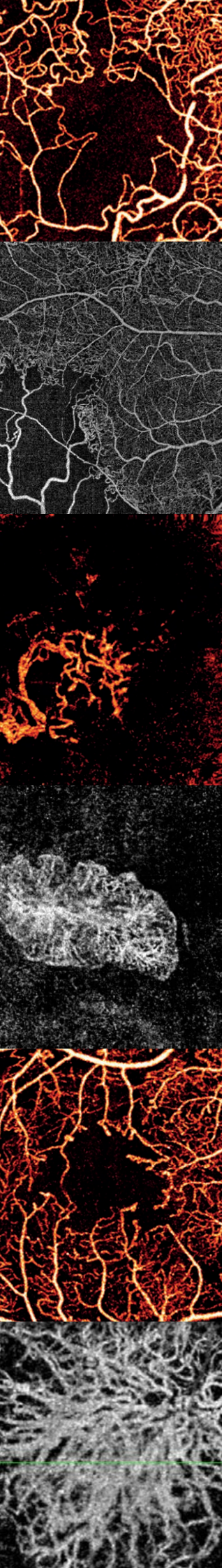


OCT Angiography in Primary Eye Care

An Image Interpretation Primer

Julie Rodman, OD, MS, FAAO and Nadia Waheed, MD, MPH

Table of Contents

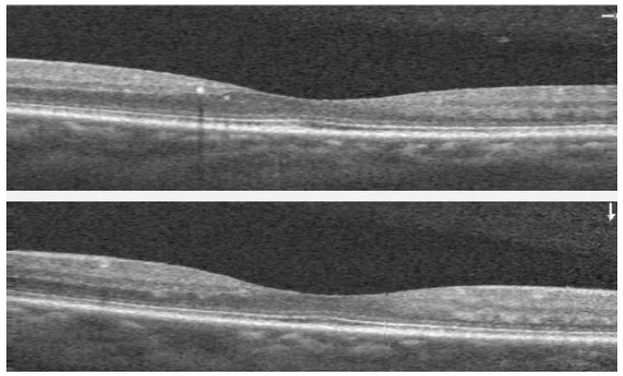
Diabetic Retinopathy Case 1

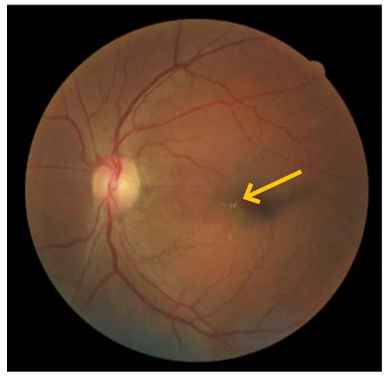
Images courtesy of Julie Rodman, OD

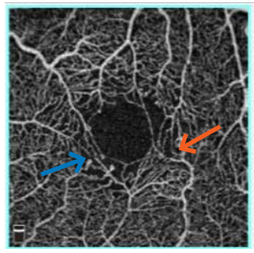
In this case, the color fundus photograph shows hard exudates inferonasal to the fovea (yellow arrow). Although there is no clear macular edema on the OCT B-scan, it shows hyper-reflective spots indicative of the hard exudates and also some structural changes and irregularity in the inner retina. These findings indicate that edema, possibly subclinical, may have been present previously.

Of the four automatically generated OCTA segmentation maps provided in the overview report, the two of most interest for evaluating diabetic eye disease are the slabs showing the superficial capillary plexus and the deep capillary plexus. Capillary dropout (white arrow), vascular remodeling (orange arrow) around the foveal avascular zone, and numerous small microaneurysms (blue arrow) are seen in the superficial and deep capillary plexus and appear to be correlated to the areas of hard exudates.

Given the hard exudates and the ischemic changes detected by OCTA, this patient is at increased risk for developing diabetic macular edema and should be monitored closely. Examination and OCT scans should be repeated in 3-4 months with a low threshold for referral if the signs worsen.







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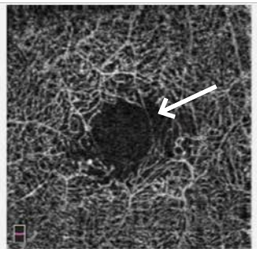
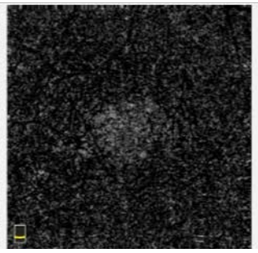
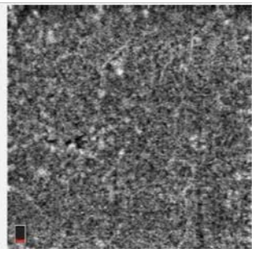


Deep Capillary Plexus



Outer Retina



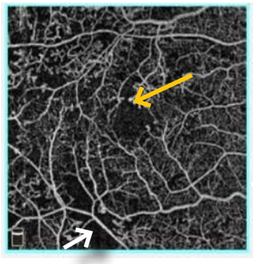
Choriocapillaris

Diabetic Retinopathy Case 2

Images courtesy of Dan Esmaili, MD

The color fundus photograph in this case indicates background diabetic retinopathy. On the OCTA images, capillary dropout (white arrows) is seen in both the superficial capillary plexus and the deep capillary plexus and it is distributed in both the superior and inferior macula. Pruning of the vasculature (yellow arrows), microaneurysms (blue arrow), and enlargement of the foveal avascular zone are also seen. In addition, the OCT B-scan shows intraretinal cystic changes that are indicative of early macular edema.

This patient should be referred to a retina specialist for determination of when treatment should be initiated.



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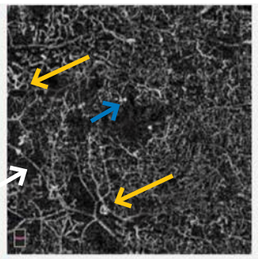

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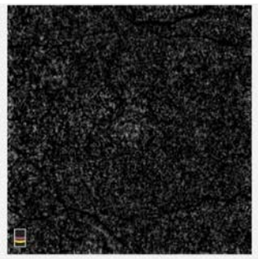

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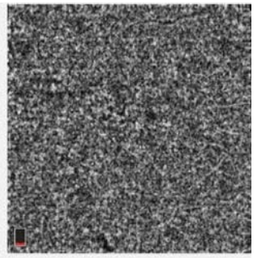
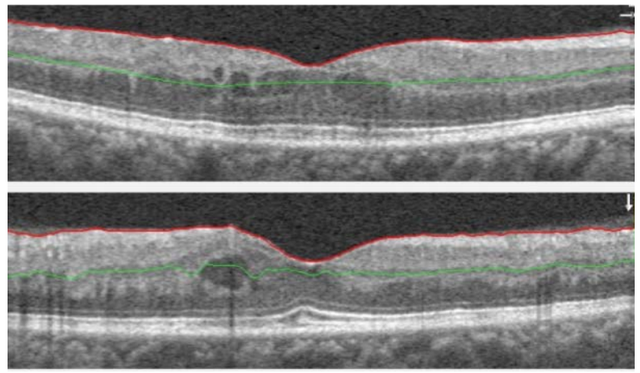
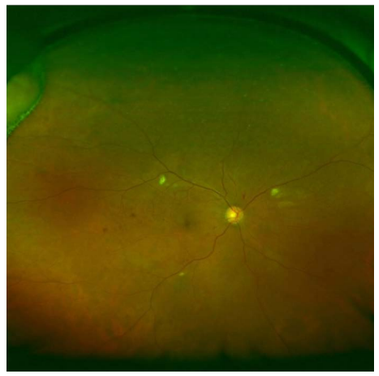


Choriocapillaris





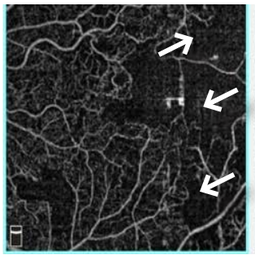
Diabetic Retinopathy Case 3

Images courtesy of Dan Esmaili, MD

Based on the intraretinal hemorrhages and cotton wool spots appearing on the color fundus photograph, this patient has moderate to severe diabetic retinopathy and ischemia.

The OCTA images of the superficial capillary plexus and the deep capillary plexus reveal severe ischemia and swaths of capillary dropout (white arrows), especially on the temporal aspect of the fovea. Interestingly, the OCT B-scan shows not only some mild intraretinal cystic changes indicative of early macular edema but also, on the temporal portion of the scan, loss of layer integrity in the inner retina and thinning of the retina associated with the areas that have profound ischemia. Recent research suggests that areas of capillary loss detected on OCTA are associated with atrophic loss of integrity of the inner retina, similar to the association previously shown to be present on fluorescein angiogram.

This patient should be examined carefully for retinal neovascularization. While immediate intervention may not necessarily be warranted, referral to a retina specialist for fluorescein angiography, preferably widefield, and closer follow-up of the macular edema is prudent. Fluorescein angiography would be useful in detecting retinal neovascularization, and, to a lesser extent, peripheral ischemia, which is likely to be present based on the central ischemia seen on OCTA.



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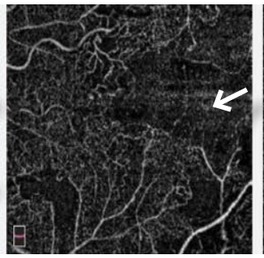
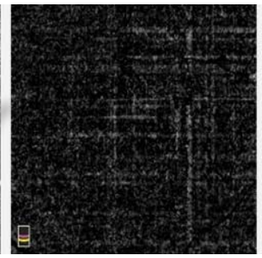
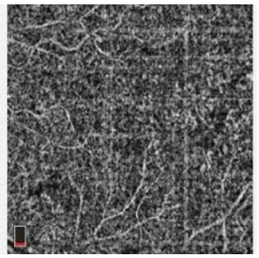


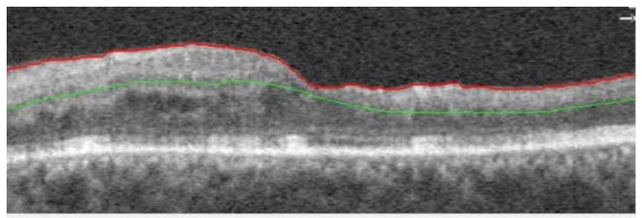
Deep Plexus

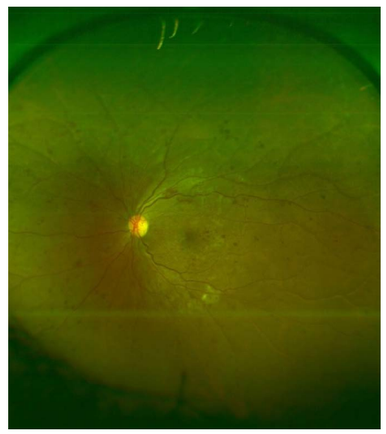


Outer Retina



Choriocapillaris





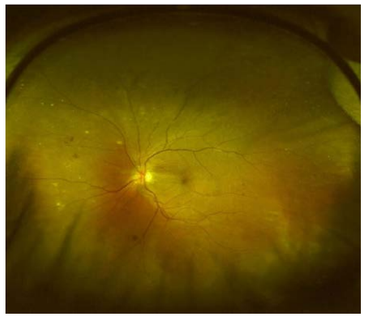
Diabetic Retinopathy Case 4

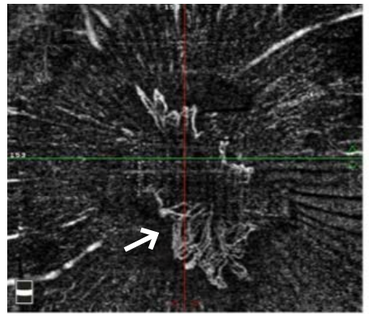
Images courtesy of Dan Esmaili, MD

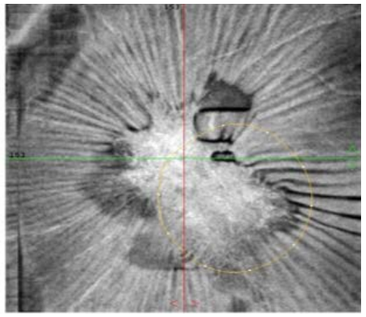
The hard exudates, microaneurysms, and cotton wool spots on this color fundus photograph indicate diabetic retinopathy. In addition, the appearance of the optic nerve suggests the possible presence of early pre-retinal neovascularization of the disc (NVD), which would signify proliferative diabetic retinopathy.

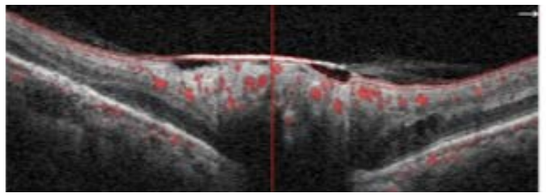
OCTA can be of enormous help when NVD is a concern. In this case, while OCT B-scans over the optic disc reveal the presence of fibrous tissue anterior to the disc extending into the vitreous, OCTA imaging of the region (Angio Disc) with vitreous segmentation confirms that the tissue is vascularized. Note how NVD is obvious on OCTA (white arrow) but could have been missed easily on the fundus photograph.

This patient has proliferative diabetic retinopathy and should be referred to a retina specialist.

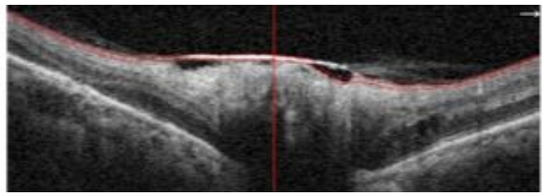








Flow Overlay OCT of Optic Nerve



OCT B-scan of Optic Nerve

Choroidal Neovascularization Case 1

Images courtesy of Julie Rodman, OD

In this case, the color fundus photograph shows pigment changes in the macula, and the OCT B-scan reveals a low-lying pigment epithelial detachment but no subretinal fluid.

Of the four automatically generated OCTA segmentation maps provided in the overview report, the two of most interest for evaluating choroidal neovascularization (CNV) are the slabs showing the avascular outer retina zone and the choriocapillaris. In this case, there appears to be abnormal vasculature/CNV seen on the outer retina and choriocapillaris slabs (white arrows). However, clinicians must be aware that projection artifact from the superficial retinal vasculature, or larger choroidal vessels that have been displaced into an area of atrophy can masquerade as CNV.

Projection artifact is an effect that occurs when the OCT signal passes through moving blood, reflects off underlying tissue, and is erroneously interpreted as blood flow. The result is the appearance of vessels that are actually located in an overlying layer. Thus retinal vessels projected onto the outer retina can mimic the appearance of CNV.

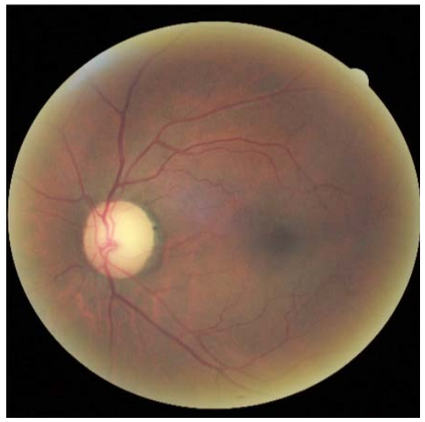
Geographic atrophy causes loss of choriocapillaris and allows larger choroidal blood vessels to migrate into the space ordinarily occupied by the choriocapillaris. These larger choroidal vessels can also give the appearance of CNV.

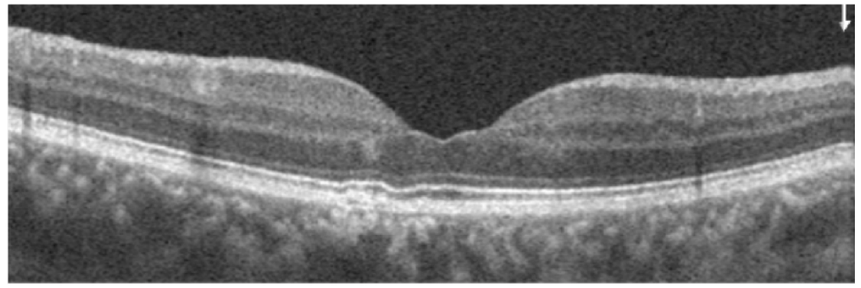
To rule out projection artifact, it is necessary to ensure the segmentation lines don't intersect with the top of a retinal pigment epithelial detachment, which would result in the normal retinal vasculature appearing to be in the outer retina. In addition, the overlying retinal vascular patterns can be compared to the vasculature in the presumed CNV to determine whether they match.

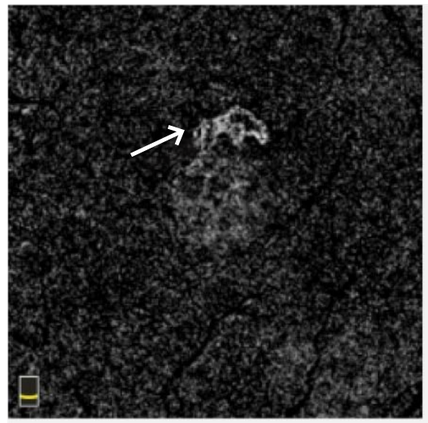
To determine whether larger choroidal vessels displaced into an area of atrophy are masquerading as CNV, evaluate the OCT B-scan over the area of interest as well as the structural en face scan. On the B-scan, atrophy is seen as loss of outer retina and retinal pigment epithelium that allows hyper-transmission of light into the choroid. This also appears as a bright area on the structural en face scan at the level of the choriocapillaris and below.

In the case shown here, no confounding projection artifacts or atrophy appear on the B-scan or en face image. Therefore, true CNV is most likely present.

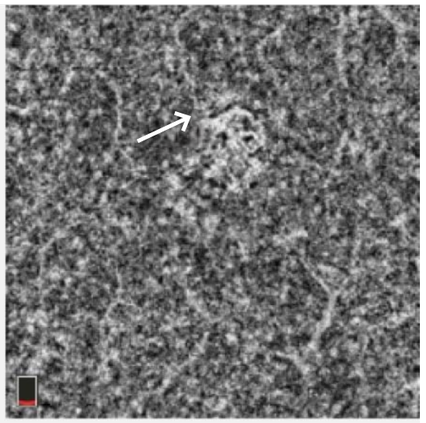
Also, as previously mentioned, no subretinal fluid appears on the OCT B-scan, which indicates that the CNV may be subclinical. It's important in this situation to scroll through all of the OCT B-scans to determine whether any fluid is present. If fluid is present, the patient should be seen by a retina specialist within a few days. If no fluid is present, the patient should be referred and seen within a few weeks. The retinal physician will most likely monitor but not treat asymptomatic CNV.



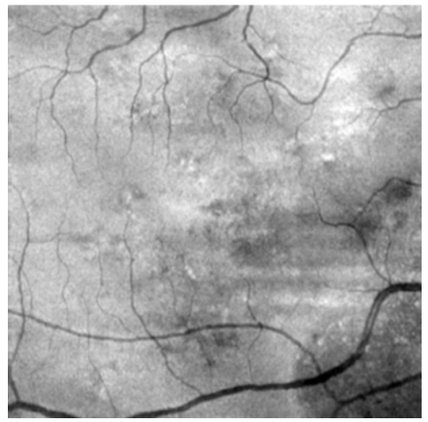




OCTA Outer Retina



OCTA Choriocapillaris



Structural En Face OCT

CHOROIDAL NEOVASCULARIZATION

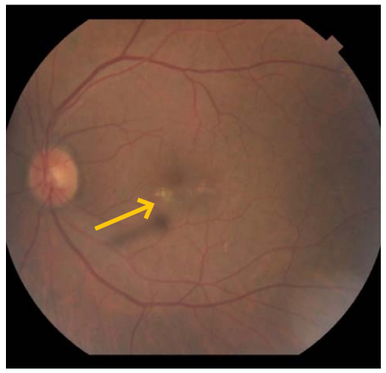
Choroidal Neovascularization Case 2

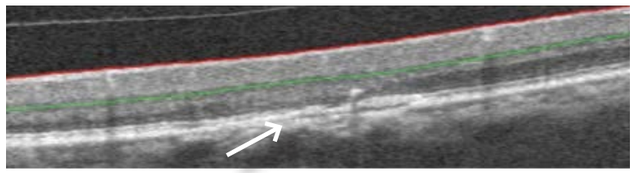
Images courtesy of Dan Esmaili, MD

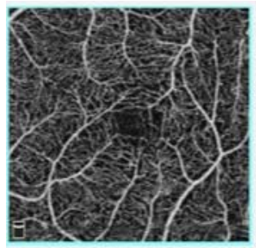
The color fundus photograph in this patient illustrates retinal pigment epithelium changes characteristic of age-related macular degeneration (yellow arrow). While the OCT B-scan indicates an absence of subretinal fluid (white arrow), CNV appears to be present on both the OCTA outer retina and choriocapillaris slabs (blue arrows).

Note how the choriocapillaris slab appears before the automatic removal of projection artifact (choriocapillaris image bottom left). The vessels of the superficial layer are projected into the choriocapillaris layer (green arrows). On the flow overlay image, the green arrow shows some flow beneath a shallow PED that represents the CNV.

As with the previous patient, look carefully for any subretinal fluid, and refer to a retinal specialist.







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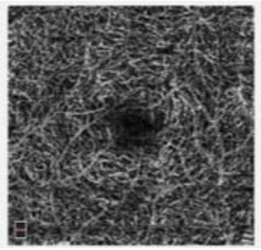

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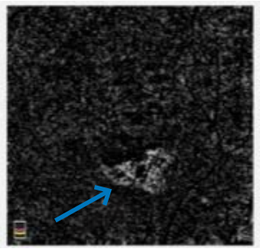
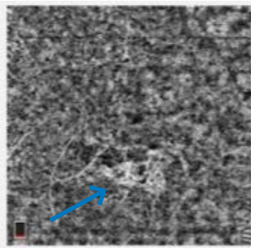


Outer Retina



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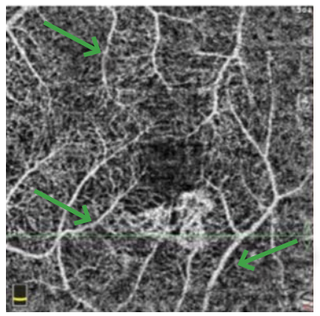
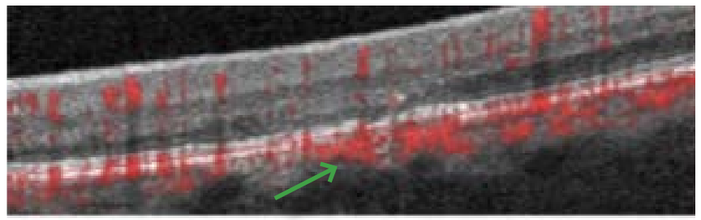


Choriocapillaris Before Projection Artifact Removal



OCT with Flow Overlay

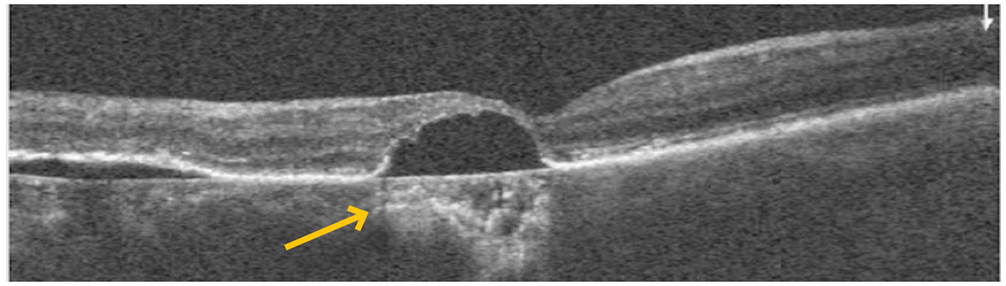
Central Serous Chorioretinopathy Case 1

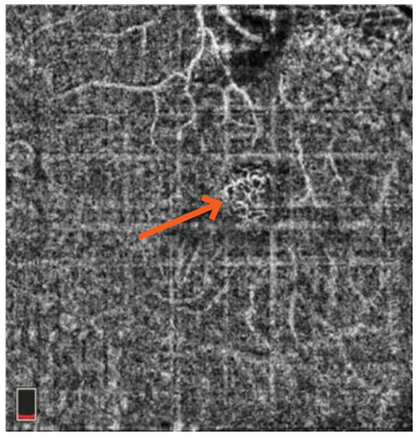
Images courtesy of Julie Rodman, OD

In this patient with central serous chorioretinopathy (CSCR), the retinal pigment epithelium atrophy and area of subretinal fluid with underlying hyper-transmission apparent on the OCT B-scan (yellow arrow) suggest chronicity.

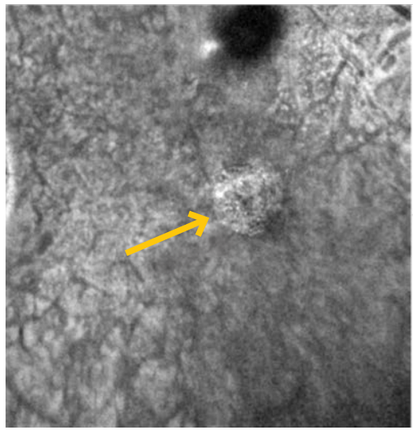
OCTA is an ideal modality for determining whether CNV is present in cases of CSCR. Here, larger vessels are seen on the OCTA choriocapillaris slab (orange arrow). However, the corresponding area of hyper-transmission on the OCT B-scan and the structural en face scan (yellow arrow) indicates that CNV may not be present. Rather, larger choroidal vessels, which likely migrated anteriorly due to choriocapillaris atrophy accompanying the retinal pigment epithelium atrophy, are visible.

Therefore, in this case of chronic CSCR with likely no CNV, the patient should be referred to a retinal specialist for further evaluation and possible fluorescein or indocyanine green angiography to rule out CNV.





OCTA Choriocapillaris



Structural En Face OCT

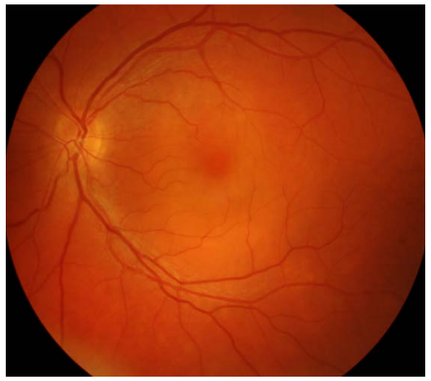
Central Serous Chorioretinopathy Case 2

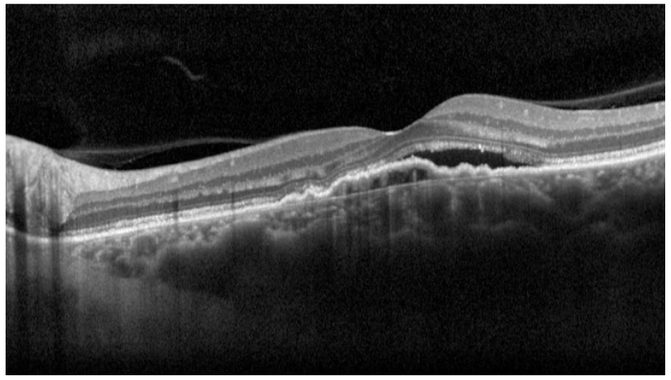
Images courtesy of David Sarraf, MD

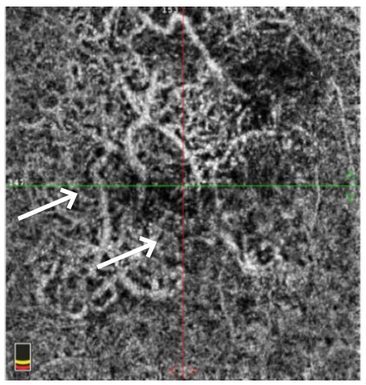
The color fundus photograph below is indicative of subretinal fluid inferior to the fovea. The OCT B-scan reveals subretinal fluid and a shallow pigment epithelial detachment.

On the OCTA outer retina slab, an abnormal vascular pattern appears (white arrows), raising the suspicion of CNV. Because the structural OCT en face image raises no suspicion of atrophy, the presence of CNV is likely. With the flow signal underlying the area of pigment epithelial detachment (yellow arrow), the OCT B-scan with flow overlay confirms the presence of type 1 CNV.

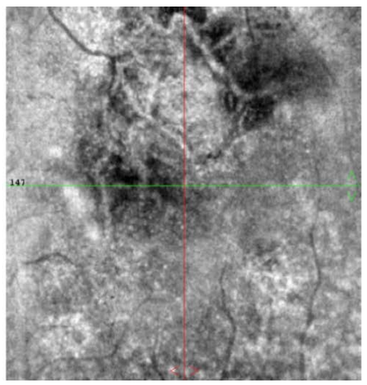
This patient should be referred to a retina specialist and seen within a few days.



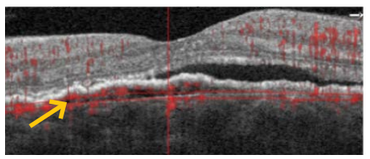




OCTA of Outer Retina and Choriocapillaris



Structural En Face OCT



OCT with Flow Overlay

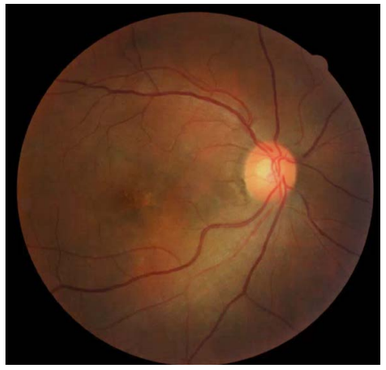
Pigment Epithelial Detachment Case 1

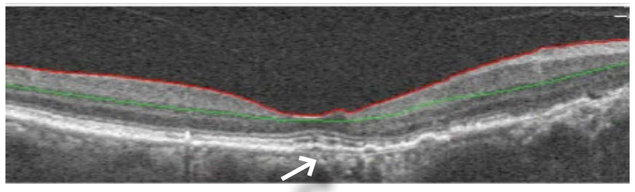
Images courtesy of Julie Rodman, OD

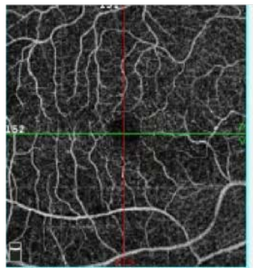
The color fundus photograph in this case illustrates a few drusen and pigment mottling. The pigment loss, nasal to the fovea, may indicate an area of atrophy or a pigment epithelial detachment.

A shallow pigment epithelial detachment is visible on the OCT B-scan (white arrow), but no subretinal fluid is apparent. However, CNV is apparent on the OCTA imaging slabs that represent the outer retina and choriocapillaris (yellow arrows). Again, in this situation, it becomes very important to scroll through all of the volumetric structural B-scans and evaluate for the presence of subretinal or intraretinal fluid. If fluid is present, it warrants an immediate referral.

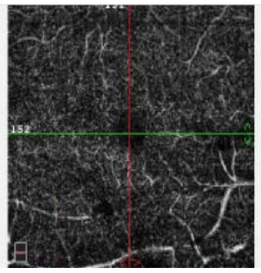
Even if subretinal or intraretinal fluid is not present, the CNV confers a high risk of conversion to exudative AMD and should be monitored. The patient should be screened for CNV symptoms such as vision loss or metamorphopsia and referred to a retina specialist to be seen in 1-3 weeks.



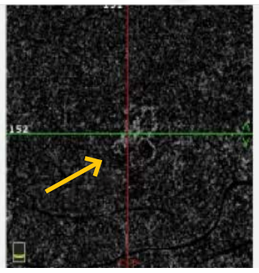




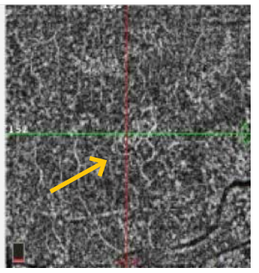
Superficial Plexus



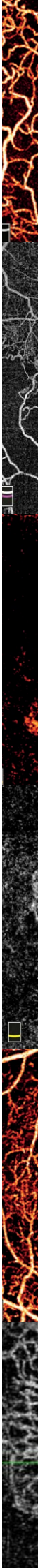
Deep Plexus



Outer Retina



Choriocapillaris



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