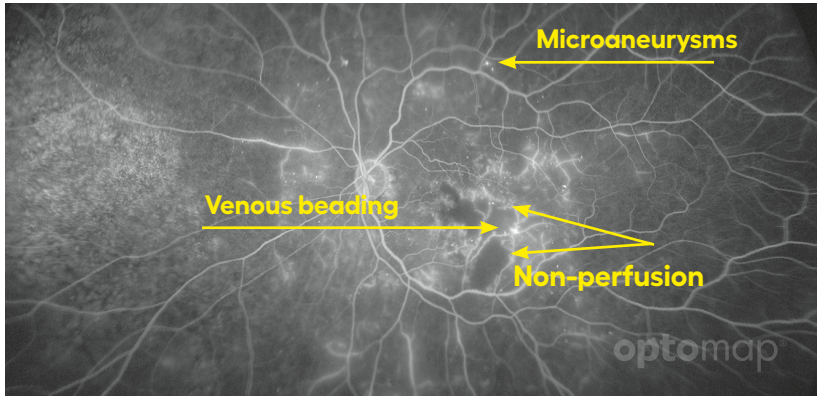


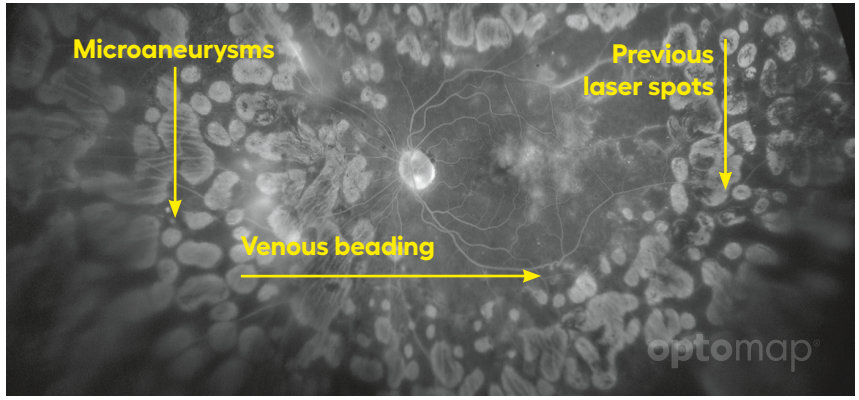




Venous Beading

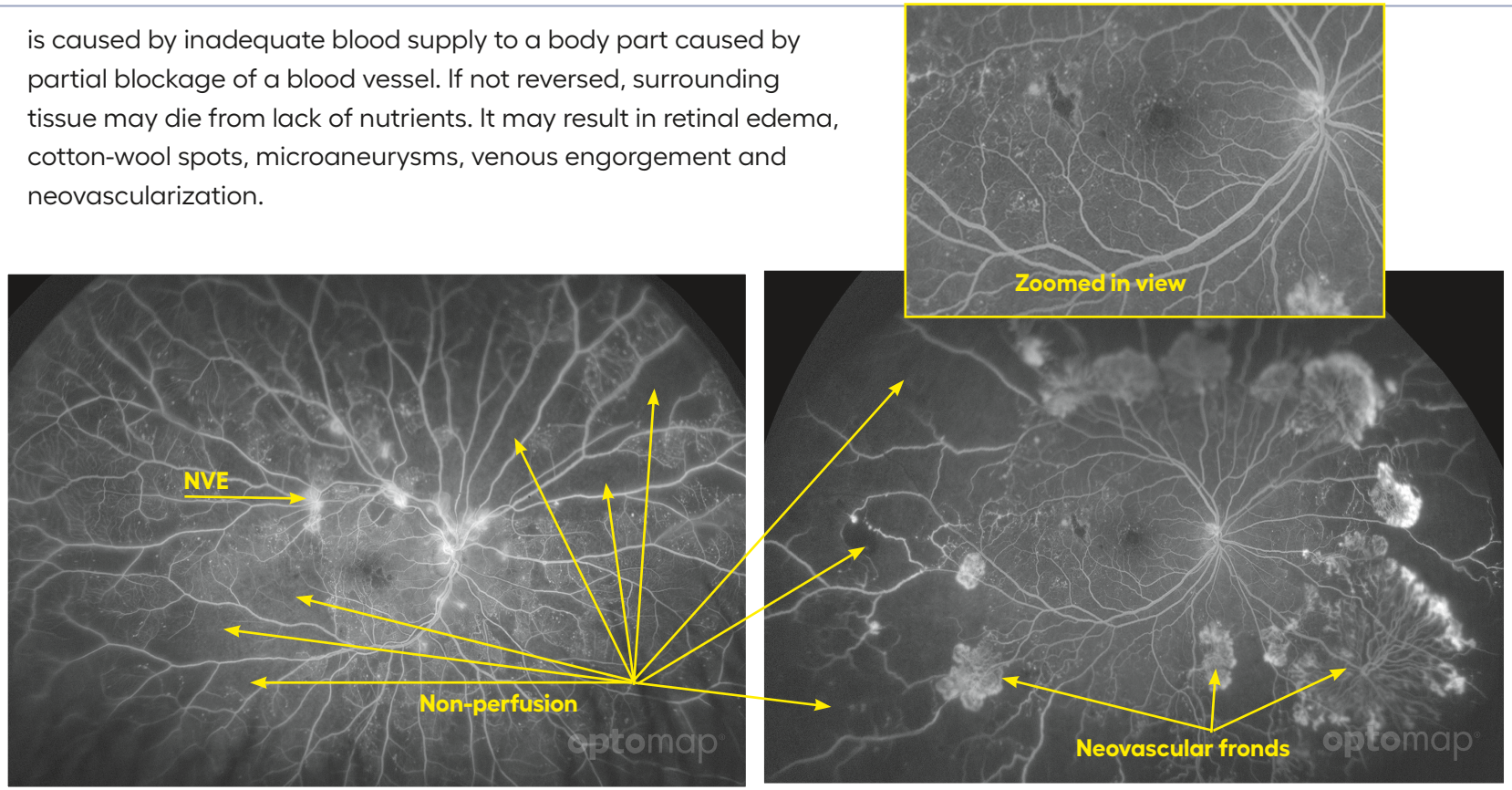
is a pattern of nodular irregularity in the retinal venous blood vessel walls that are typically next to areas of non-perfusion. This can be found in Coats' disease and diabetic retinopathy.





Ischemia, Non-Perfusion

is caused by inadequate blood supply to a body part caused by partial blockage of a blood vessel. If not reversed, surrounding tissue may die from lack of nutrients. It may result in retinal edema, cotton-wool spots, microaneurysms, venous engorgement and neovascularization.

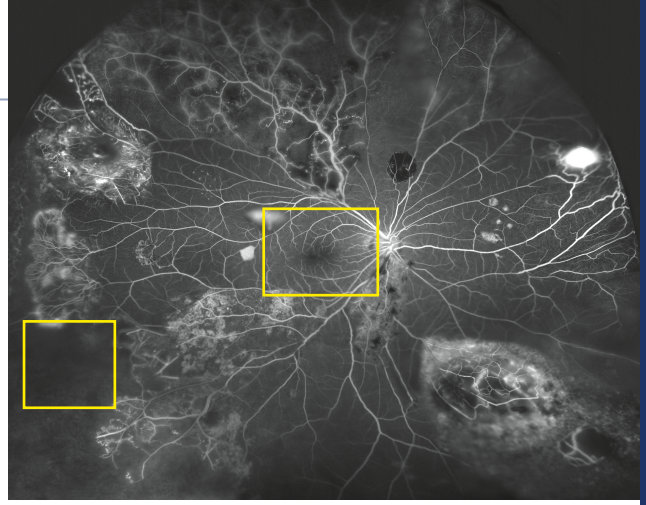


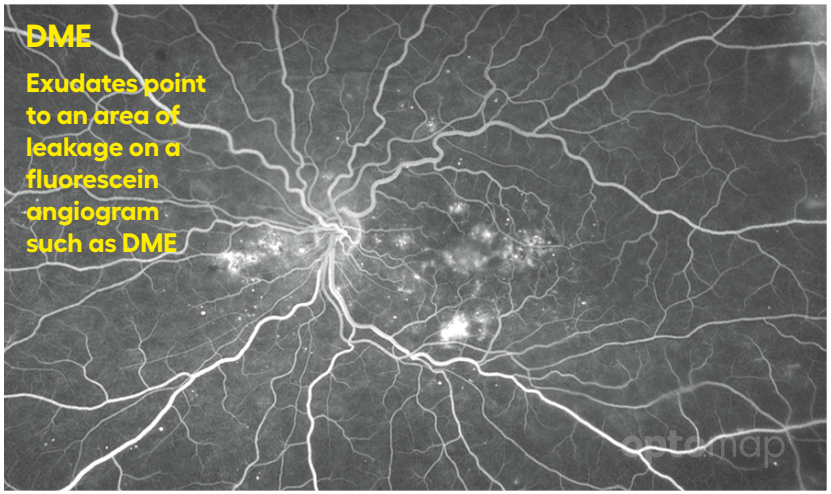
optomap *fa* has been demonstrated to show 3.9 times more non-perfusion than traditional ETDRS.[1] Another study concluded that non-perfusion in DR begins in the midperipheral retina and ischemia, thus accounting for the increased risk of progression.[2]

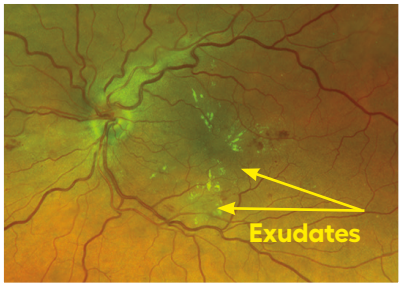
1. Kiss et al. Ultra Wide Field Angiography Improves the Detection and Classification of Diabetic Retinopathy. Retina. 2012
2. Aiello et al. Diabetic Retinopathy Severity and Peripheral Lesions Are Associated with Non-perfusion on Ultrawide Field Angiography. Ophthalmology, 2015.

Diabetic Macular Edema (DME)

is retinal swelling and cyst formation in the macular area. It usually results in temporary decreased or permanent vision loss. DME will hyperfluoresce as pooling on a fluorescein angiogram.

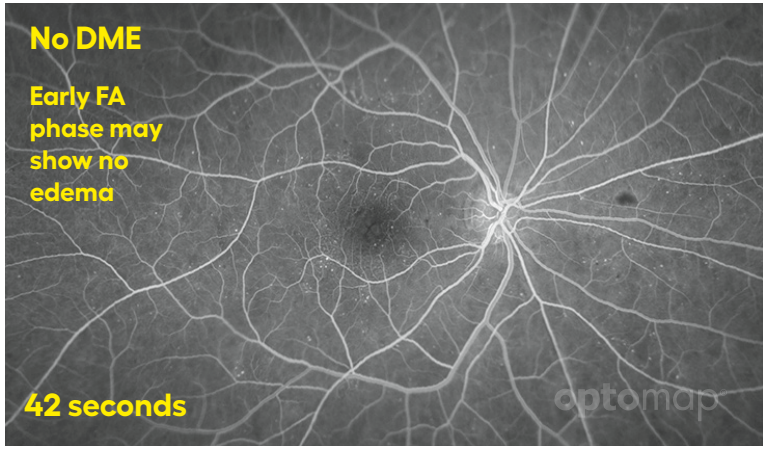


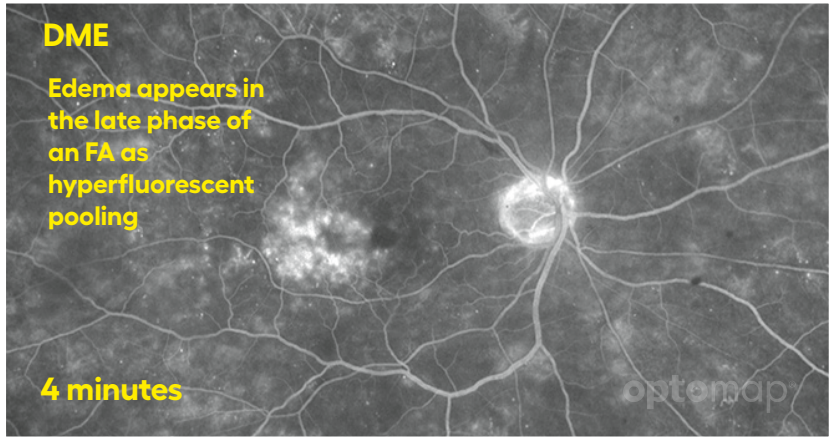




optomap *fa* findings have been correlated to traditional FA imaging methods macular edema and signs of macular ischemia on SD-OCT.[1]

Exudates are proteins or lipids that leak from blood vessels into the surrounded tissue or space.

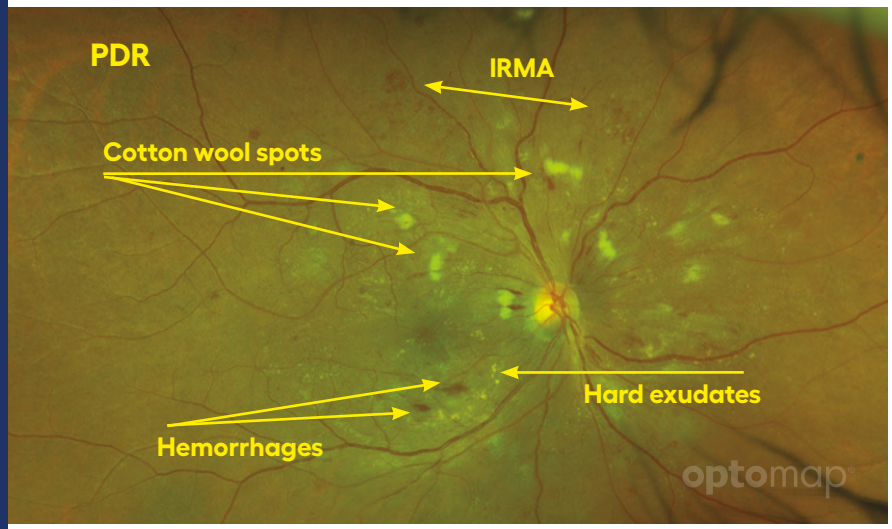


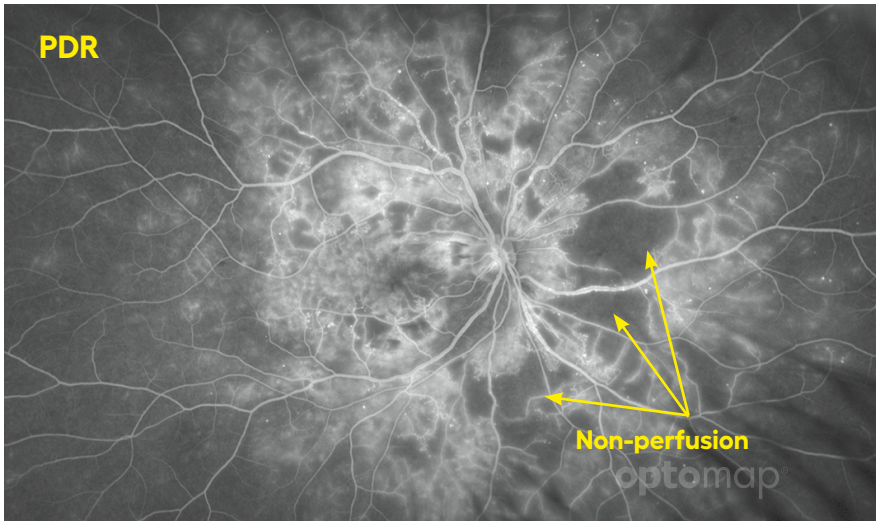


1. Tsui et al. Ultra Wide Field Fluorescein Angiography Can Detect Macular Pathology in Central Retinal Vein. OSLI. 2012.

Intraretinal Microvascular Abnormalities (IRMA)

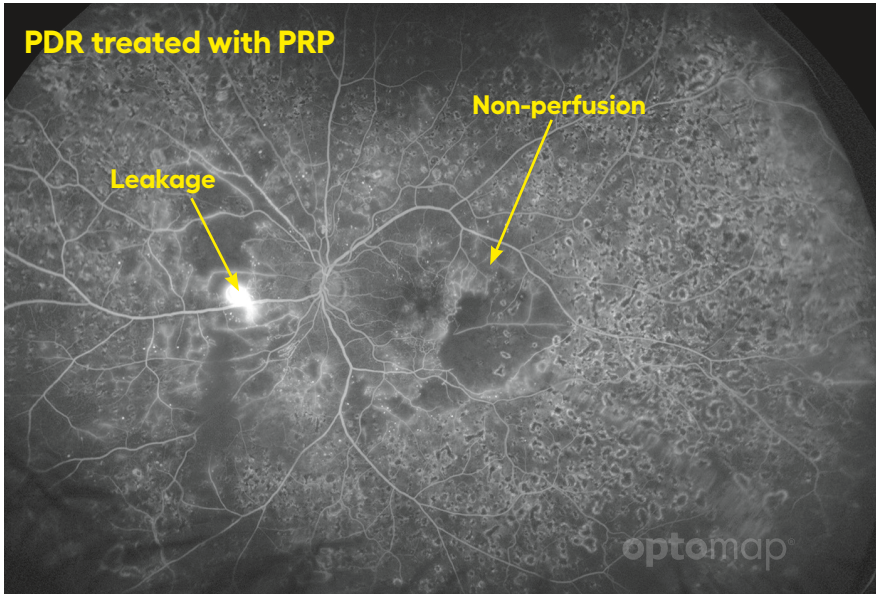
is a development of abnormal blood vessels with tiny aneurysms along with connections (shunts) from arterioles to venules. They occur in hypertensive and diabetic retinopathy, when blood is unable to flow through the normal capillaries, resulting in retinal anoxia and possible edema.





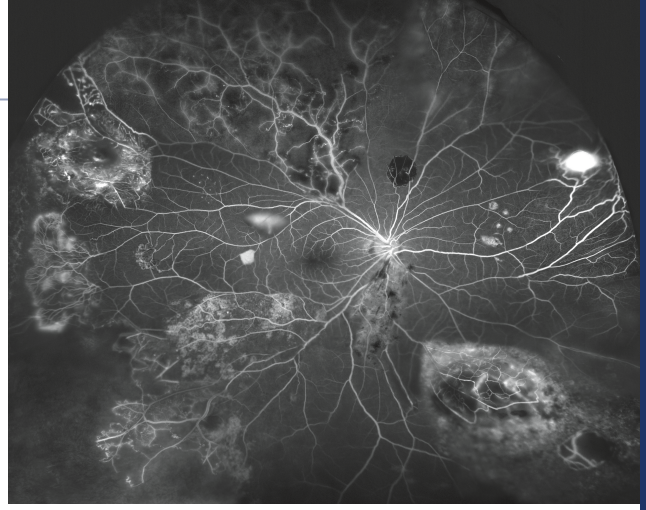
Pan-Retinal Photocoagulation (PRP)

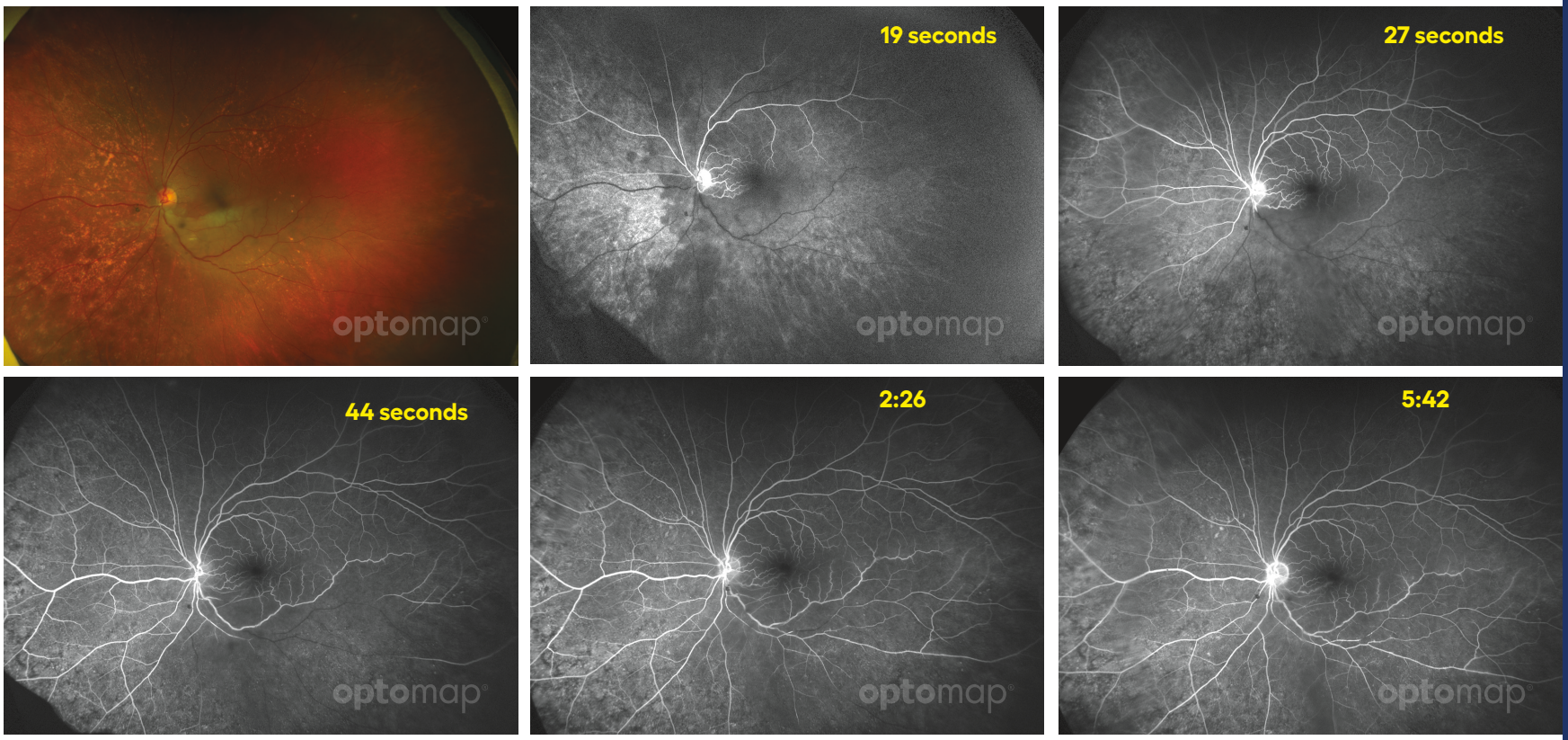
is used to treat the vascular abnormalities associated with diabetic retinopathy. Laser photocoagulation uses the heat from a laser to seal or destroy abnormal, leaking blood vessels in the retina. **opto**map imaging can be used to help determine areas that need laser treatment.



Retinal Artery Occlusion

occurs when there is an obstruction to the blood flow in the arteries. It is found in elderly patients who have arteriorsclerotic disease or younger patient whom have an embolic obstruction of the artery or its branches.

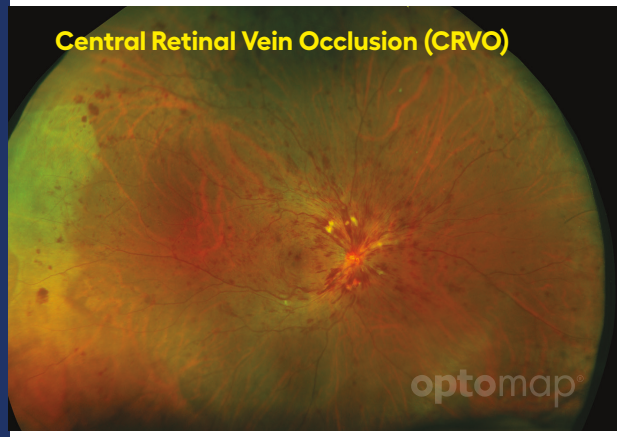


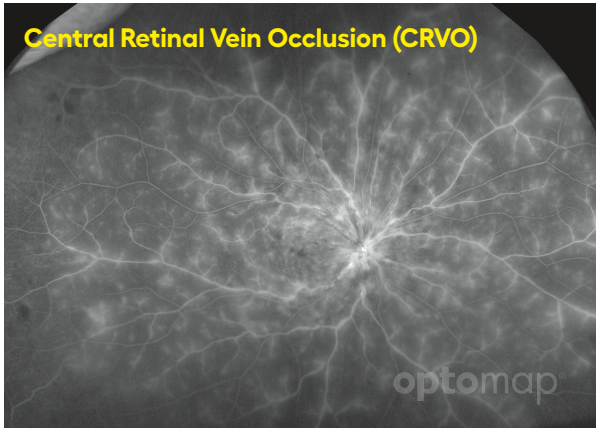


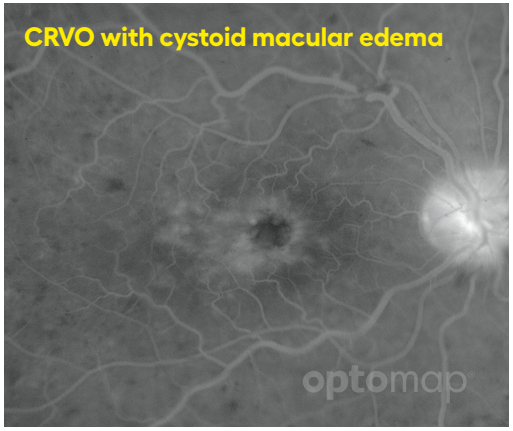
optomap *fa* images show delayed filling in Branch Retinal Artery Occlusion in a fluorescein angiography series.

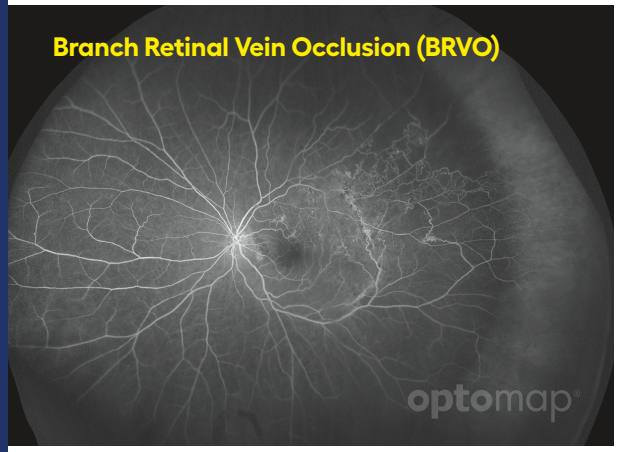
Retinal Vein Occlusion

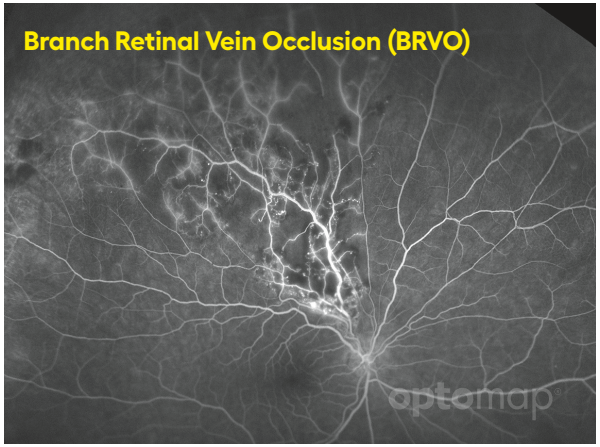
is a retinal vascular disorder that can involve the central retinal vein, a major branch of the central vein, or any part of a branch. Fluorescein circulation is delayed showing areas of non-perfusion and the point of the occlusion can usually be seen with angiography. Vessel leakage and staining can occur in the vessels extending off the region of occlusion. Cystoid macular edema (CME) can also be present and visual acuity is greatly decreased.

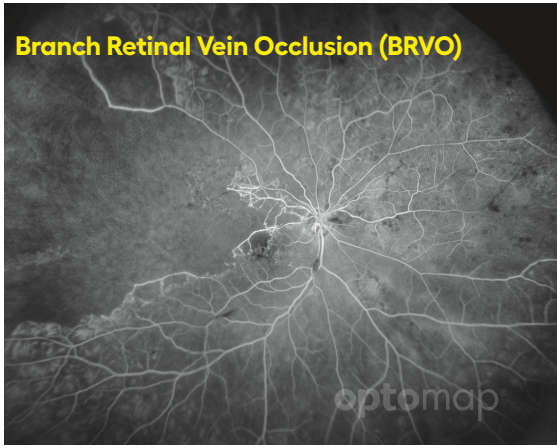






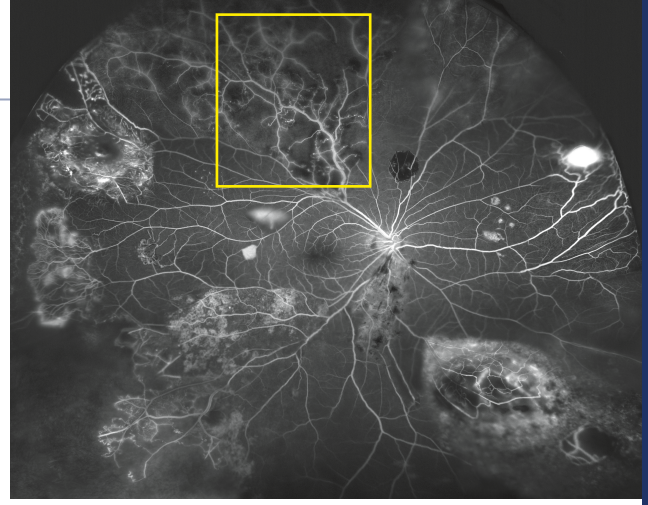


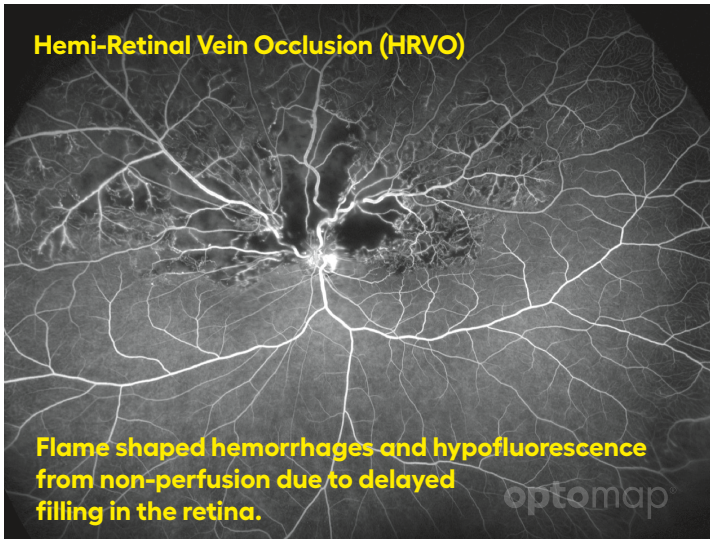


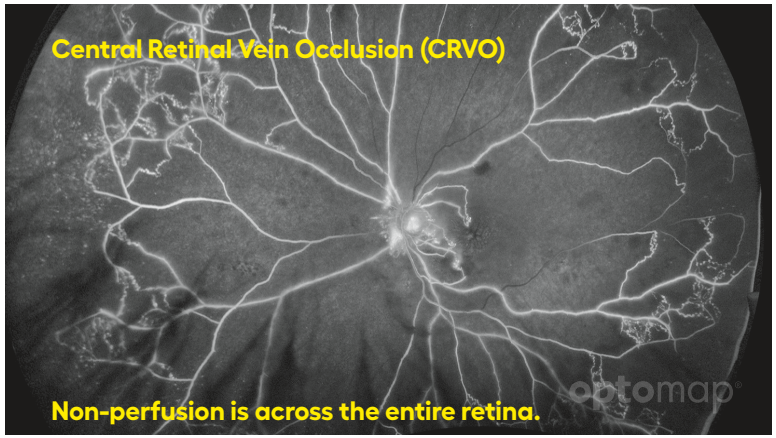


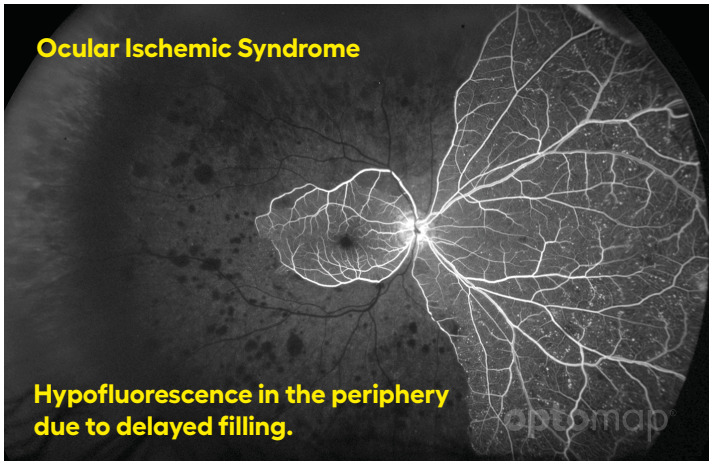
Ocular Ischemic Syndrome

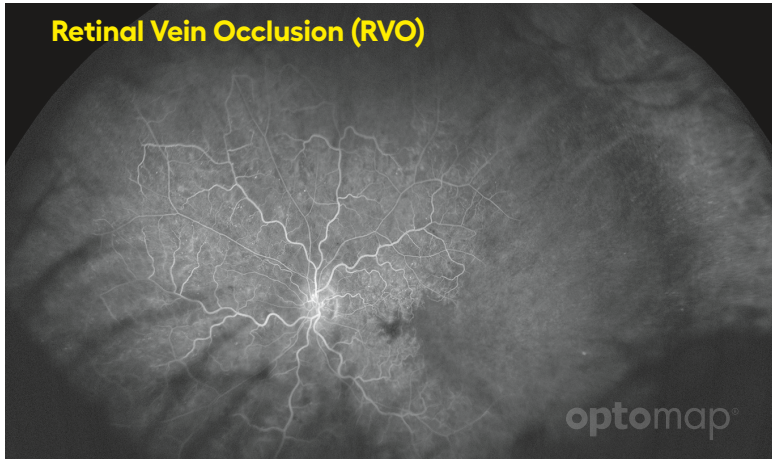
is a retinal vascular disorder, which is a result of carotid artery insufficiency. Delayed perfusion of the retina and choroidal circulation, macular edema and disc staining are seen with fluorescein angiography.





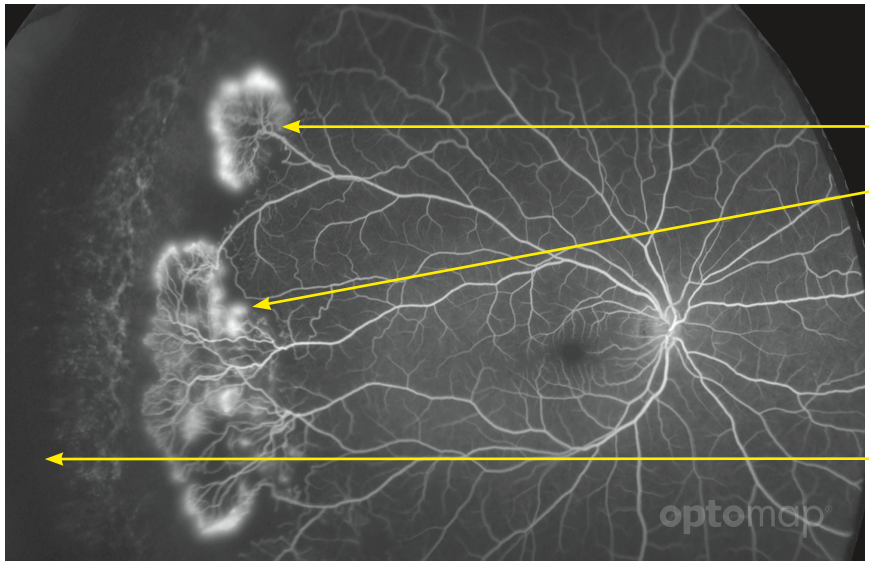


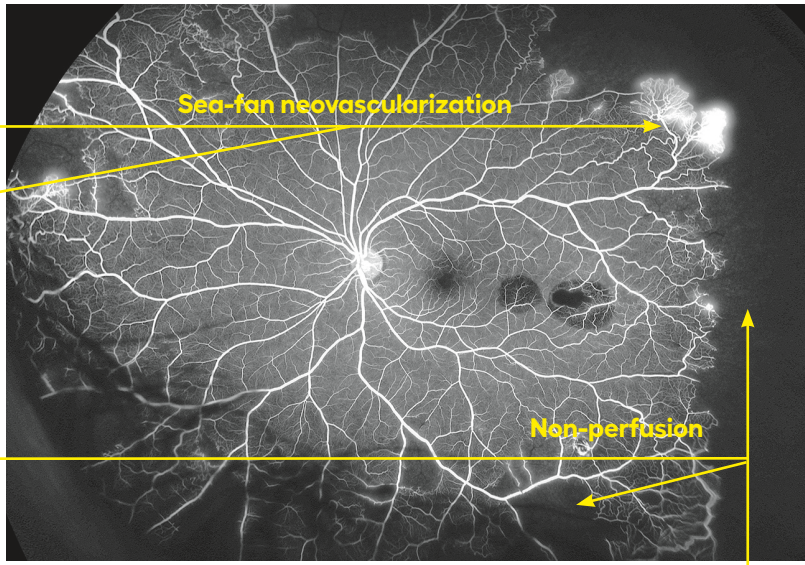


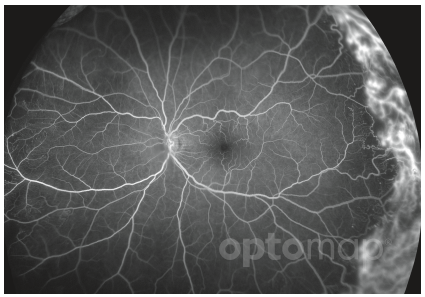


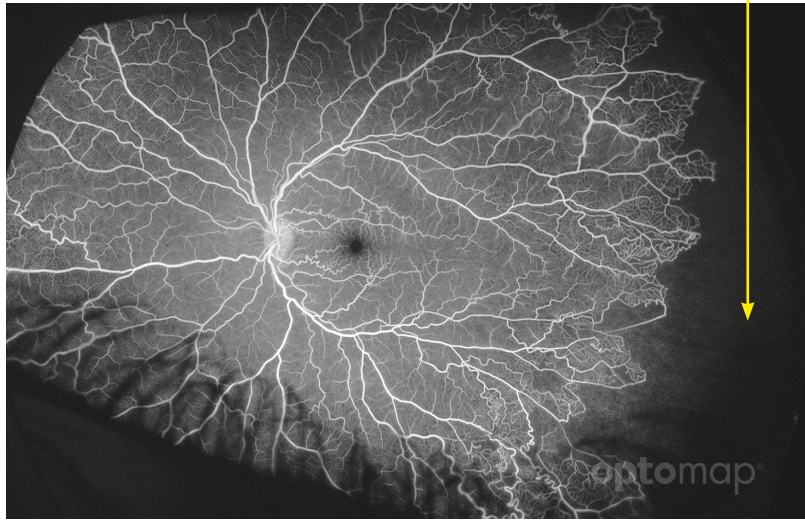
Sickle Cell Retinopathy

is a hereditary blood disorder that causes systemic problems relating to localized clumping of blood cells. In the eye, retinal changes occur such as: neovascularization, sea-fans, arterial blockage, capillary closure, angioid streaks, and retinal deposits. **opto**map *fa* is used to show extent of peripheral vascular changes.







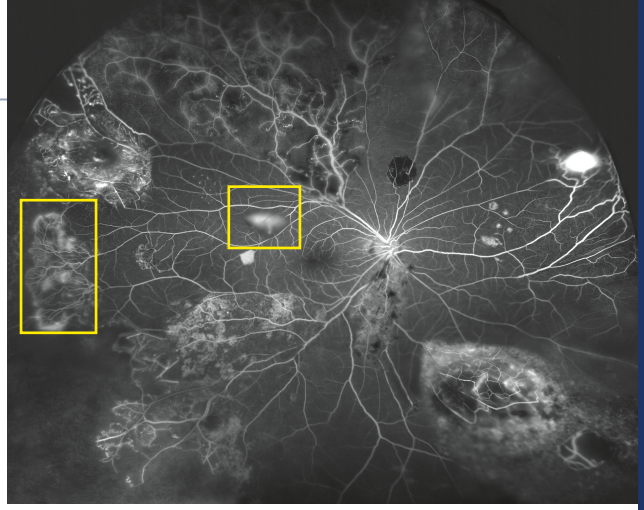


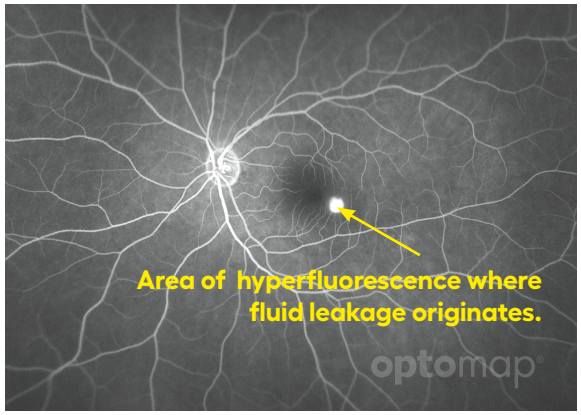
Peripheral non-perfusion observed on **opto**map *fa* is greater in those with sickle cell disease and proliferative retinopathy and has been correlated with macular vessel density on OCTA[1].

1. Han et al. Correlation of ultra-widefield fluorescein angiography and OCT angiography in sickle cell retinopathy. Ophthalmology Retina. 2017.

Central Serous (Chorio) Retinopathy (CSR, CSCR)

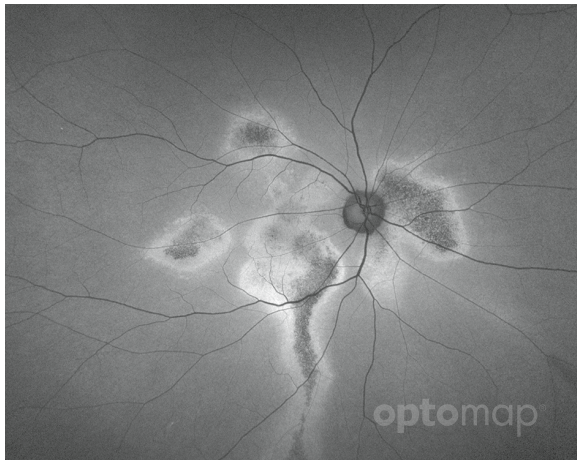
is a blister-like elevation of sensory retina in the macula (area of central vision), with localized detachment from the pigment epithelium. Results in reduction and/or distortion of vision that usually recovers within a few months.

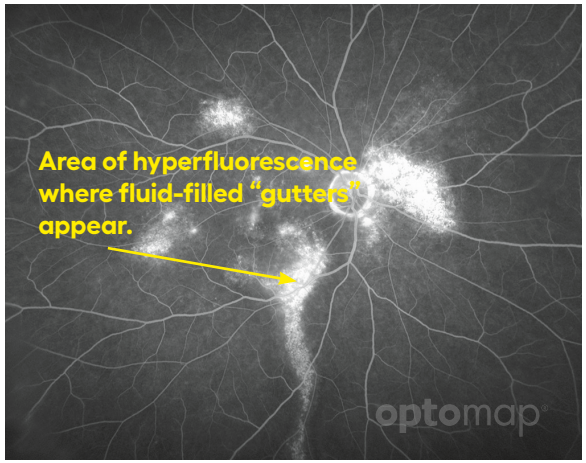




optomap *fa* is used to identify the source of leakage and whether it is from a single or multiple sources.

Color imaging alone can be challenging to pinpoint the area of leakage from CSR.

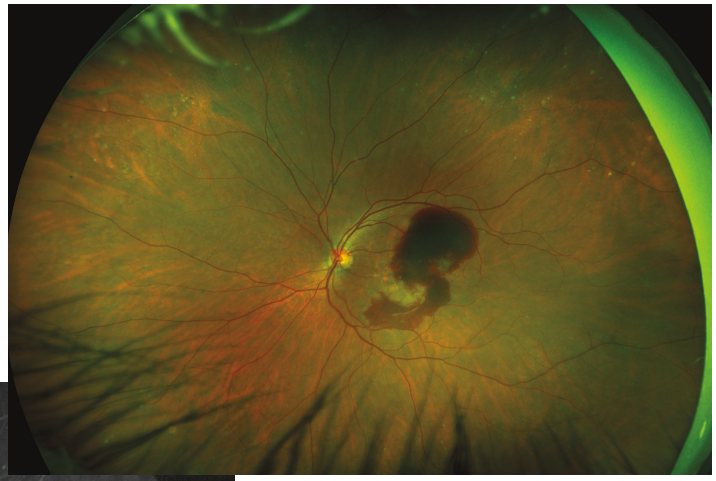


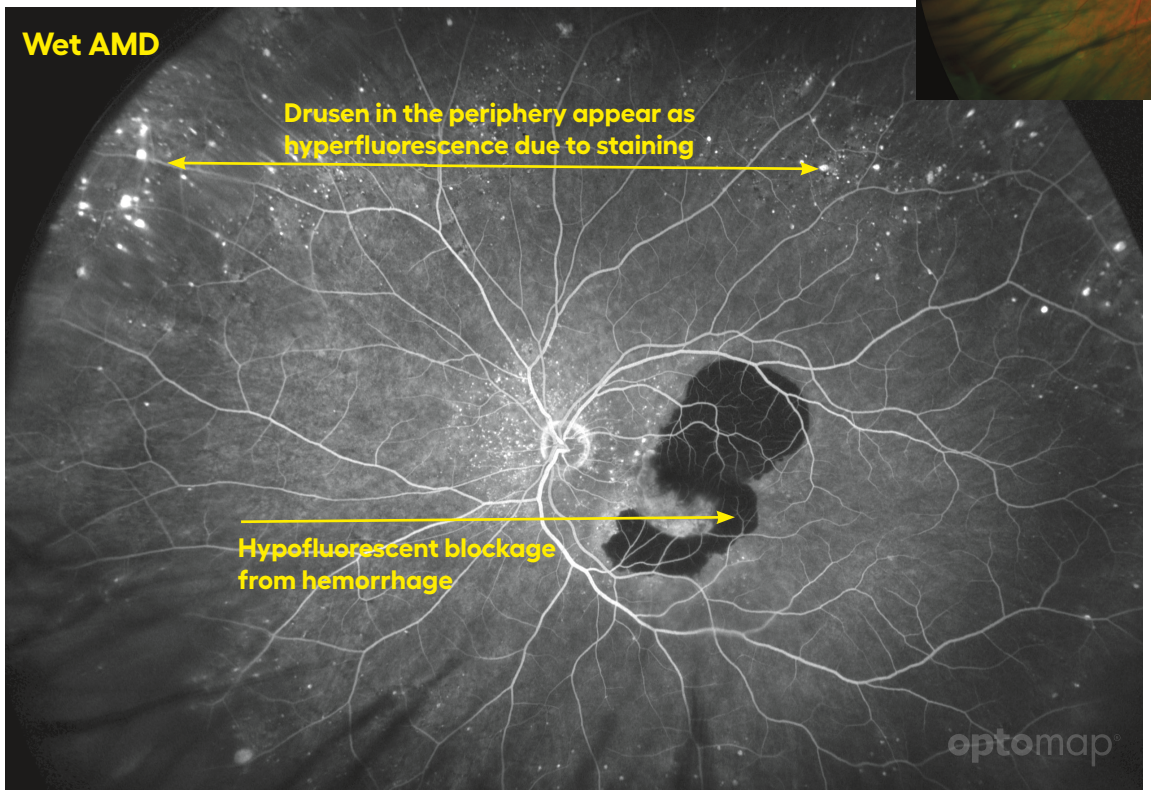


Age-Related Macular Degeneration (AMD, ARMD)

is a group of conditions that include deterioration of the macula, resulting in loss of sharp central vision. Two general types: dry and wet. Dry is usually evident as a disturbance of macular pigmentation and deposits of yellowish material under the pigment epithelial layer in the central retinal zone.

Wet AMD is abnormal new blood vessel growth under the retina which leaks fluid and blood, further disturbing macular function. **opto**map *fa* is used to rule out progression to wet AMD.



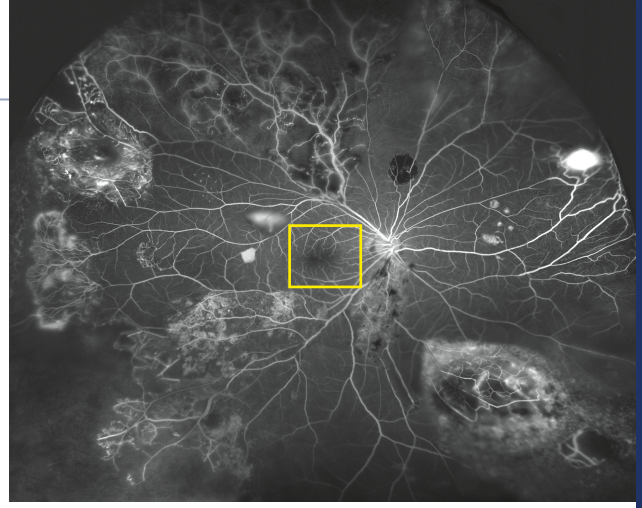


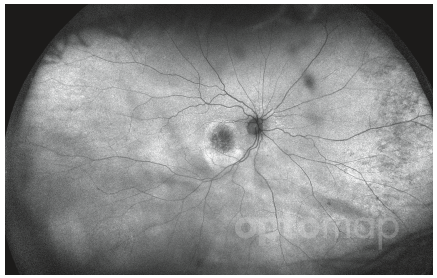
Age-related macular degeneration is best managed with multimodal imaging and may be more than a "macular" condition but one that involves the entire retina.[1]

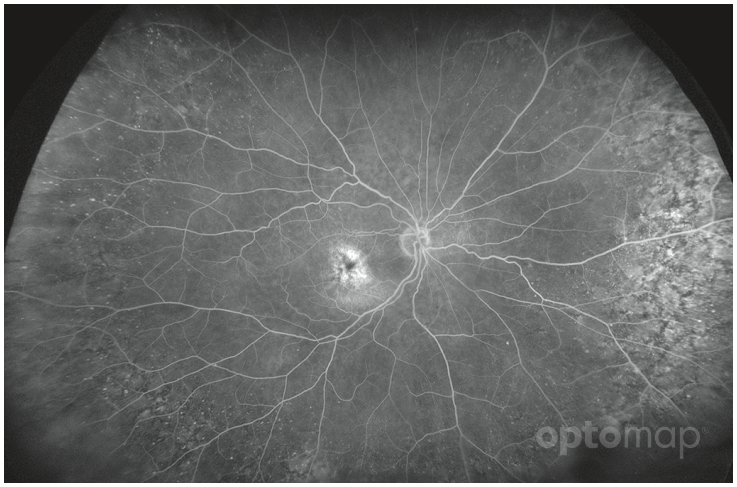
1. Friberg. Peripheral Retinal Changes Associated with Age-Related Macular Degeneration in the Age-Related Eye Disease Study 2. Ophthalmology. 2016.

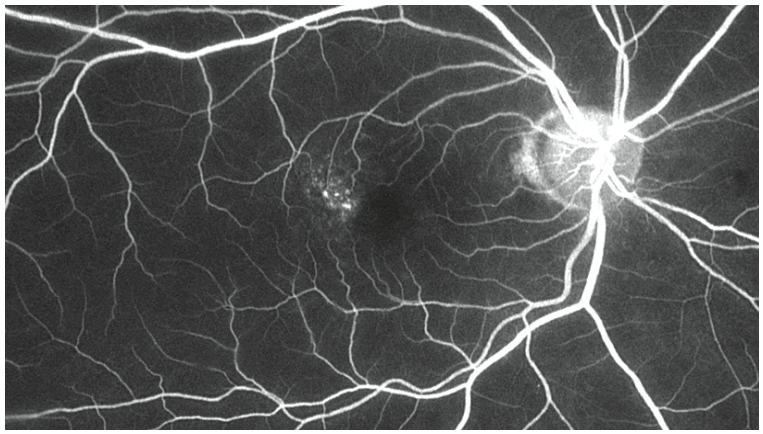
Choroidal Neovascular Membrane (CNV, CNVM)

is associated with AMD and there are two types: classic and occult. Classic will appear in the early phase with a well-defined area of hyperfluorescence. Occult may be poorly defined and areas of neovascularization are fuzzy, bright hyperfluorescent regions.









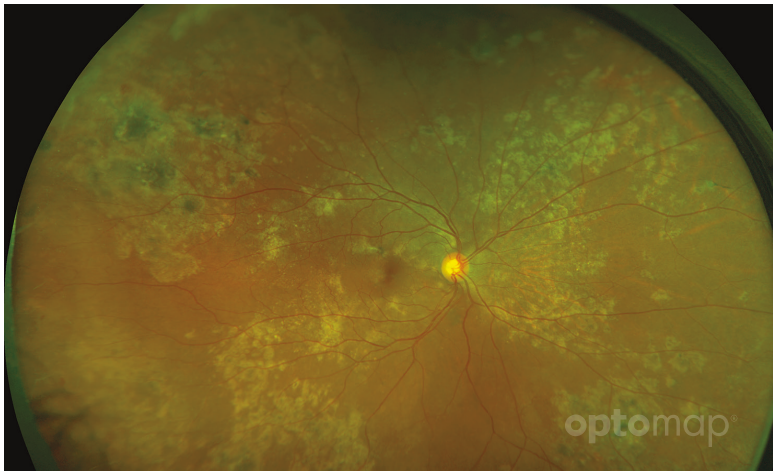
A recent study, looked at AMD subjects using UWF fluorescein angiography and found that 84.59% had hyperfluorescent characteristics in the periphery of which the main contributors were drusen, paving stone, and atrophic areas.[2]

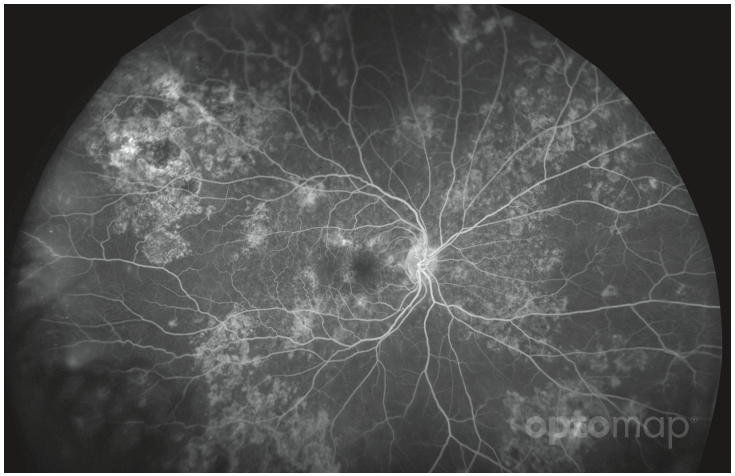
optomap *fa* imaging has been validated to have equivalent resolution in the central pole to traditional imaging methods and ETDRS.[2]

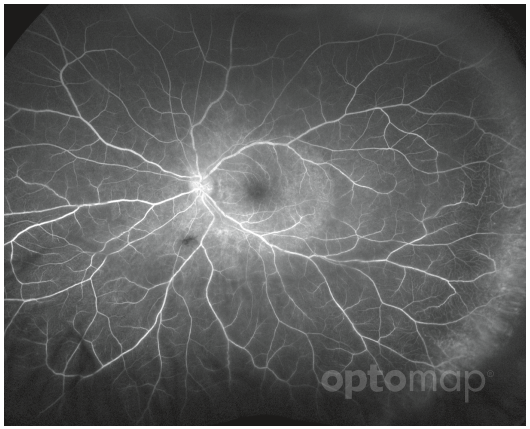
1. Friberg. Morphologic and Angiographic Peripheral Retinal Changes in Patients with Age-related Macular Degeneration. Ophthalmology. 2017.
2. Tsui. Ultra Wide Field Fluorescein Angiography Can Detect Macular Pathology in Central Retnal Vein Occlusion. 2012.

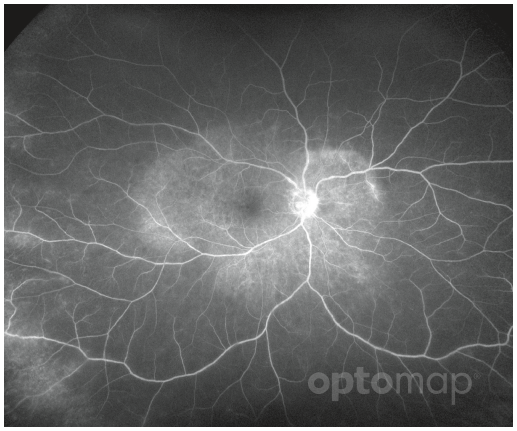
Uveitis

is inflammation of any of the structures of the uvea: iris, ciliary body or choroid. **opto**map *fa* is used to look for localized and diffuse leakage throughout the retina. Images may appear slightly blurry due to inflammatory cells in the vitreous, called vitreous haze.







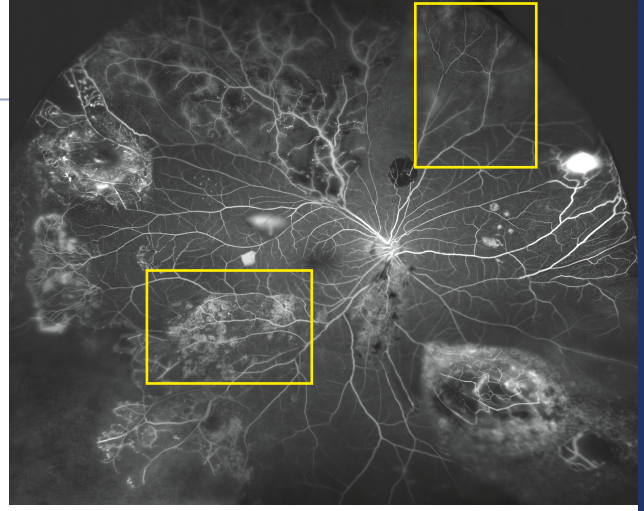


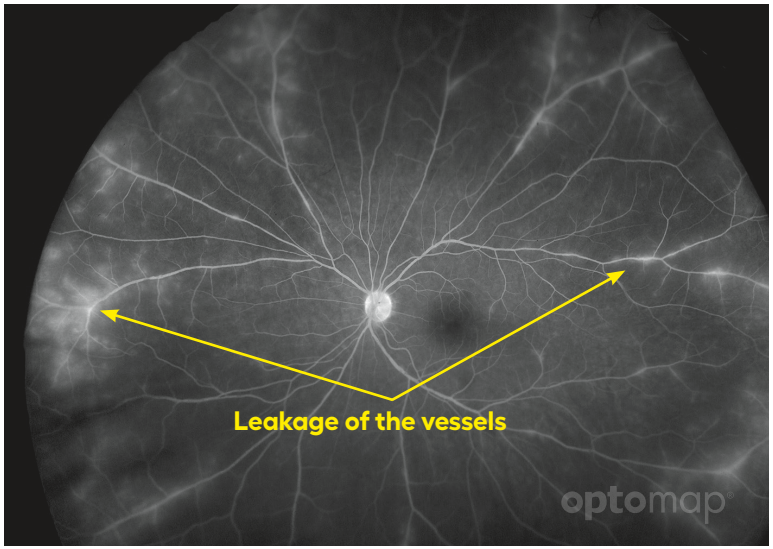
optomap *fa* shows hyperfluorescent staining of the peripheral lesions seen in uveitis. One study showed combined ultra-widefield color and **opto**map *fa* altered management in 48% of patients[1]

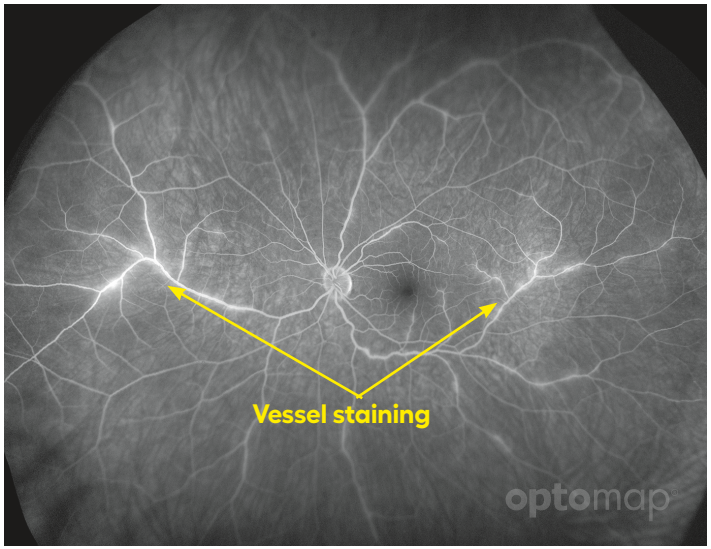
1. Campbell et al. Wide-field Retinal Imaging in the Management of Noninfectious Posterior Uveitis American Journal of Ophthalmology 2012

Vasculitis

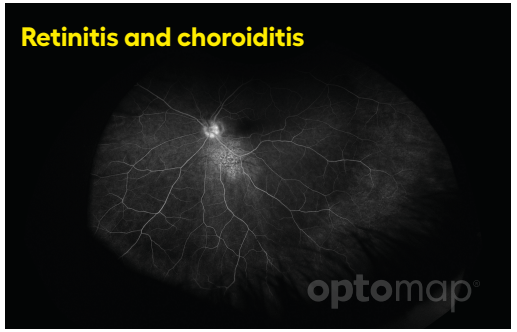
is the inflammation of a blood or lymph vessel. Fluorescein angiography is used to identify these areas of leakage or vessel staining. **opto**map *fa* is used to identify the level of activity pre and post-treatment.







optomap *fa* has been found to detect up to 59% more changes associated with vasculitis than conventional imaging and exam. It has also been reported that the changes seen on **opto**map *fa* has impacted treatment decisions up to 65% of the time. [1,2]

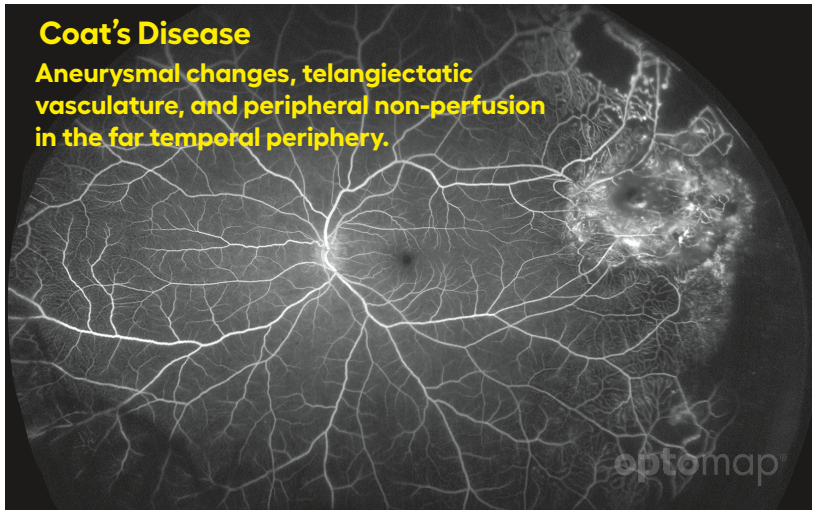


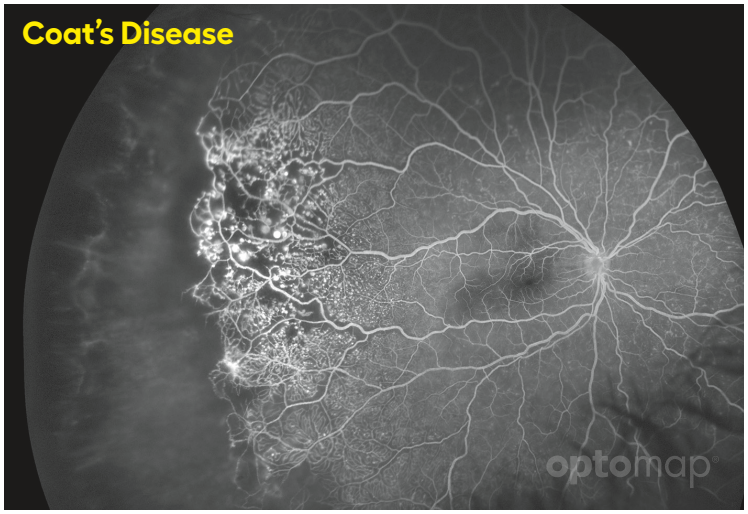
1. Leder et al. Ultra-wide-field retinal imaging in the management of non-infectious retinal vasculitis. Journal of Ocular Inflammation, 2013.

2. Stanga et al. Ultra-widefield fundus fluorescein angiography in the diagnosis and management of retinal vasculitis. Eye. 2017.

Coats' Disease

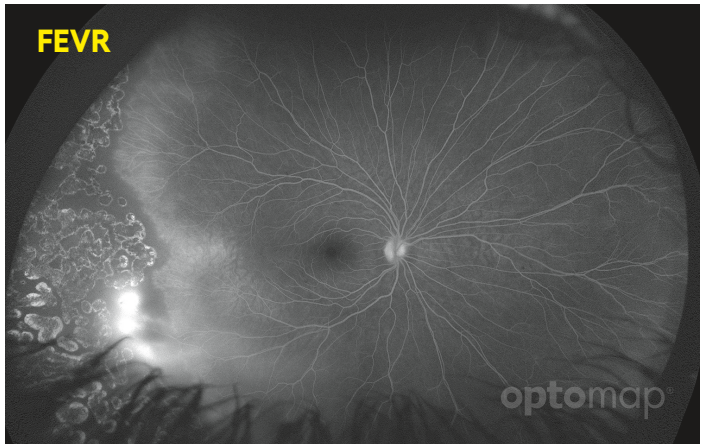
is a chronic, progressive retinal disorder characterized by massive white exudates under the retina, with eventual detachment and glaucoma. This disorder is associated with malformed, tortuous retinal blood vessels and aneurysmal dilatations.

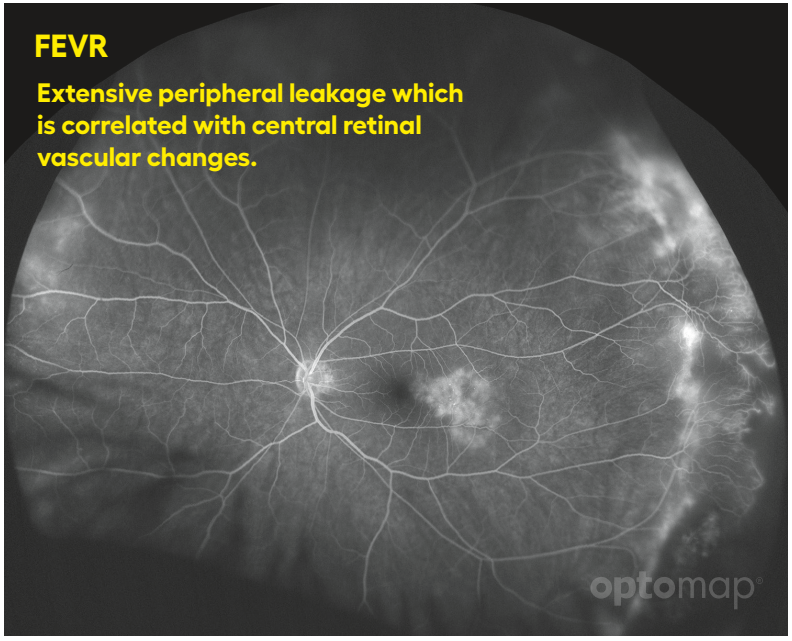




Familial Exudative Vitreoretinopathy (FEVR)

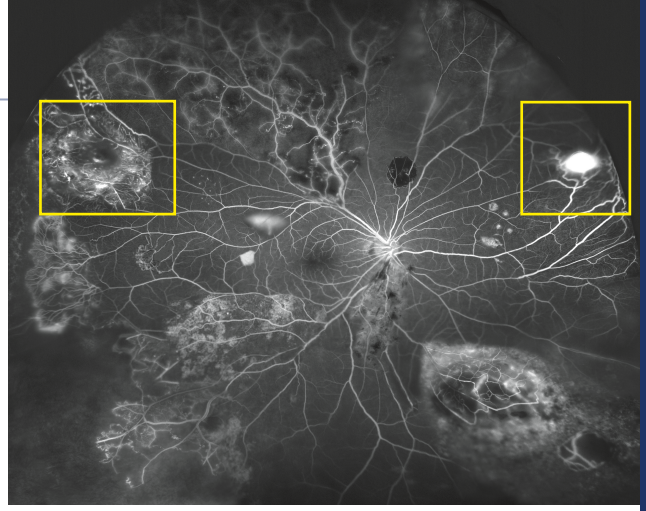
is a hereditary condition characterized by fluid leakage from the retina, and vitreo-retinal membrane formation with new blood vessels.

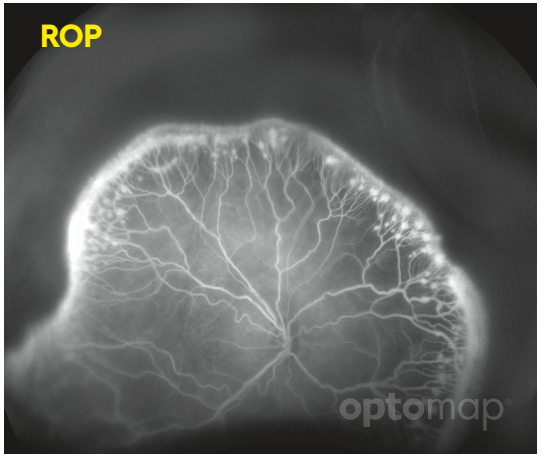


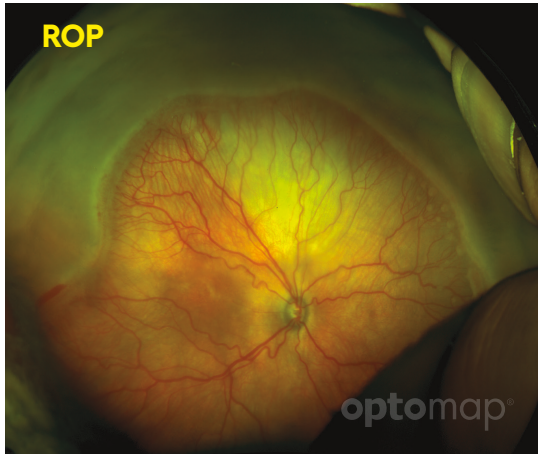


Retinopathy of Prematurity (ROP)

is a retinal vasculature disorder that affects severely premature babies, resulting from incomplete peripheral vascularization at birth followed by abnormal vascularization. **opto**map *fa* is used to determine the extent of vasculature present to grade the level of ROP and monitor response to treatment.



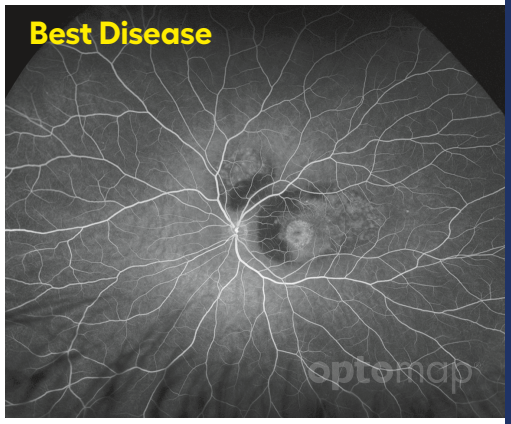




optomap can obtain high-quality images in babies with retinopathy of prematurity (ROP) down to 34 weeks.[1] **opto**map has been shown to capture up to 75% more abnormal peripheral pathology in pediatric patients unseen by conventional imaging methods in ROP.[1,2]

Best Disease

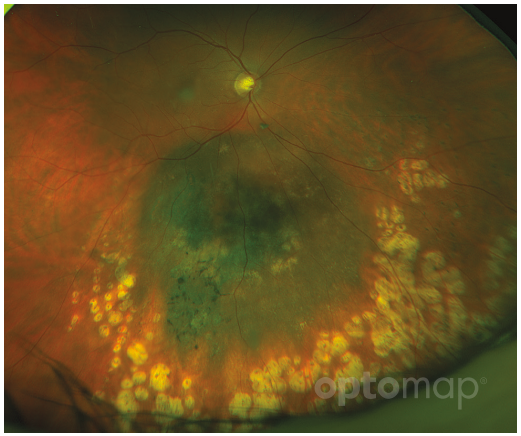
is a juvenile disease and vitelliform macular degeneration is an inherited eye condition. Best disease can start to cause changes at the back of the eye between the ages of 3 to 15 although it does not usually affect vision until later on in life.

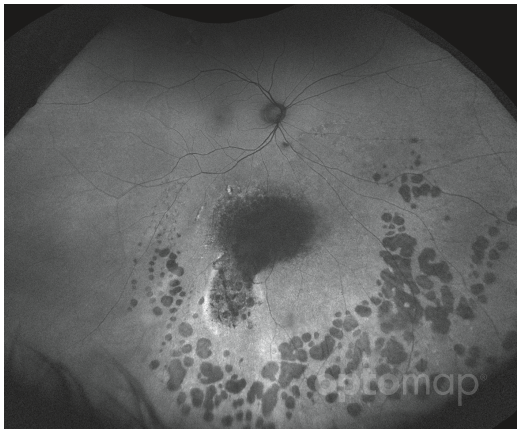


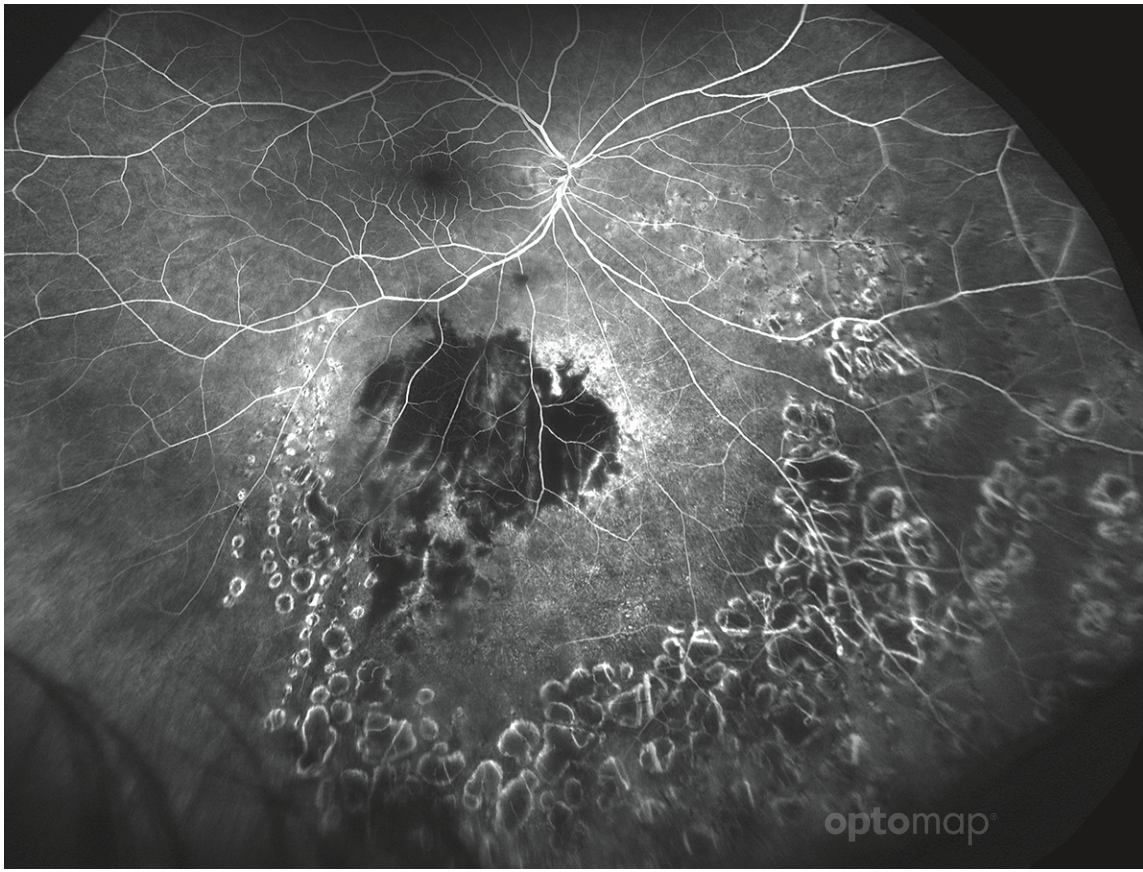
1. Patel et al. Non-contact Ultra-widefield imaging of Retinopathy of Prematurity Using the Optos dual Wavelength scanning Laser Ophthalmoscope. Eye. 2013.
2. Kang et al. Ultra-widefield imaging for the management of pediatric retinal diseases. Journal of Pediatric Ophthalmology and strabismus. 2013.

Choroidal Melanoma

is a form of malignant tumor derived from pigment cells initiated in the choroid. If an ocular tumor is suspected, **opto**map *fa* can aid in determining the characteristics of the retinal circulation at or around the tumor mass as well as establishing if the tumor is leaking dye or blocking fluorescence.

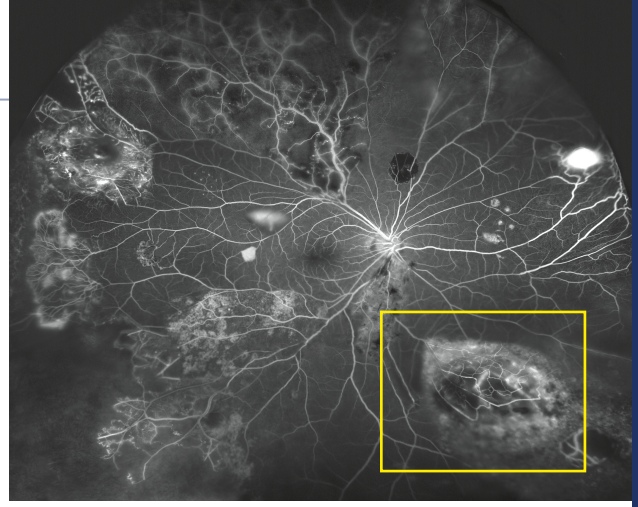




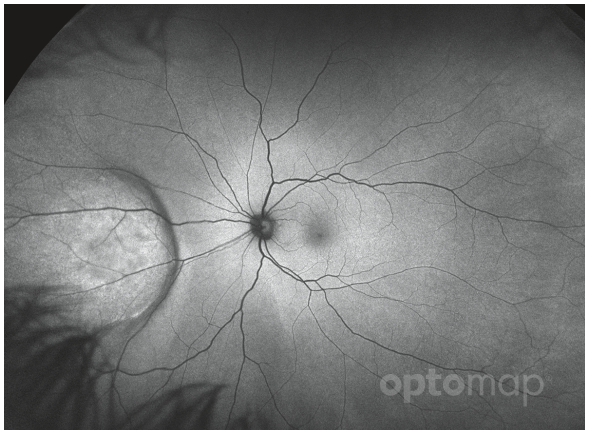


Multimode **opto**map *fa* imaging allows for documentation and monitoring of the extensive retinal changes and patterns of vascular damage that can be associated with choroidal tumors and their treatment.[1]

1. McCannel et al. New Ultra-Wide-Field Angiographic Grading Scheme for Radiation Retinopathy after Iodine-125 Brachytherapy for Uveal Melanoma . Retina. 2017.




optomap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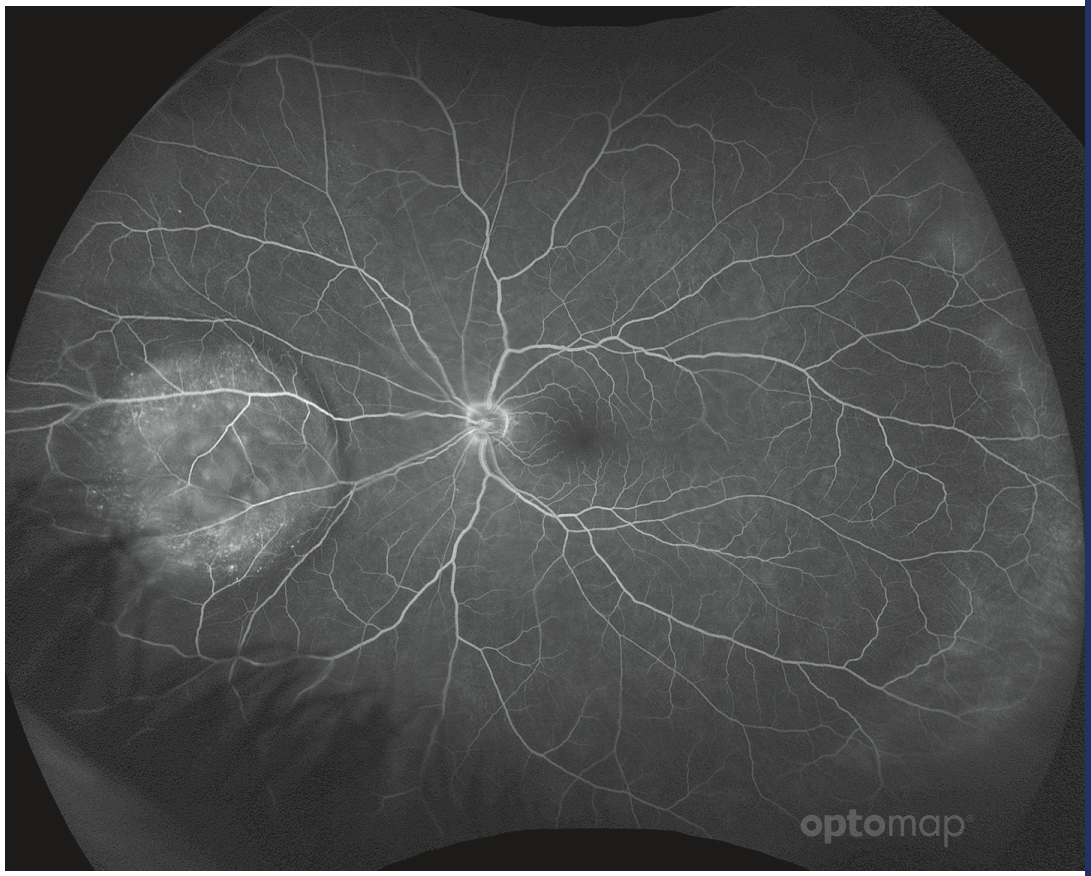
optomap

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The **opto**map *fa* Diagnostic Atlas: A Retinal Reference Guide
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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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