-Retina-

# Journal Article Review

## Clinical application of MultiColor imaging technology

Tan ACS, Fleckenstein M, Schmitz-Valckenberg S, Holz FG. Ophthalmologica 2016; 236: 8-18.

### Background and Purpose

Color fundus photography (CFP) closely resembles findings on clinical examination, although it has several important limitations. Media opacities influence the quality of fundus photos, its contrast is limited, and interpatient variability in fundus pigmentation and illumination make (semi)automated analyses difficult. Confocality suppresses stray light outside of the focal plane, allowing for optical sectioning, increasing optical resolution, and enhancing image contrast of fundus features. Heidelberg Engineering has enhanced the SPECTRALIS® by incorporating the MultiColor (MC) Module. MC uses three laser wavelengths simultaneously to provide diagnostic images that show distinct structures at different depths within the retina. This paper describes the clinical utility of MC imaging in a variety of sight-threatening retinal pathologies and correlates the findings with multimodal imaging techniques, including CFP.

### Methods

MC images (30° and 55°) were taken from 150 eyes of 76 consecutive patients with a variety of diseases. Fovea-centered, mydriatic CFPs of 30° to 40° retinal eccentricity were also acquired on these same patients. Additional imaging, e.g. fundus autofluorescence (FAF), spectral-domain optical coherence tomography (SD-OCT) volume scans, fluorescein angiography (FA) or indocyanine-green angiography (ICGA), was performed in a subset of these cases. The inter-modality correspondence of observed features was qualitatively evaluated by retinal specialists.

### Discussion

- The authors describe similarities and differences between MC and CFP in a variety of retinal conditions and their associated pathological features:
- Age-related macular degeneration (AMD)
    - More distinct on MC than on CFP: Retinal hemorrhage – an important sign of neovascular AMD (Fig 1), reticular pseudodrusen – a feature associated with all AMD stages that may indicate a high-risk of progression (Fig 2), and boundaries of geographic atrophy (Fig 3).
    - Polypoidal choroidal neovascularization (PCV) appeared as an orange-red nodule on CFP and as darker red with a greenish tinge on MC; likely due to the PCV lesion being located deep under the retinal pigment epithelium, in contrast to the redder superficial hemorrhage (Fig 4). Thus, “MultiColor may have the added advantage to distinguish hemorrhage in different retinal layers in contrast to CFP, although this finding will need to be verified in larger studies.”
    - MC provided high contrast of hard exudates and surrounding fluid of the PCV (Fig 4). In areas of subretinal fluid, the loss of photoreceptor bands on SD-OCT correlated with a distinct border on MC but not CFP (Fig 5).
- Diabetic retinopathy
    - At the optic disk, MC visualized new vessels and highlighted fibrovascular proliferation in green, while these features were seen less clearly with CFP (Fig 6). MC showed the presence of intraretinal cysts in diabetic macular edema and sclerotic vessels (Fig 7).
- Retinal vascular occlusions
    - CFP provided better visualization of collateral and sclerotic vessels, while the area of choroidal neovascularization was seen clearly in both MC and CFP (Fig 8).
    - Demarcations of intraretinal thickening possibly associated with inner retinal ischemia and subsequent branch retinal artery occlusion were visible on both CFP (pale) and MC (greenish) (Fig 9).
- Acute central serous chorioretinopathy
    - Boundaries of serous neurosensory detachments were better defined on MC than on CFP (Fig 10).



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- Inherited retinal dystrophies
    - Subretinal bleeding around CNV, associated with pseudoexanthoma elasticum, was seen with both CFP and MC. In this case, an angioid streak was best seen on FAF and less distinct on both CFP and MC (Fig 11).
    - Flecks typical for Stargardt disease were visible on both CFP and MC, while the boundaries of central atrophy were more distinct on MC as compared to CFP. The latter helped to distinguish the area of foveal sparing, which can be difficult with FAF (Fig 12).
- Other pathologies
    - Choroidal tumors, nevi and melanomas showed a varying degree of color on MC, depending on the depth of the lesion, degree of pigmentation and surrounding blood, fluid or atrophy.
    - Both MC and CFP could clearly visualize choroidal rupture due to ocular trauma.
    - The fovea's location and the pattern of epiretinal membranes could be better characterized with MC.

## Conclusions

MultiColor is an optional module of the SPECTRALIS multimodal imaging platform; as such it can improve the workflow efficiency in high-volume clinics while offering advantages to smaller clinics where monetary and spatial constraints only allow for limited imaging equipment. 55° MC images are best suited for documenting the disease status and for general screening, while 30° MC images are better for the identification of small-scale pathological features and the characterization of details of different pathologies. Nonmydriatic MC imaging may be advantageous in screening programs following validation studies to improve screening of diabetic retinopathy and AMD. The correlation of atrophic outer retinal changes on MC and FAF may have advantages over CFP in diseases exhibiting such features. Disadvantages of MC include a slightly longer acquisition time, the presence of central artifacts (other than known from CFP), and MC appears to be less comparable in appearance to clinical examination than CFP. The authors conclude that MultiColor has many potential clinical applications and may offer complementary or additional clinically relevant information to CFP for several indications.

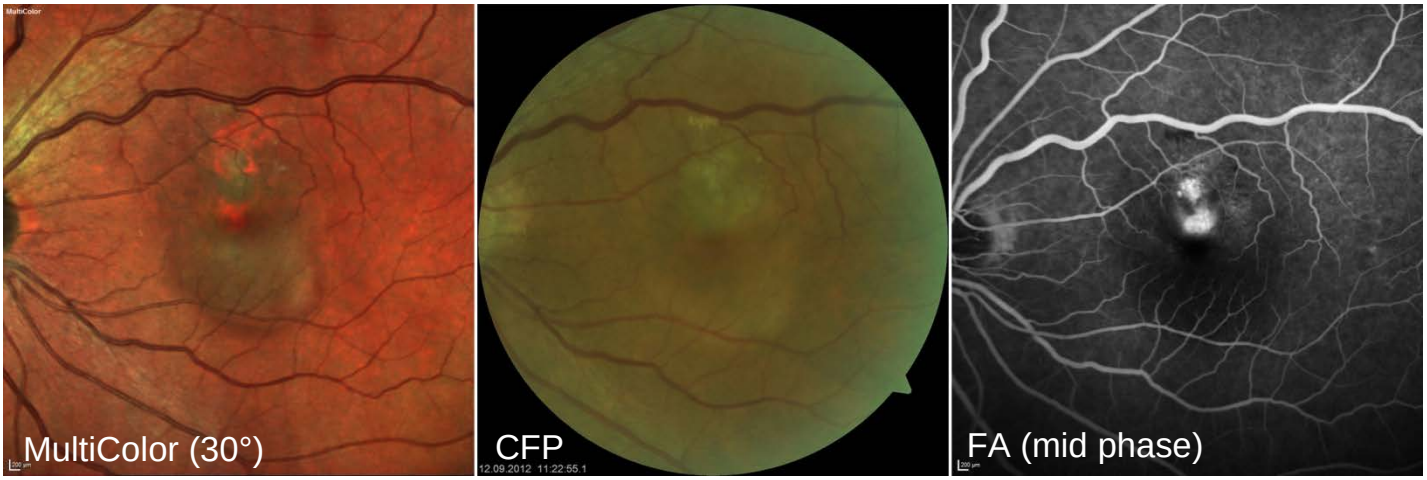

Fig 1. Choroidal neovascularization with intraretinal hemorrhage in AMD.

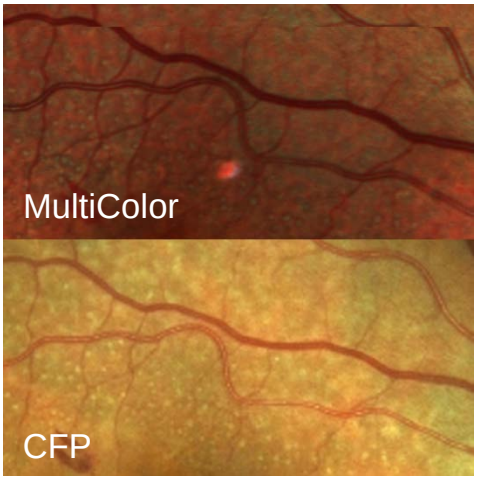

Fig 2. Reticular pseudodrusen and small hemorrhage (bright red in the MultiColor image) in AMD.

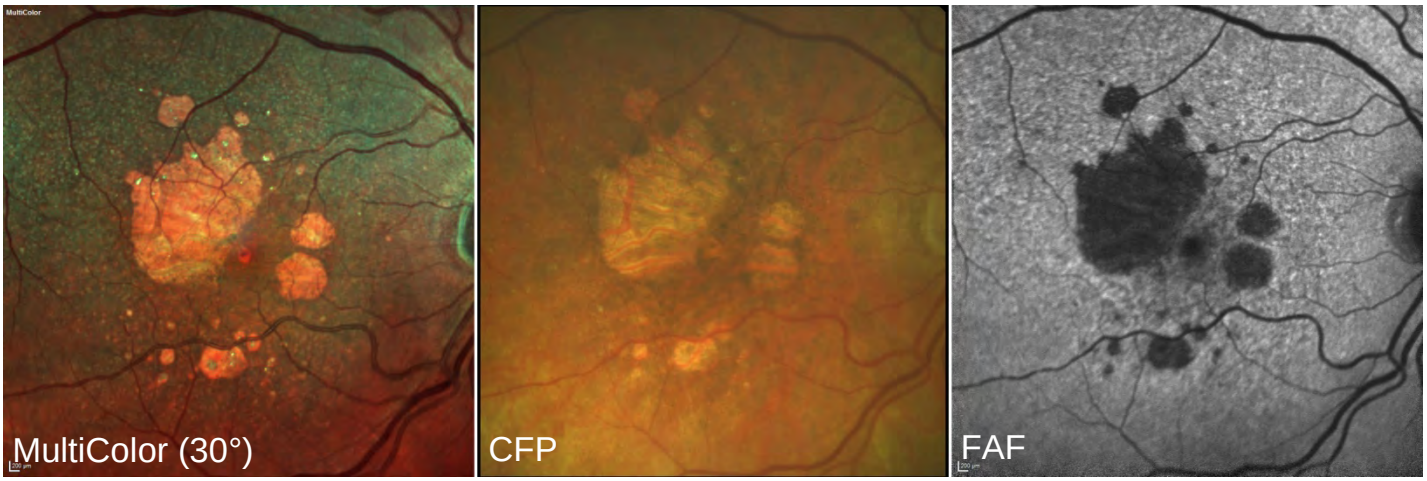

Fig 3. Geographic atrophy in AMD.

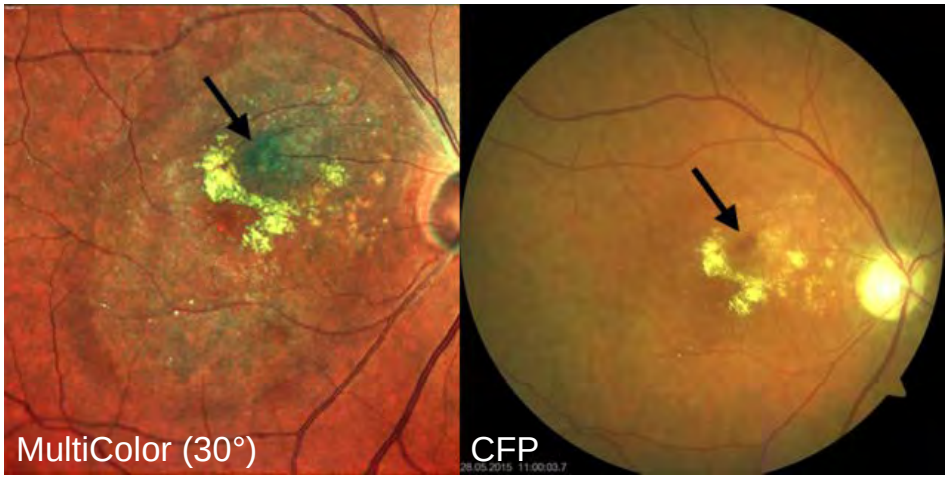

Fig 4. Polypoidal choroidal vasculopathy (PCV) in AMD with hard exudates shown as bright green and surrounding fluid in darker green. The PCV lesion is indicated by the black arrows.

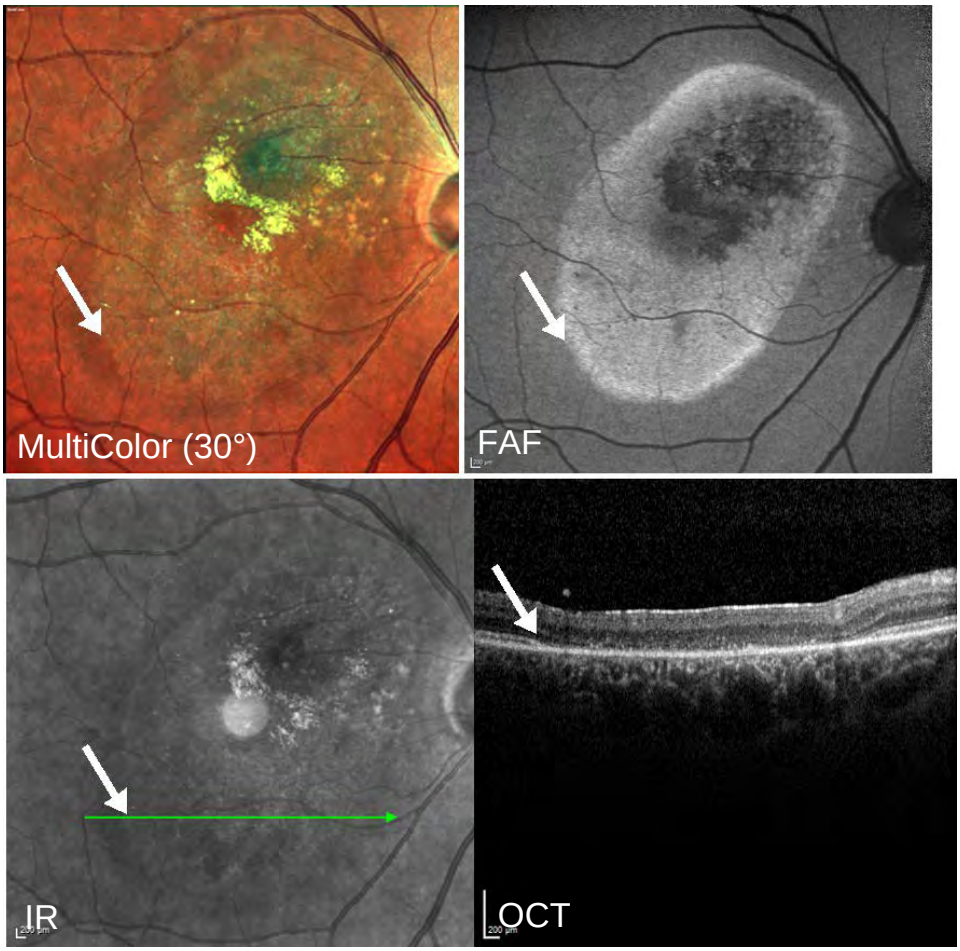

Fig 5. Photoreceptor damage associated with polypoidal choroidal vasculopathy (PCV) in AMD.

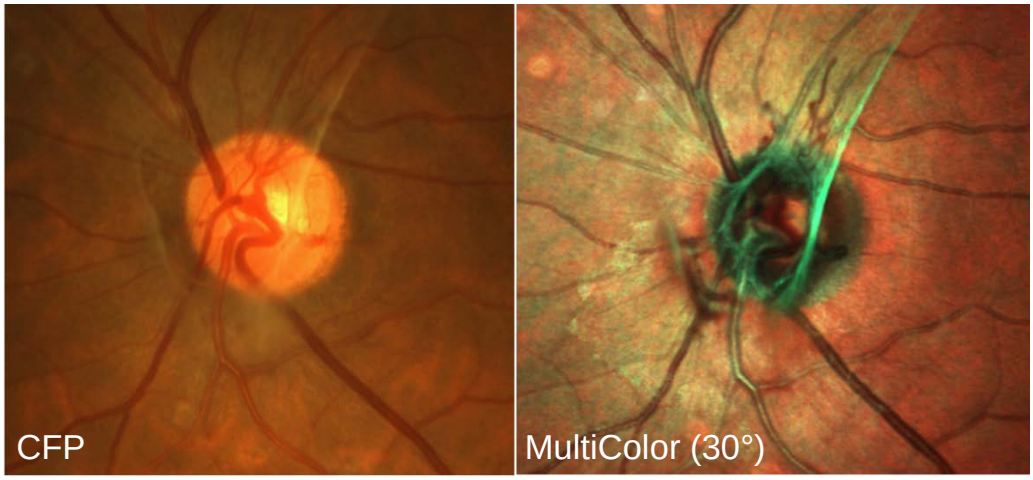

Fig 6. Proliferative diabetic retinopathy with fibrovascular proliferation at the optic nerve head.

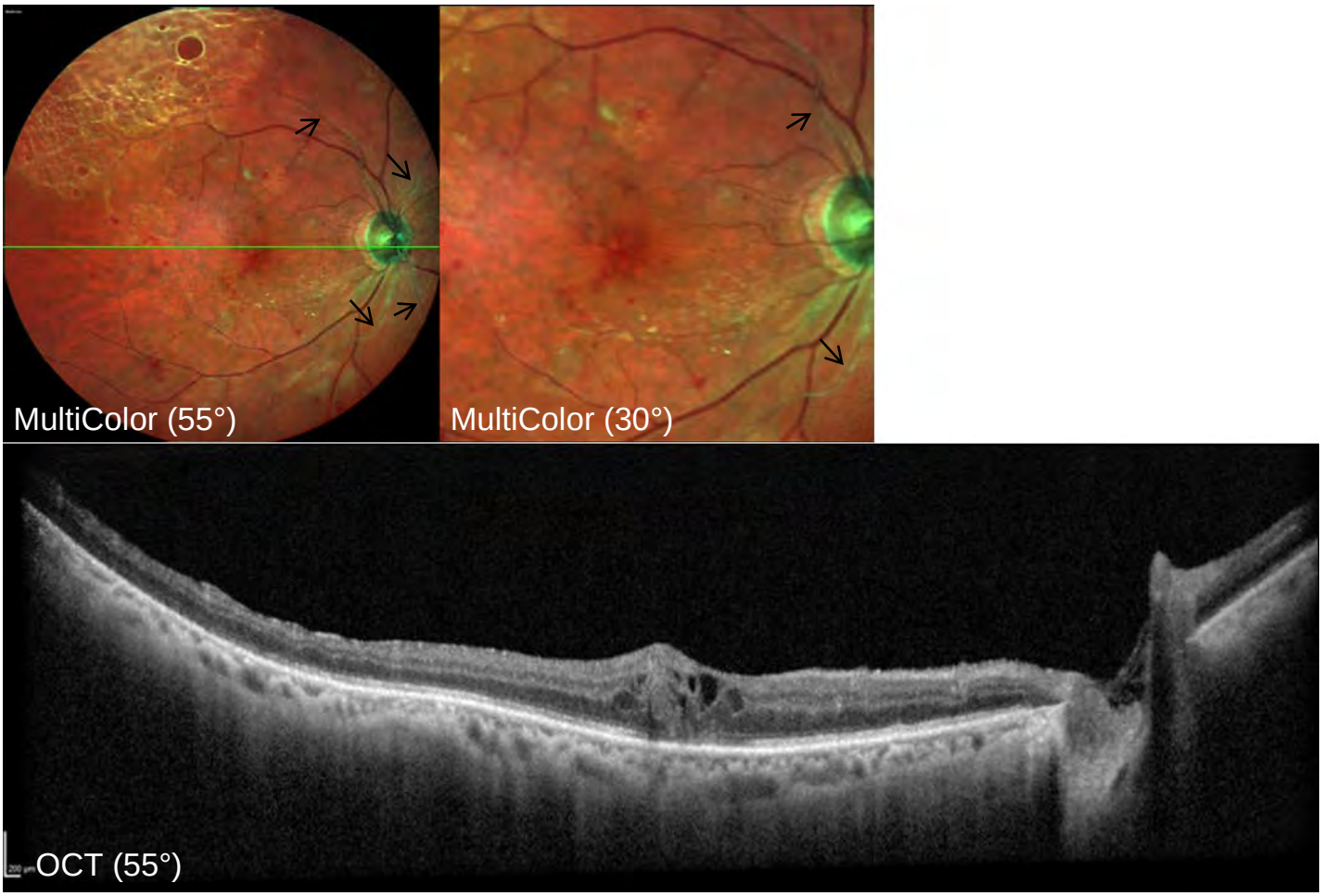


Fig 7. Proliferative diabetic retinopathy with intraretinal cysts and sclerotic vessels (black arrows). The yellowish area in the upper left of the 55° MultiColor image is an imaging artifact caused by tear film irregularities.

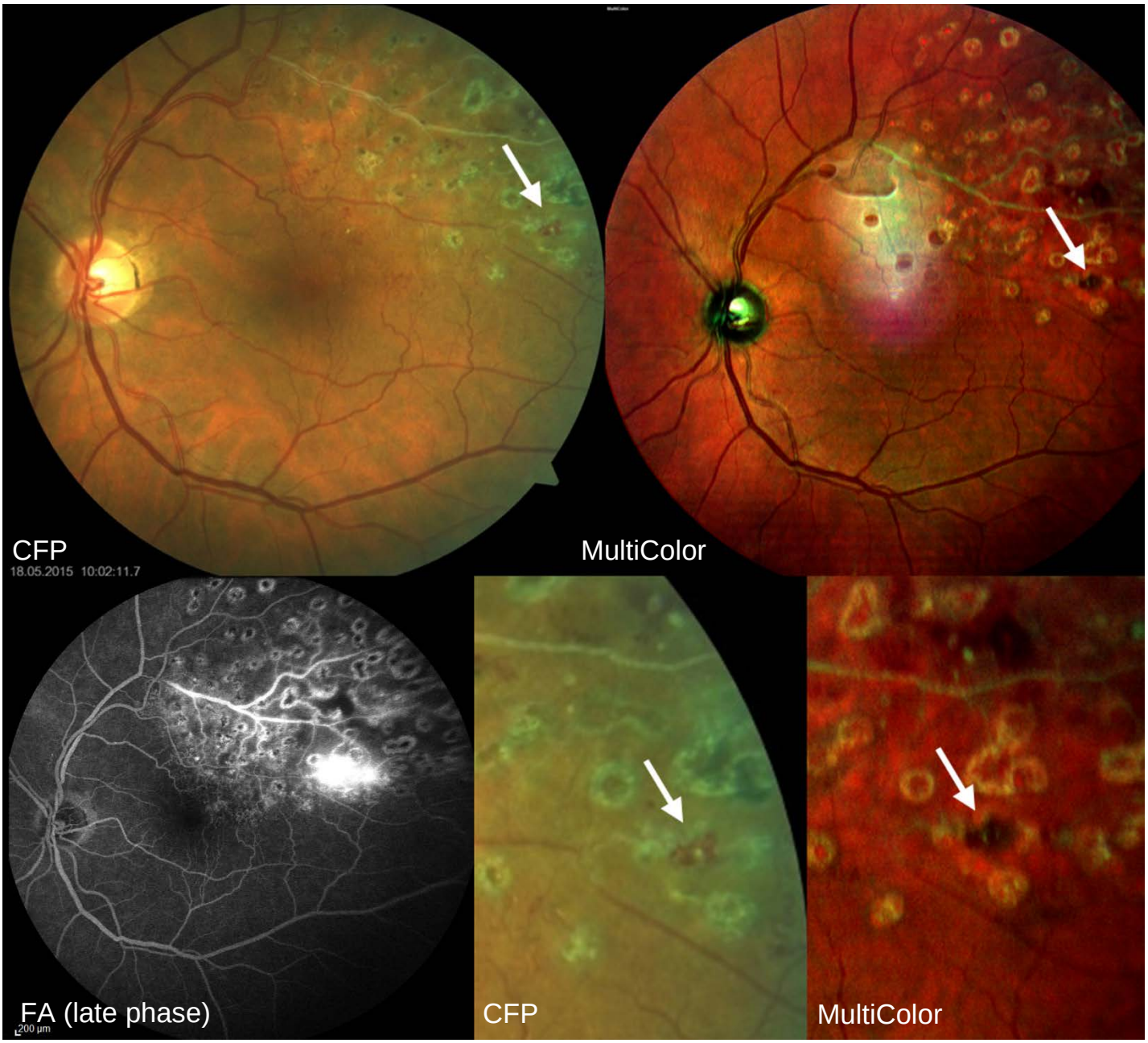


Fig 8. Ischemic branch retinal vein occlusion with secondary retinal neovascularization. Bottom right panels: a magnified view of the area of neovascularization seen on CFP and MC.


Fig 9. A branch retinal artery occlusion, showing an area of intraretinal thickening on OCT that shows as pale on CFP and as green on MultiColor.



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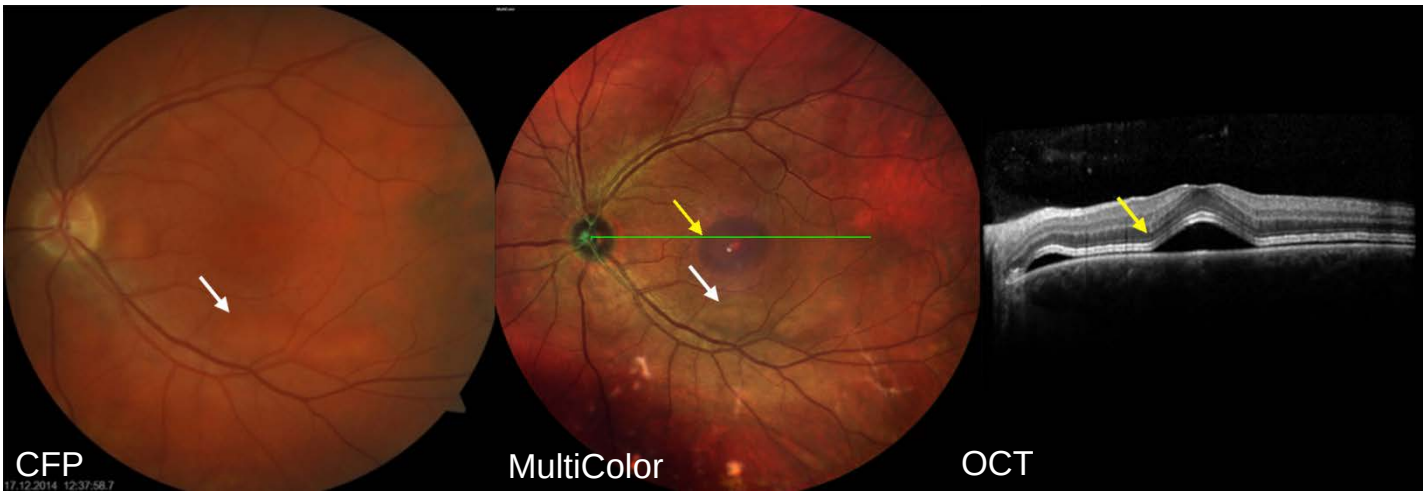


Fig 10. Idiopathic multifocal CSCR. Extrafoveal collections of subretinal fluid (white arrows) “was seen more clearly on MultiColor, as well as the boundary of subretinal serous fluid around the central CSCR” (yellow arrows).

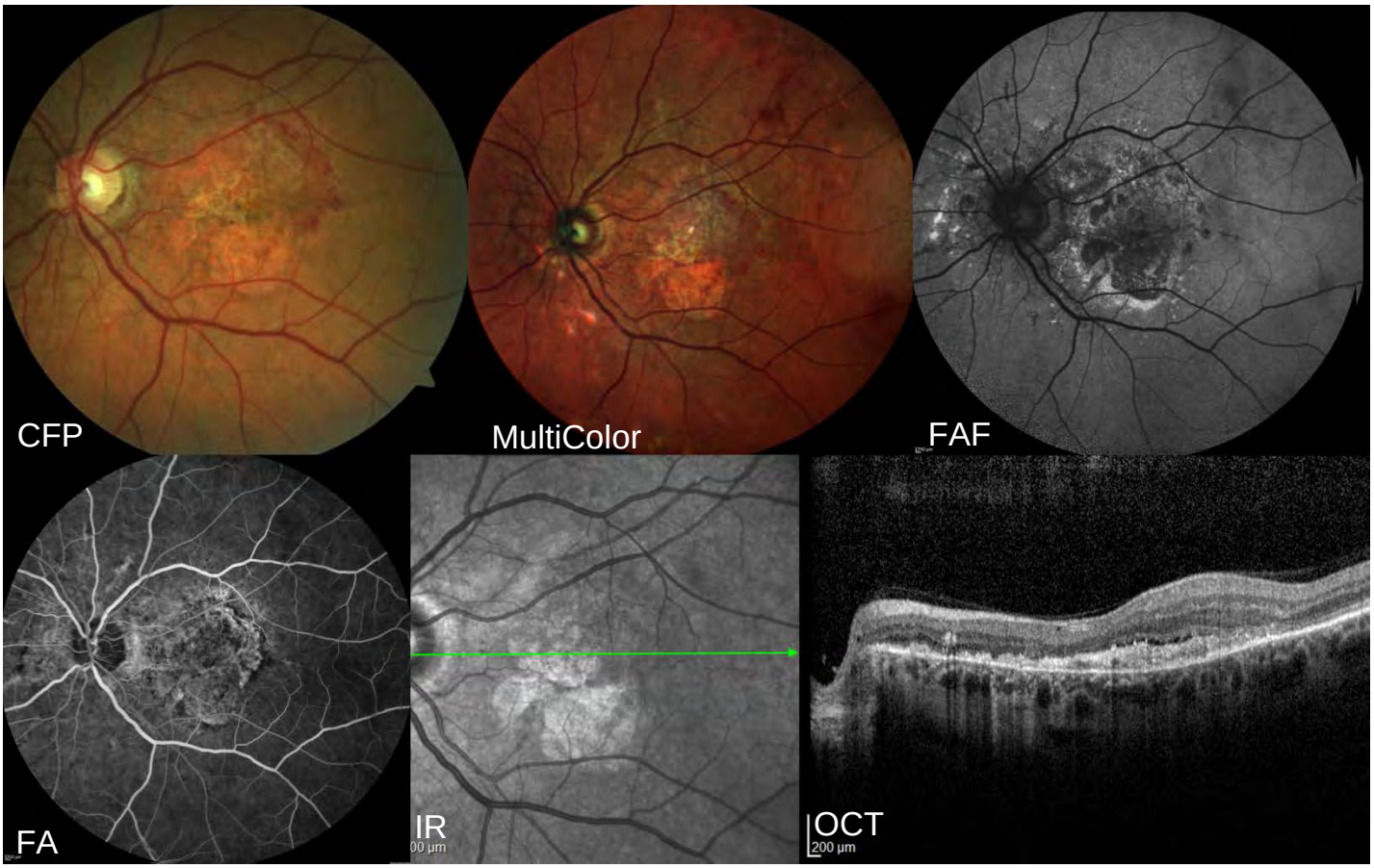


Fig 11. Pseudoxanthoma elasticum with complications, including choroidal neovascularization, subretinal hemorrhage and atrophy. The area of atrophic change inferior to the fovea (pink on CFP, red on MultiColor) is “more clearly demarcated on the MultiColor image and shows better correlation with the FAF image than the CFP image.”

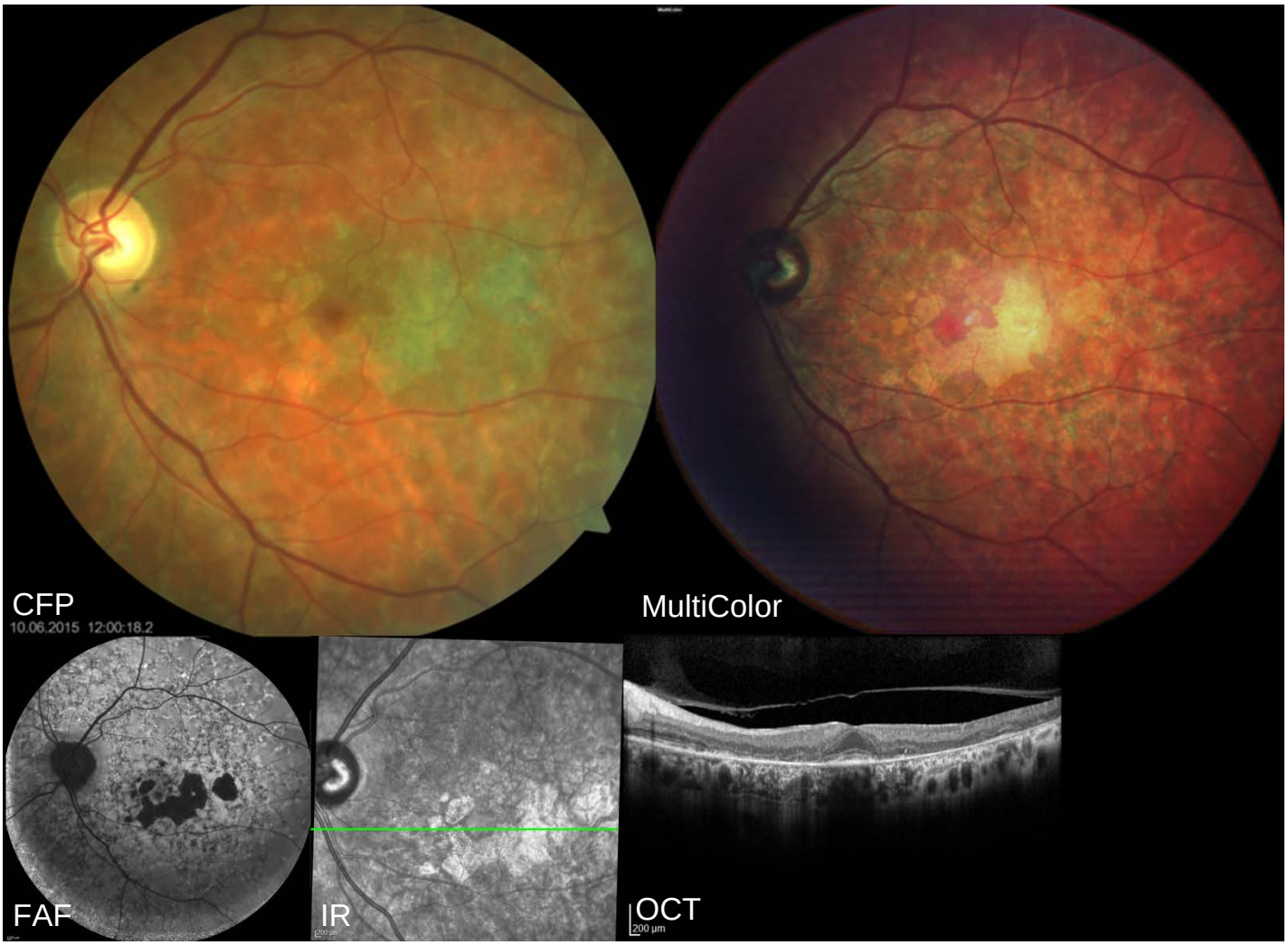

Fig 12. Stargardt macular dystrophy with atrophy of the outer retinal layers and sparing of the foveal area.