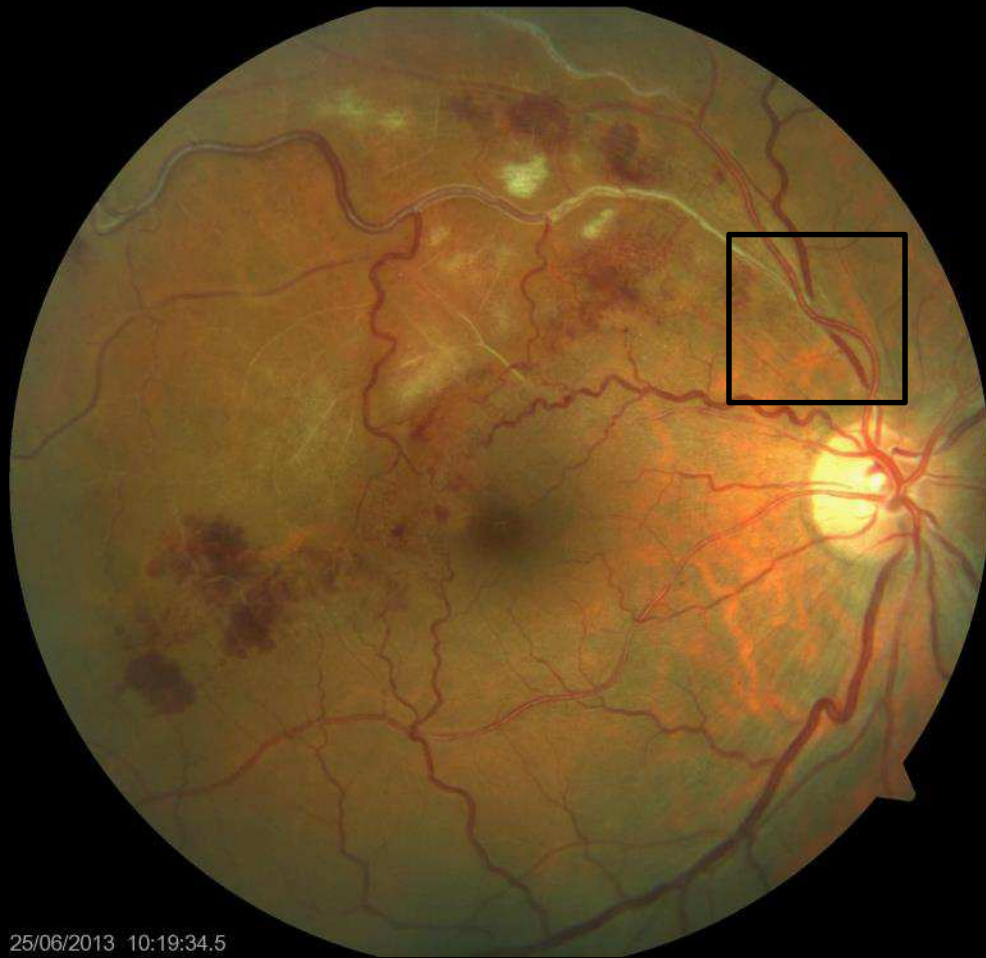
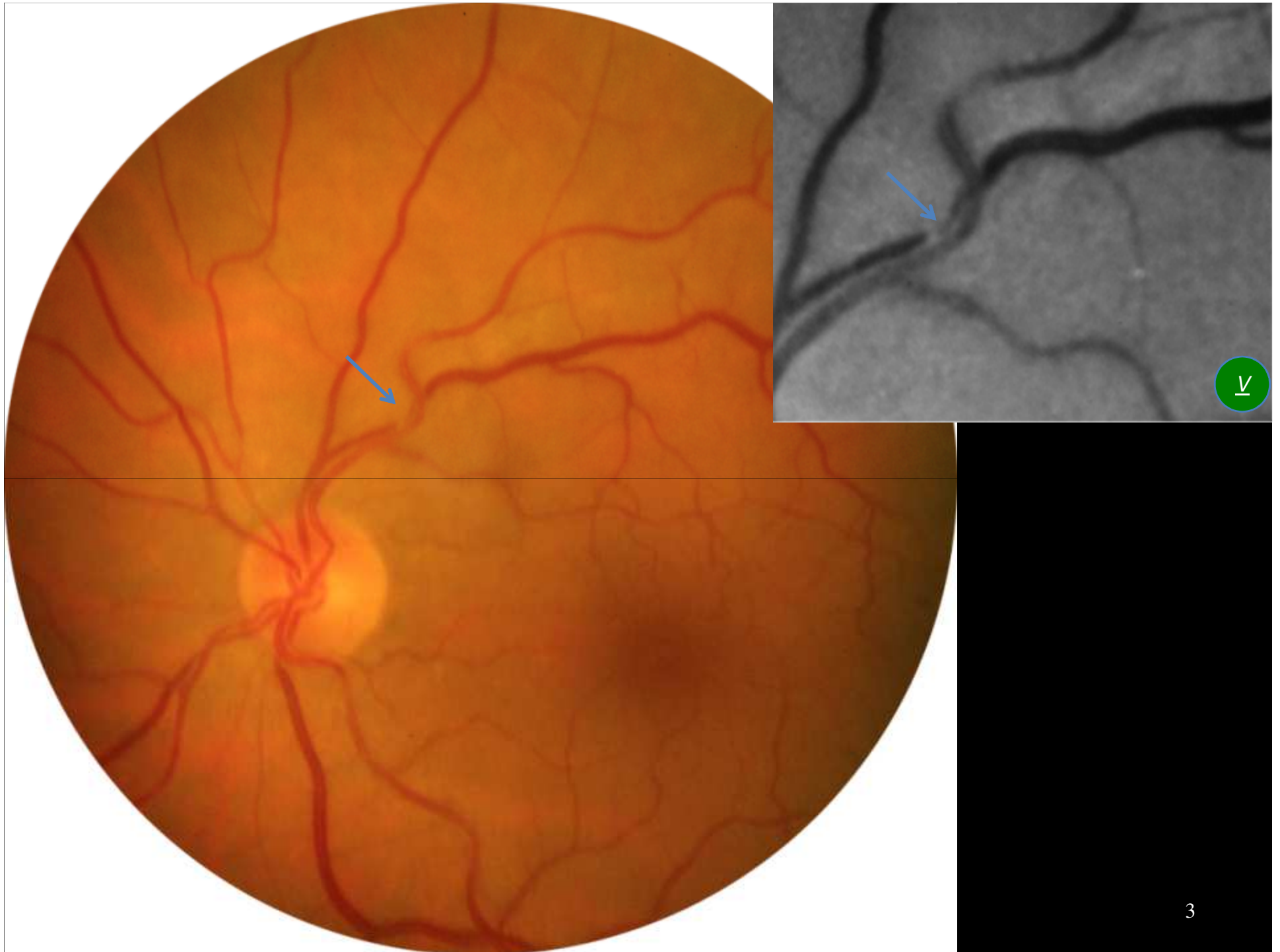


Le lieu de survenue des OBVR est observable, mais le mécanisme en cause est incertain

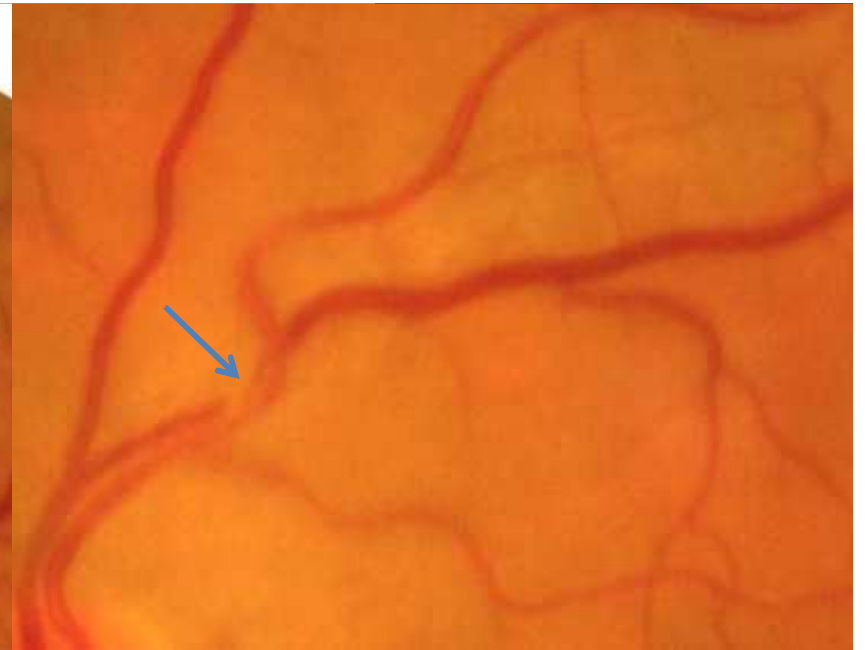


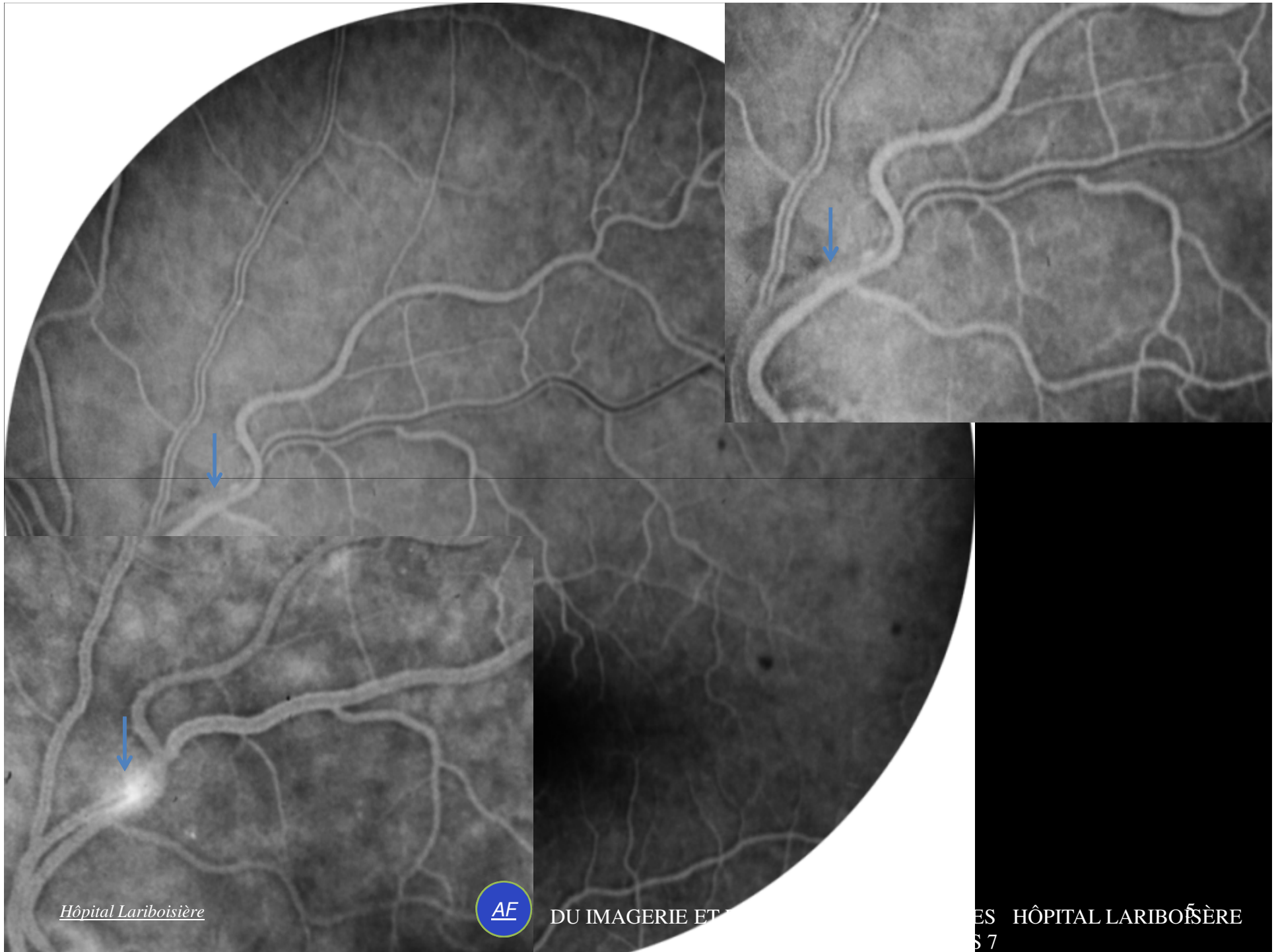
OBV : Sémiologie

- Signe de « pré occlusion »
 - Signe du croisement accentué + hémorragie en flammèche + dilatation veineuse en amont
 - Fluorescence pariétale au niveau du croisement
- Occlusion
 - Rarement complète d'emblée
 - Peut se compléter progressivement
- Topographie
 - Toutes les veines peuvent être affectées
 - Les sujets âgés ont plus fréquemment des atteintes des petites veines

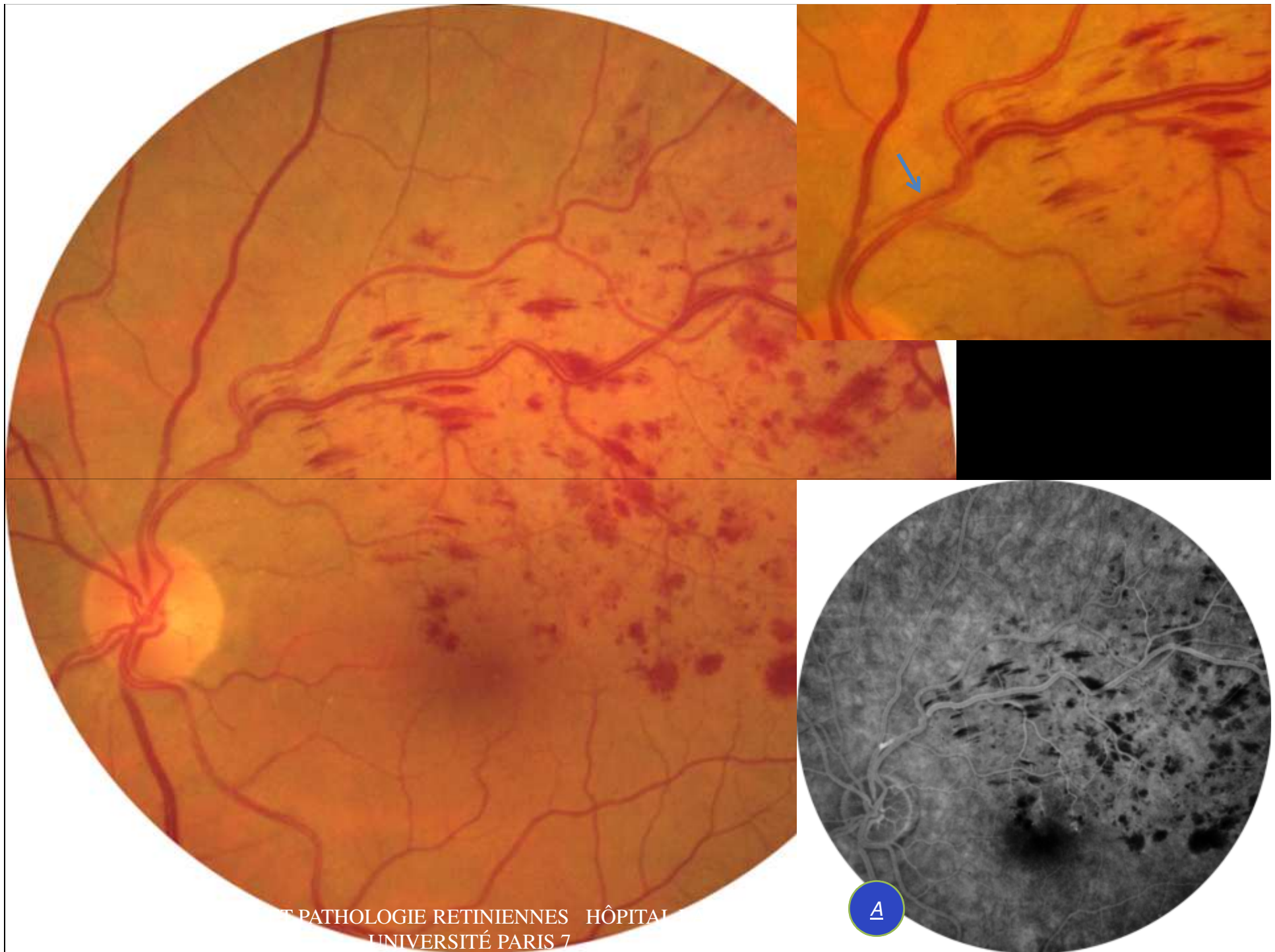


Un mois plus tard

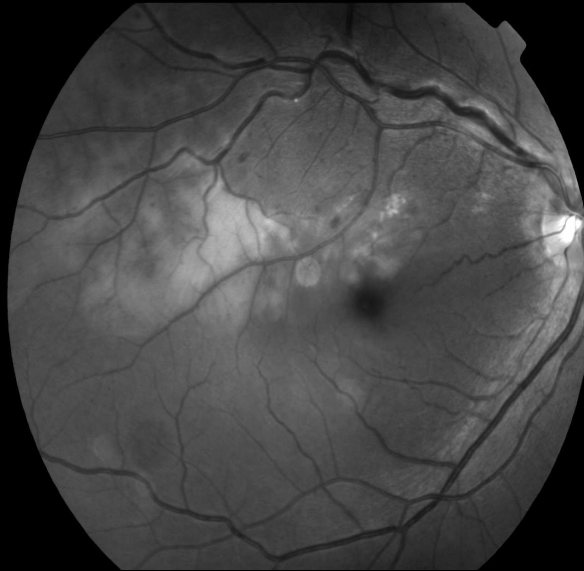




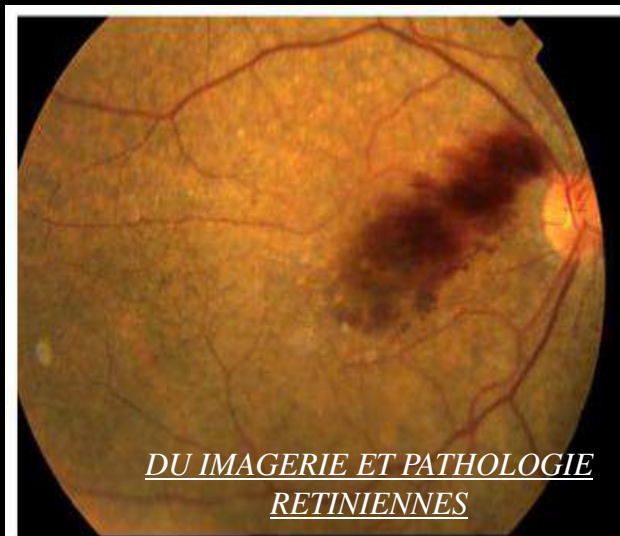




- Les héli-occlusions peuvent être de type A ou B



- Les OBVR sont (virtuellement) toutes des types B



Evolution

- Elle dépend du degré de sténose, de la possibilités de suppléance et du remodelage microvasculaire
 - normalisation
 - circulations de suppléances
 - œdème maculaire chronique
 - TelCaps
 - Nonperfusion, avec ou sans néo-vascularisation
 - *PAS de risque de GNV, qui n'est observé que dans les OVCR (et rarement dans les hémioVR)*

Évolution spontanée

- Régression des hémorragies, des nodules cotonneux, et de l'œdème maculaire en quelques mois

Graefe's Arch Clin Exp Ophthalmol (1999)
237:1024-1027 © Springer-Verlag 1999.

CLINICAL INVESTIGATION

Maurizio Battaglia Parodi
Sandro Saviano
Giuseppe Ravalico

Grid laser treatment in macular branch retinal vein occlusion

Table 3 Improvement macular edema

	Group E	Group D	Group C
Stereophotography	29 (87.8%)	25 (80.6%)	28 (80%)
Fluorescein angiography	25 (75.5%)	22 (70.9%)	24 (68.5%)

OBV perfusion/non-perfusion

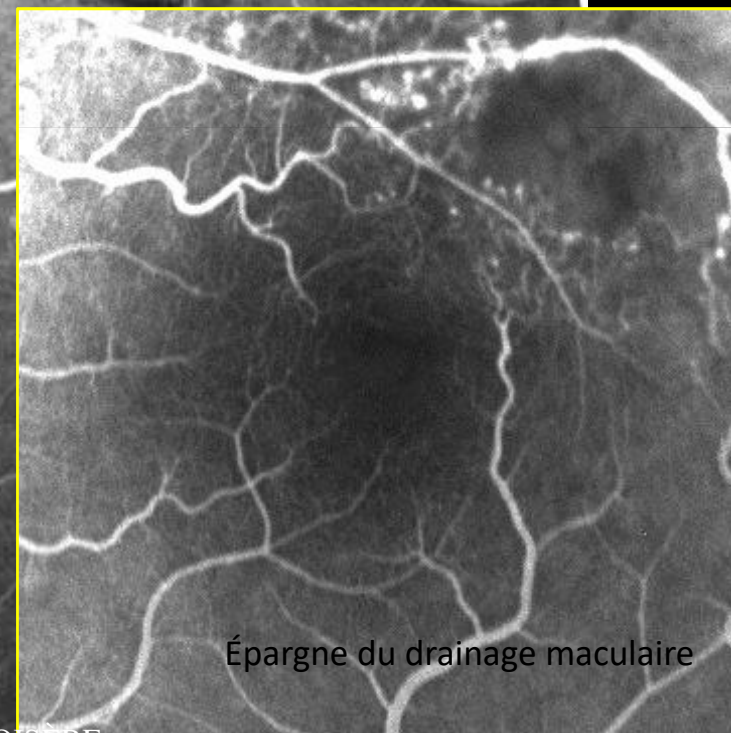
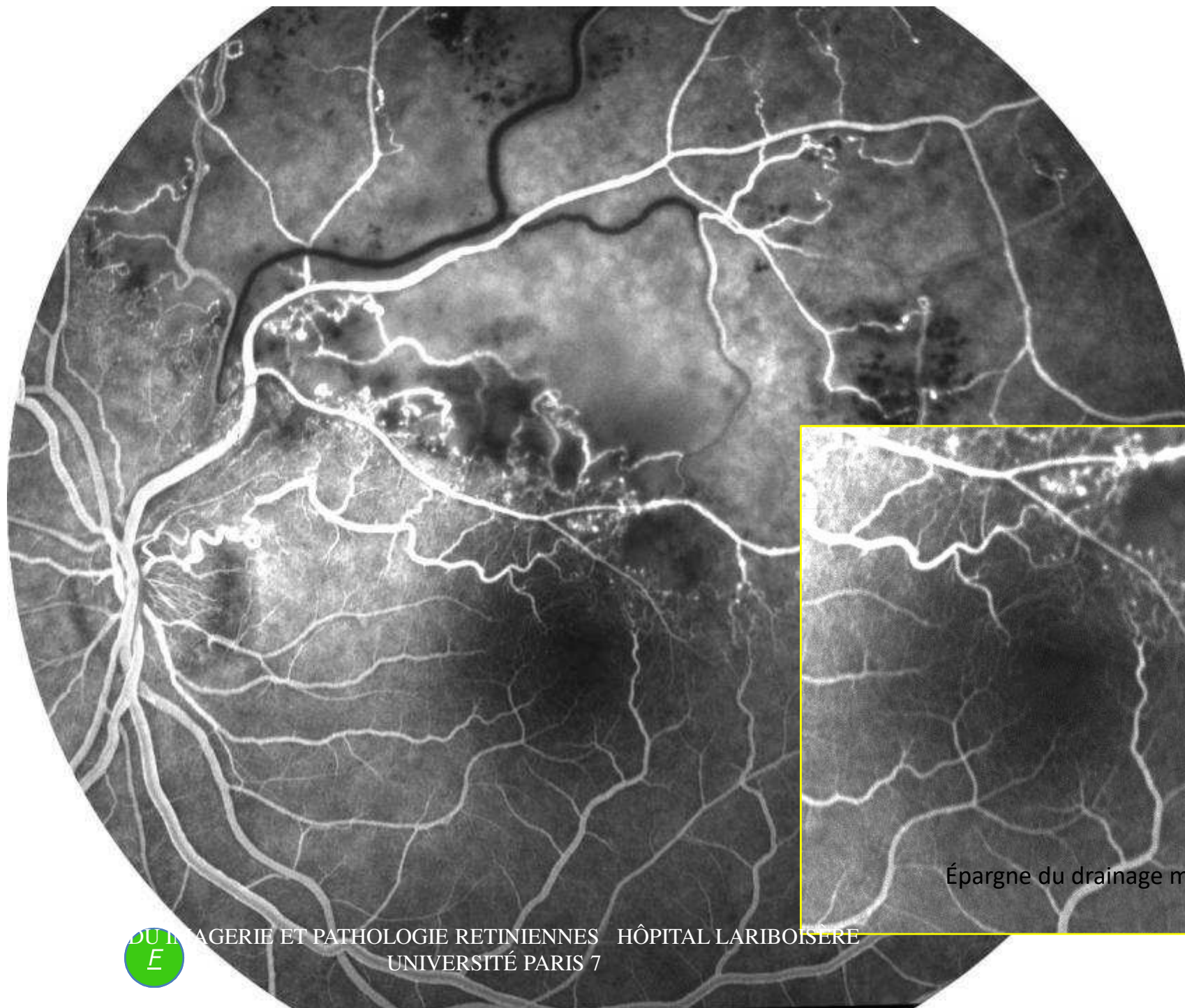
Table 2. Retinal Perfusion Status at Baseline, Week 24, and Week 52

	Laser/IAI (n = 90)	IAI (n = 91)
Baseline, n (%)		
Perfused	62 (68.9)	55 (60.4)
Nonperfused	16 (17.8)	20 (22.0)
Cannot grade	10 (11.1)	16 (17.6)
Missing	2	0
Week 24, n* (%)		
Perfused	55/82 (67.1)	65/81 (80.2) [†]
Nonperfused	27/82 (32.9)	16/81 (19.8)
Missing	8	10

Clark WL, Boyer DS, Heier JS, et al. Intravitreal Aflibercept for Macular Edema Following Branch Retinal Vein Occlusion: 52-Week Results of the VIBRANT Study. Ophthalmology. October 2015

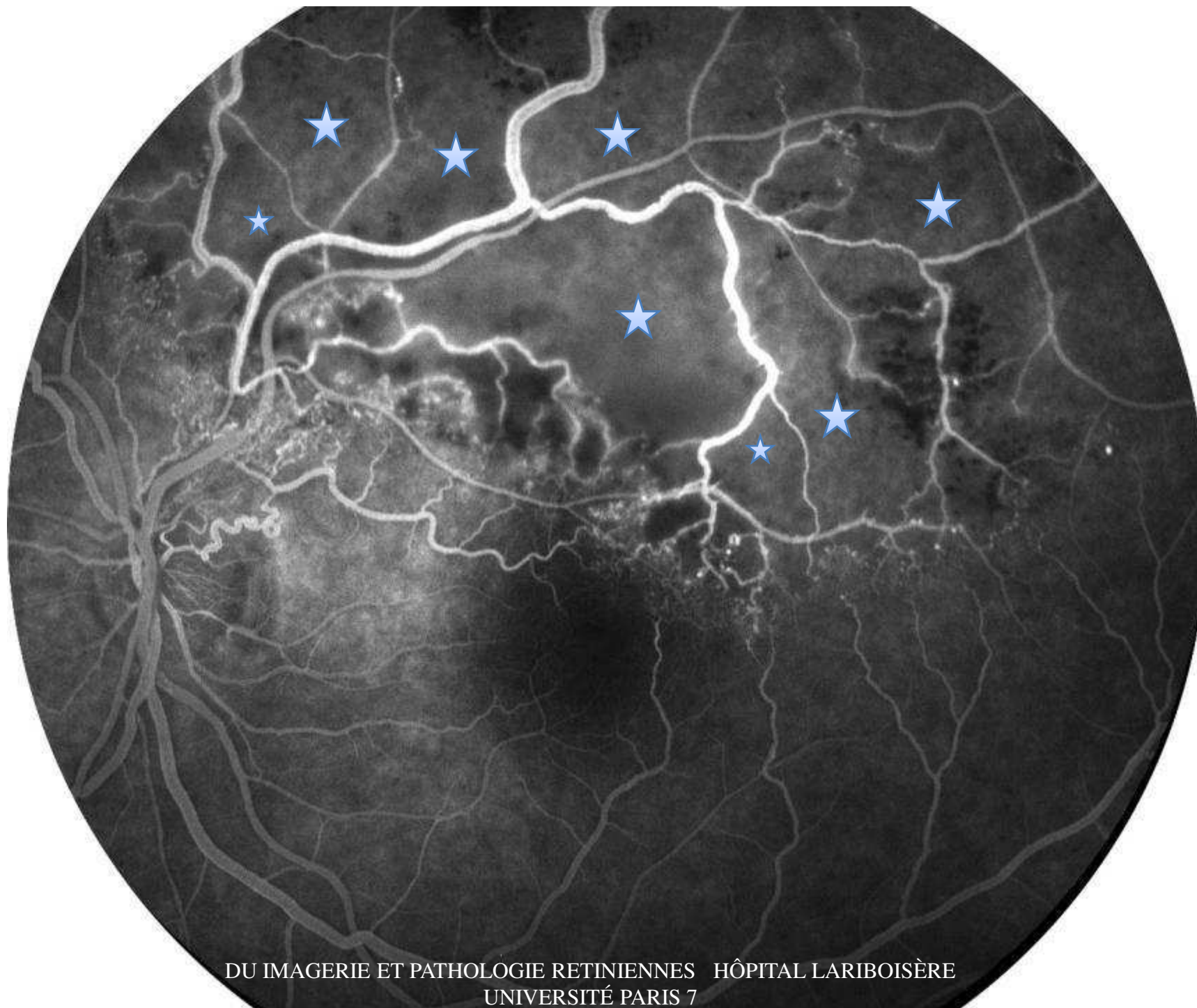


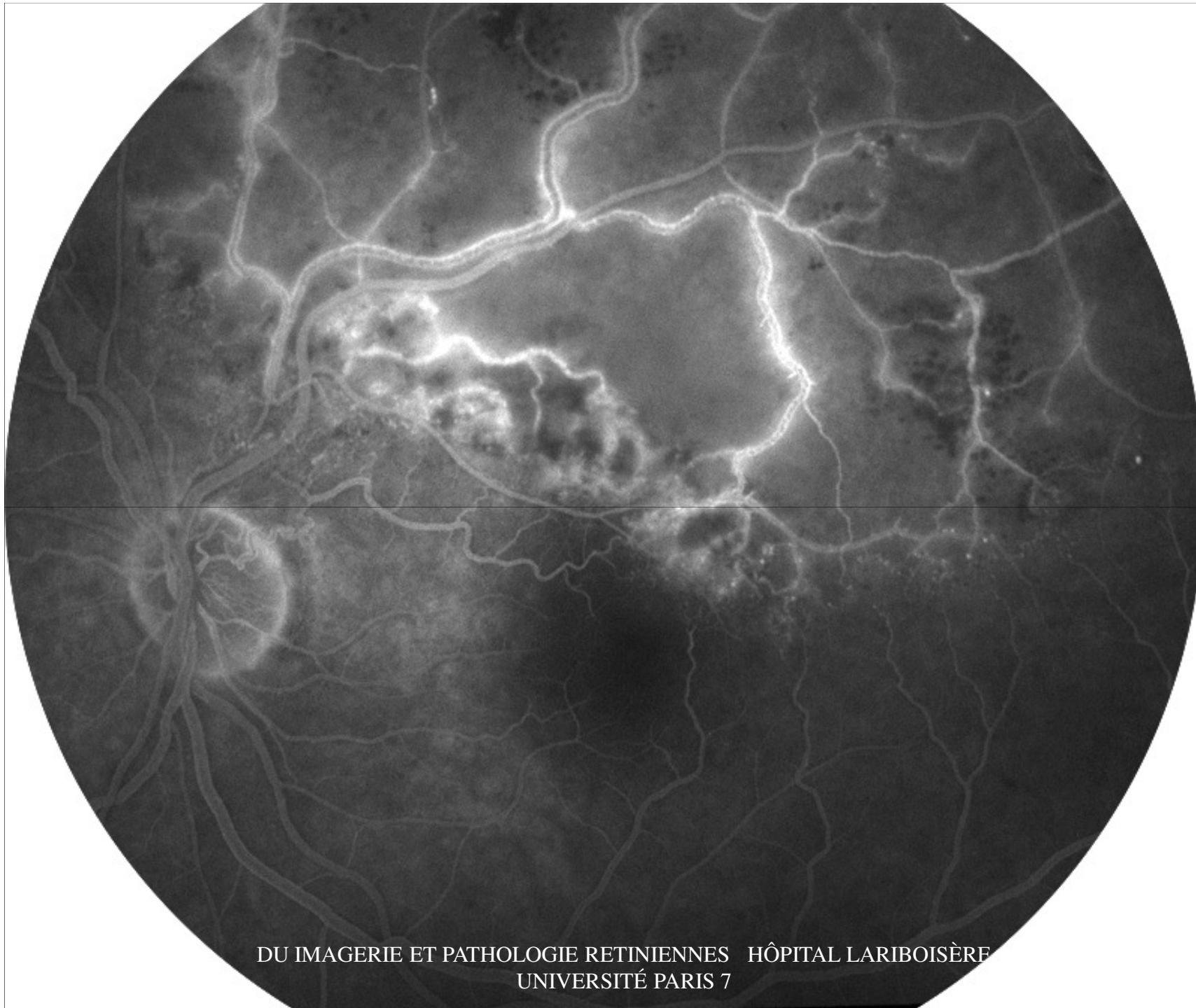




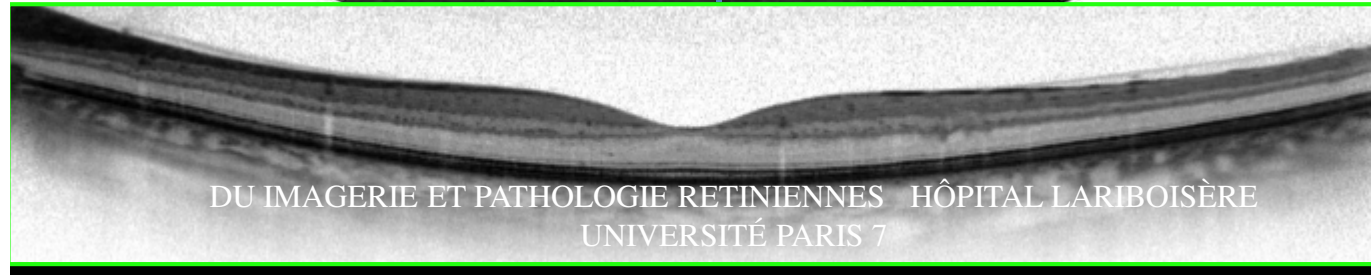
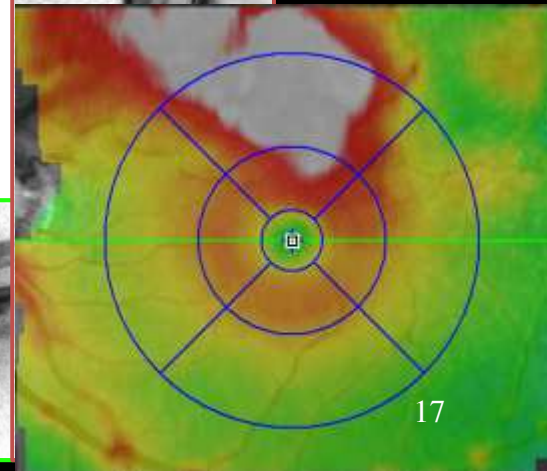
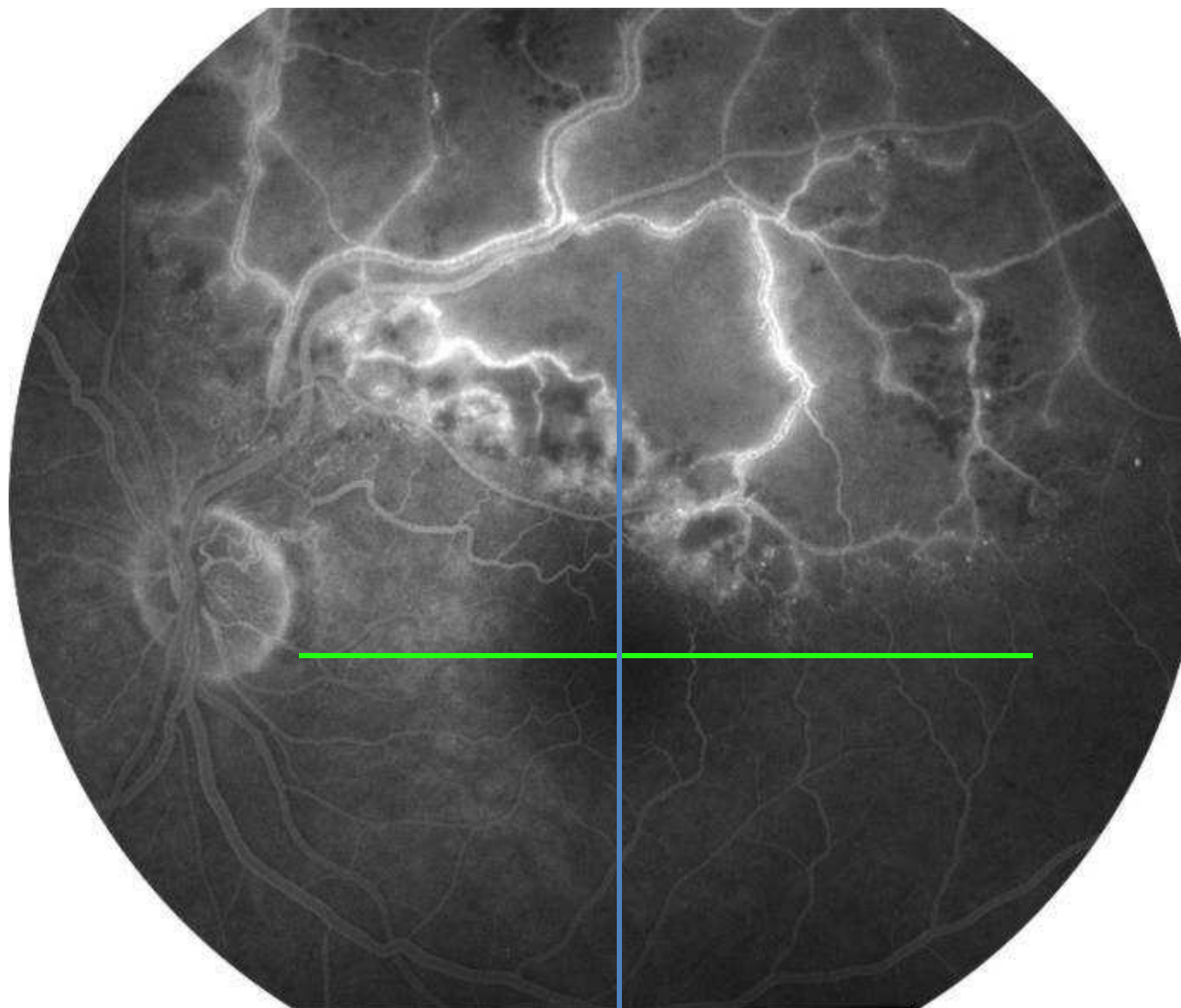
Épargne du drainage maculaire







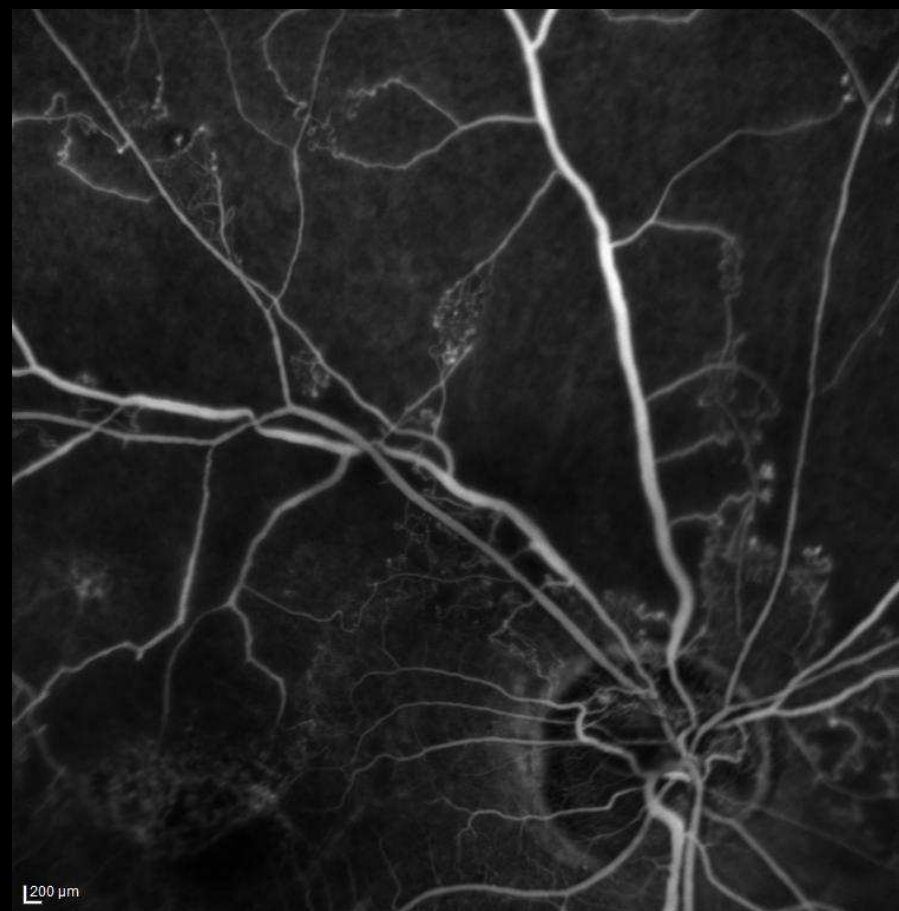
DU IMAGERIE ET PATHOLOGIE RETINIENNES HÔPITAL LARIBOISÈRE
UNIVERSITÉ PARIS 7





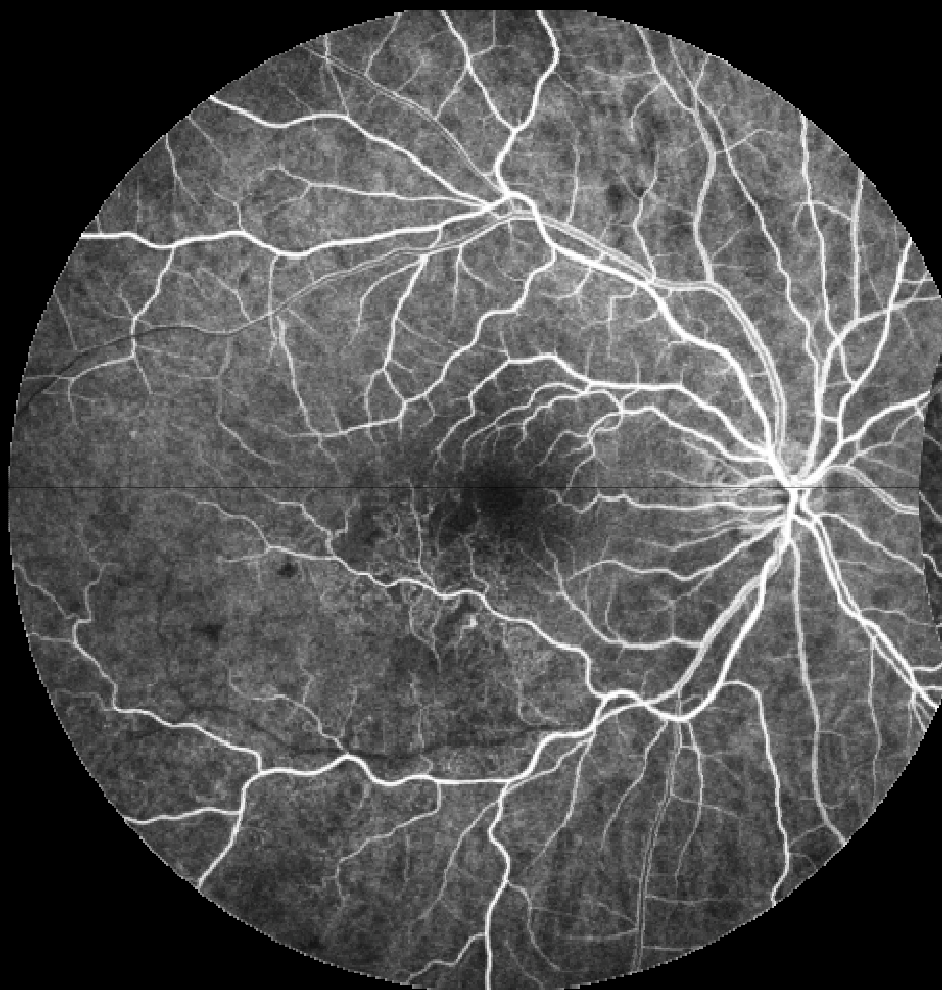
21/02/2014, OD
FA 1:32.26 55° ART(11) 207177.1

HEIDELBERG
ENGINEERING

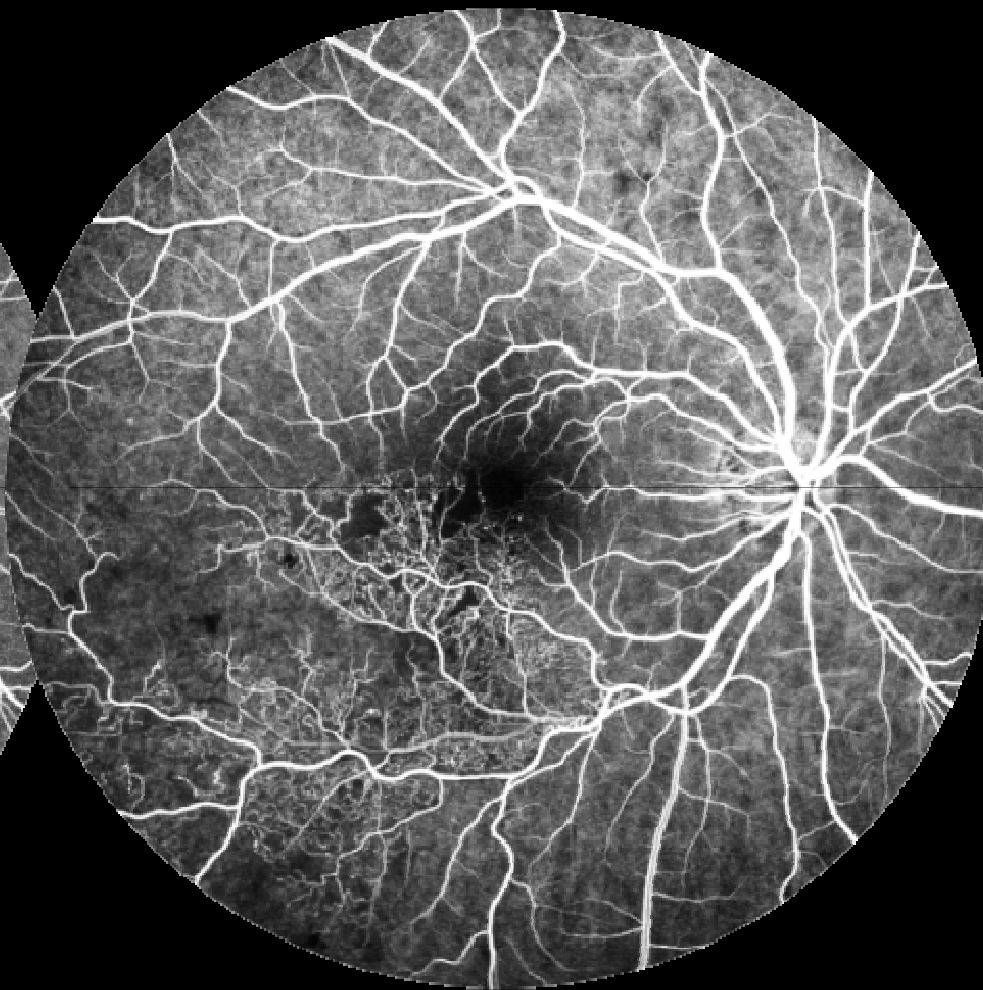


21/02/2014, OD
FA 1:02.15 30° ART(11)

HEIDELBERG
ENGINEERING



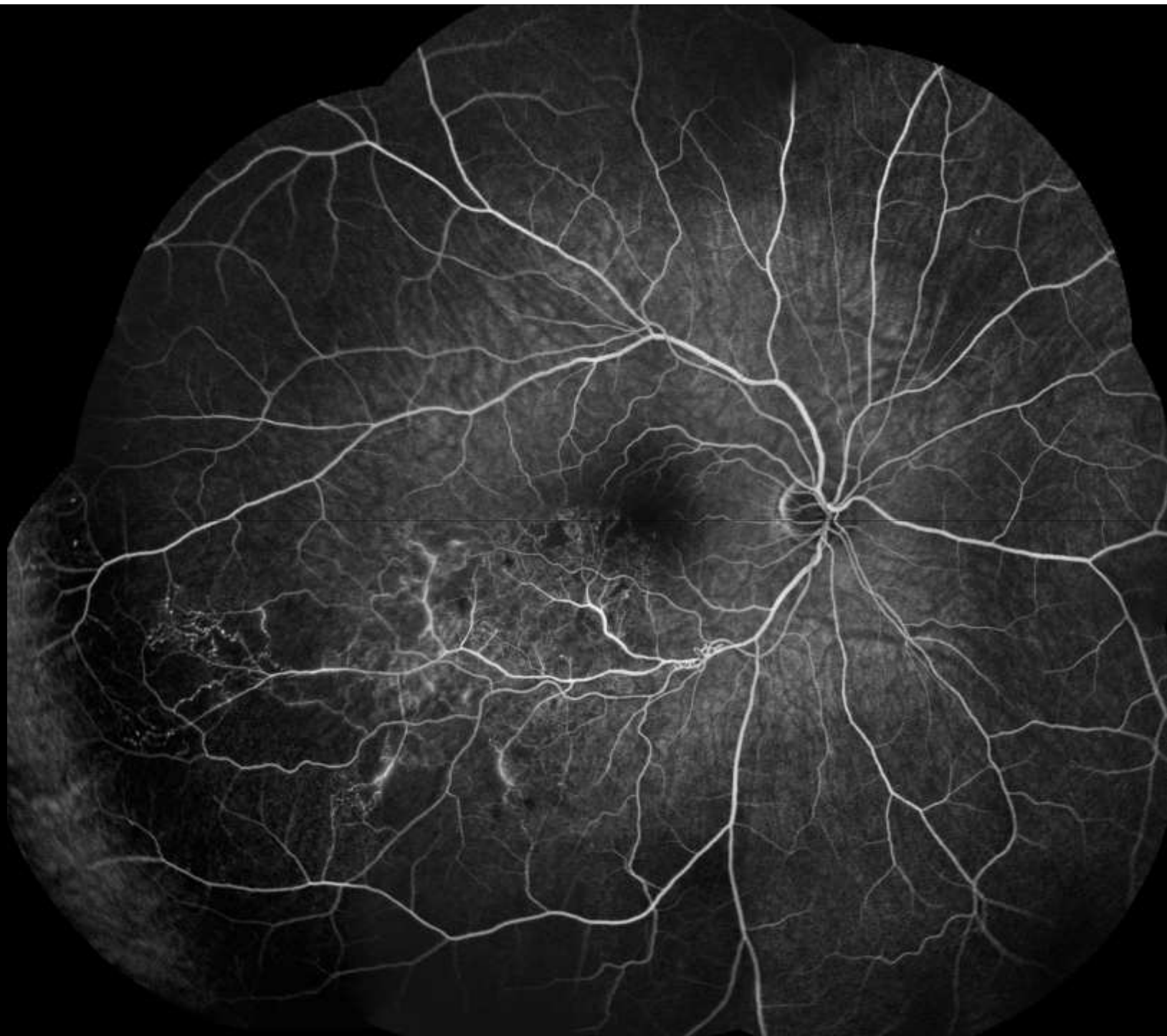
23 sec



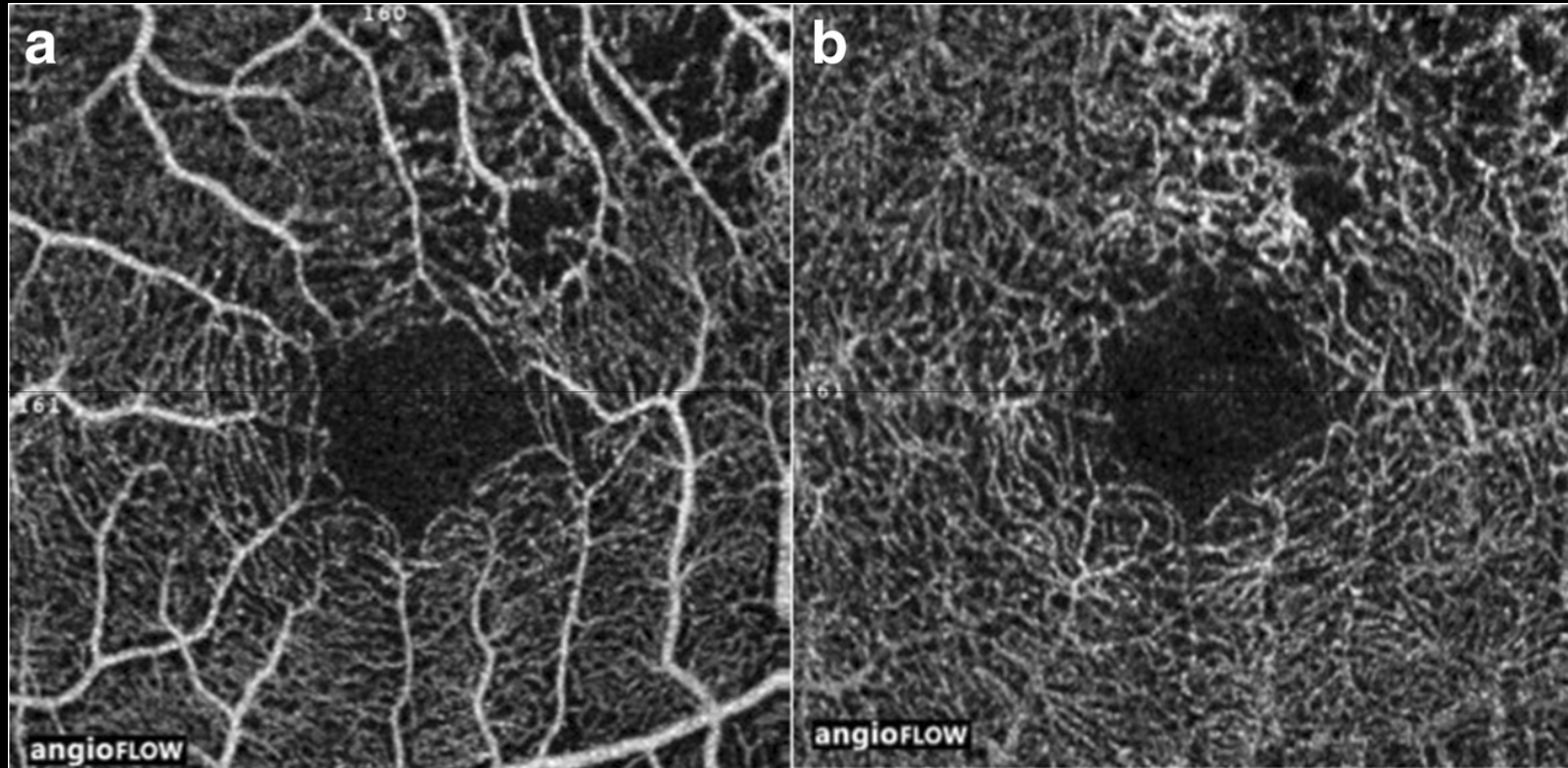
27 sec



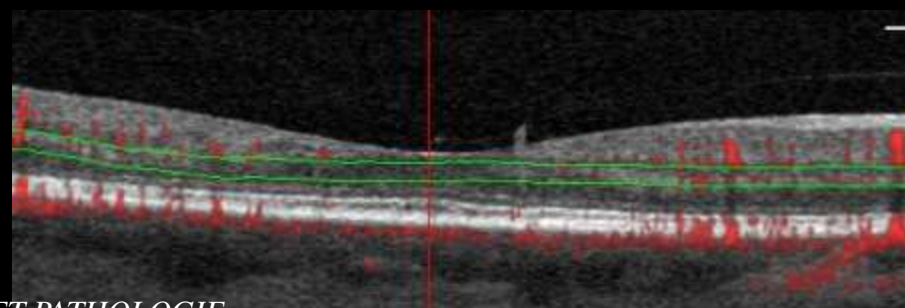
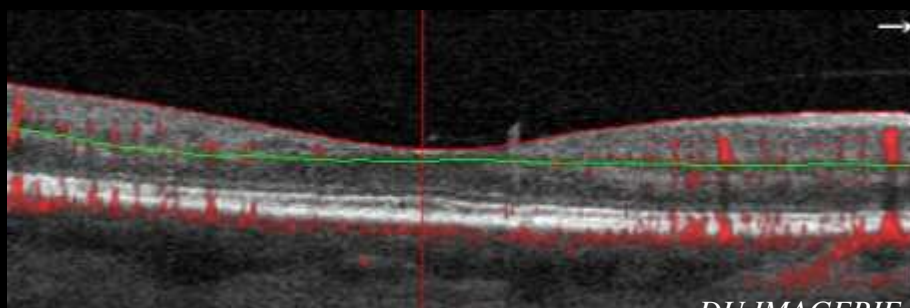
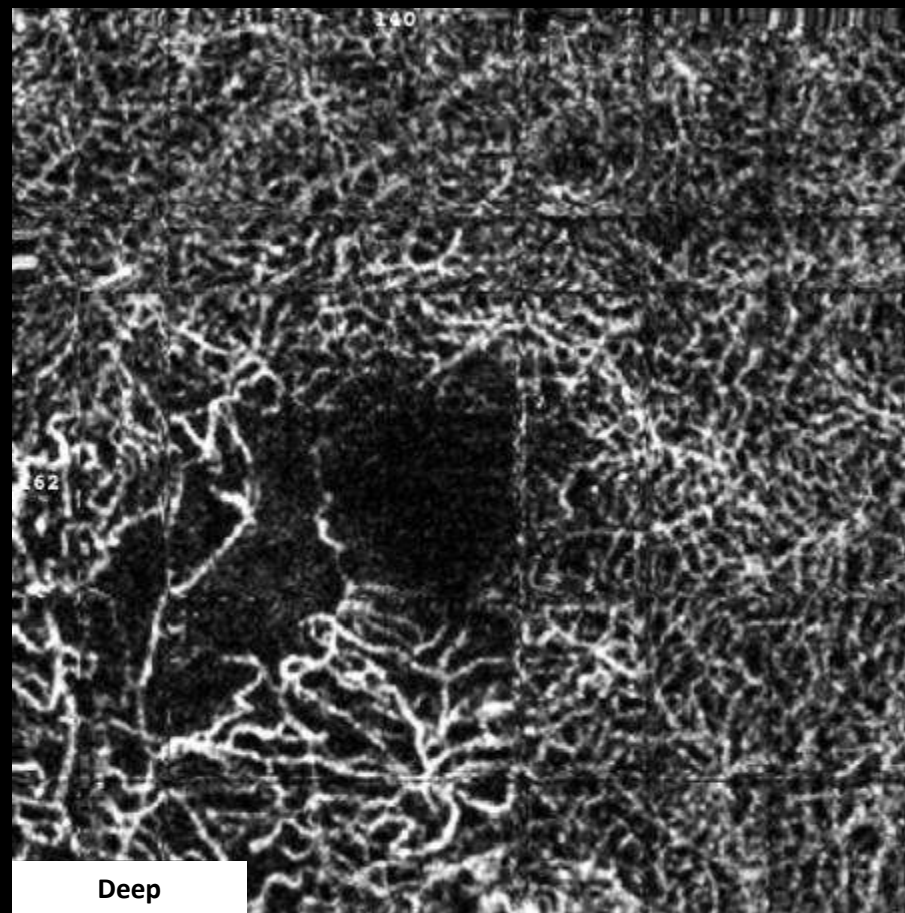
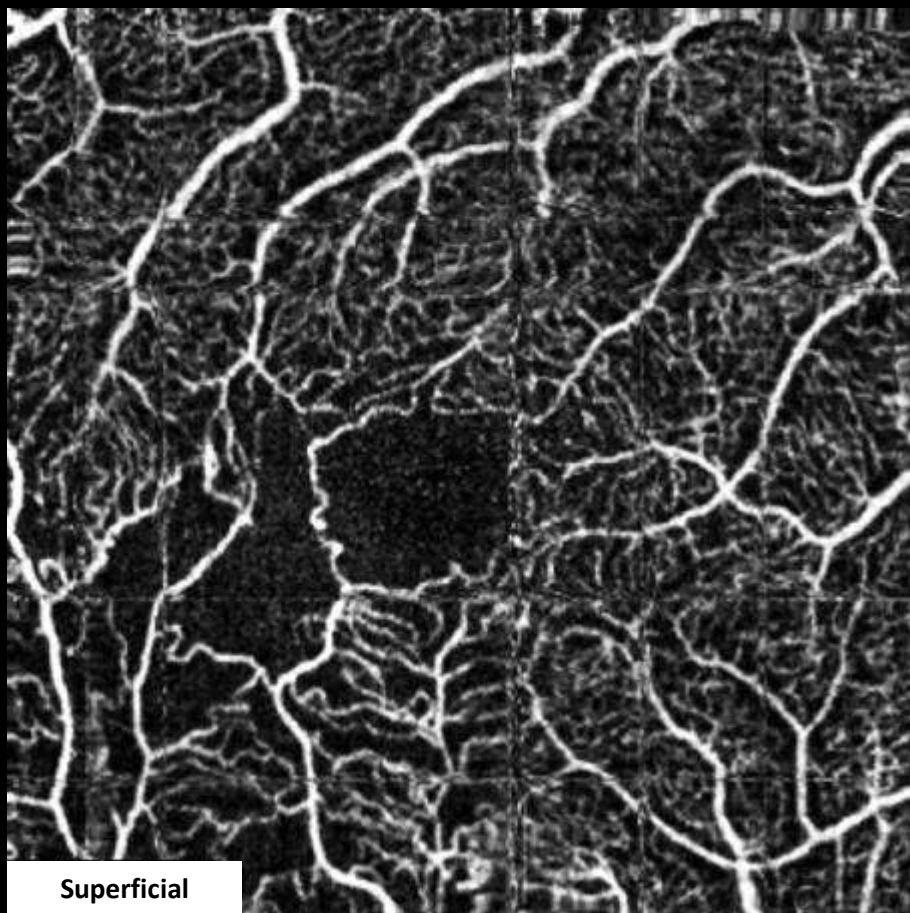
3 min



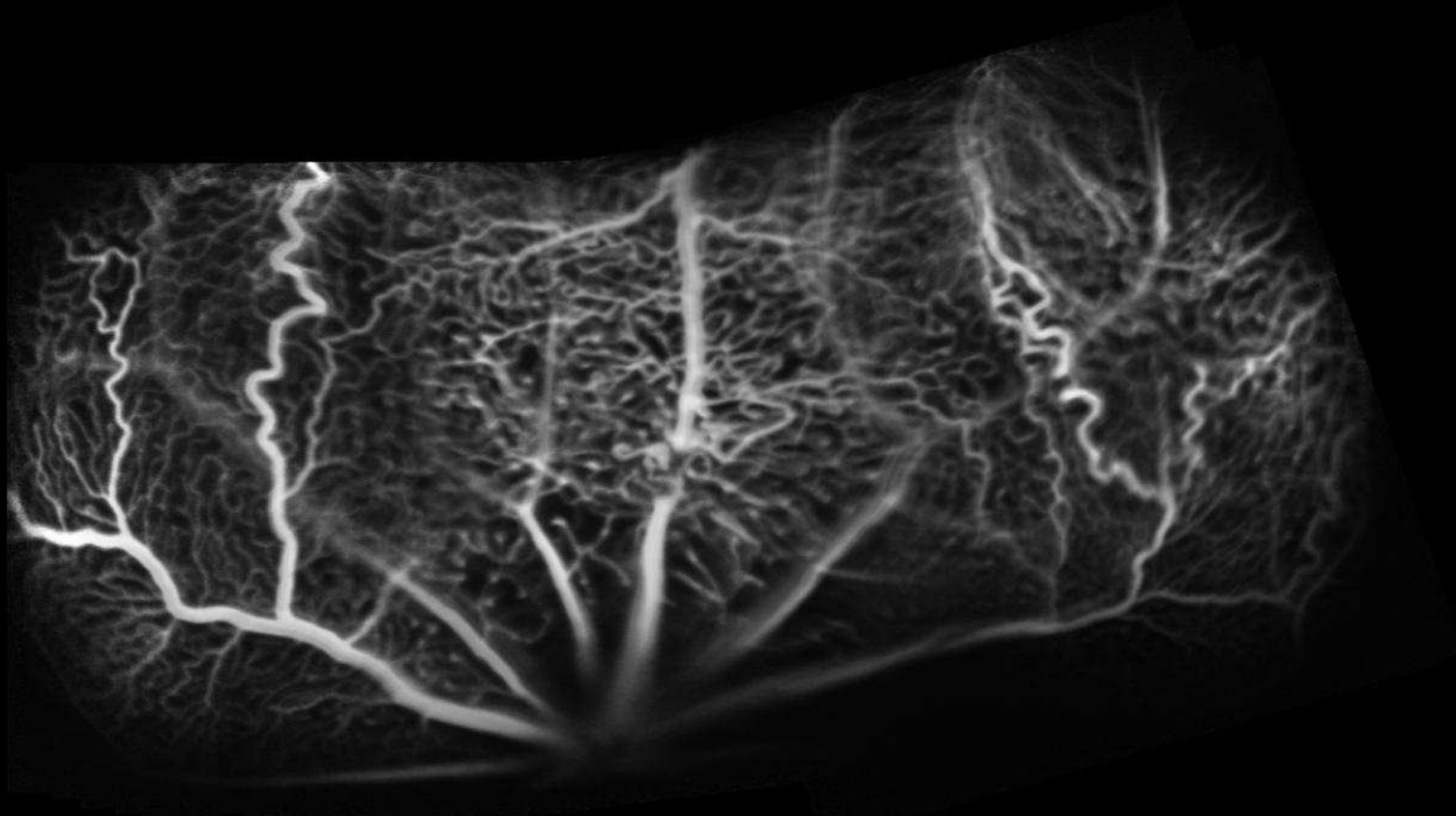
Les collatérales se développent surtout dans le réseau profond



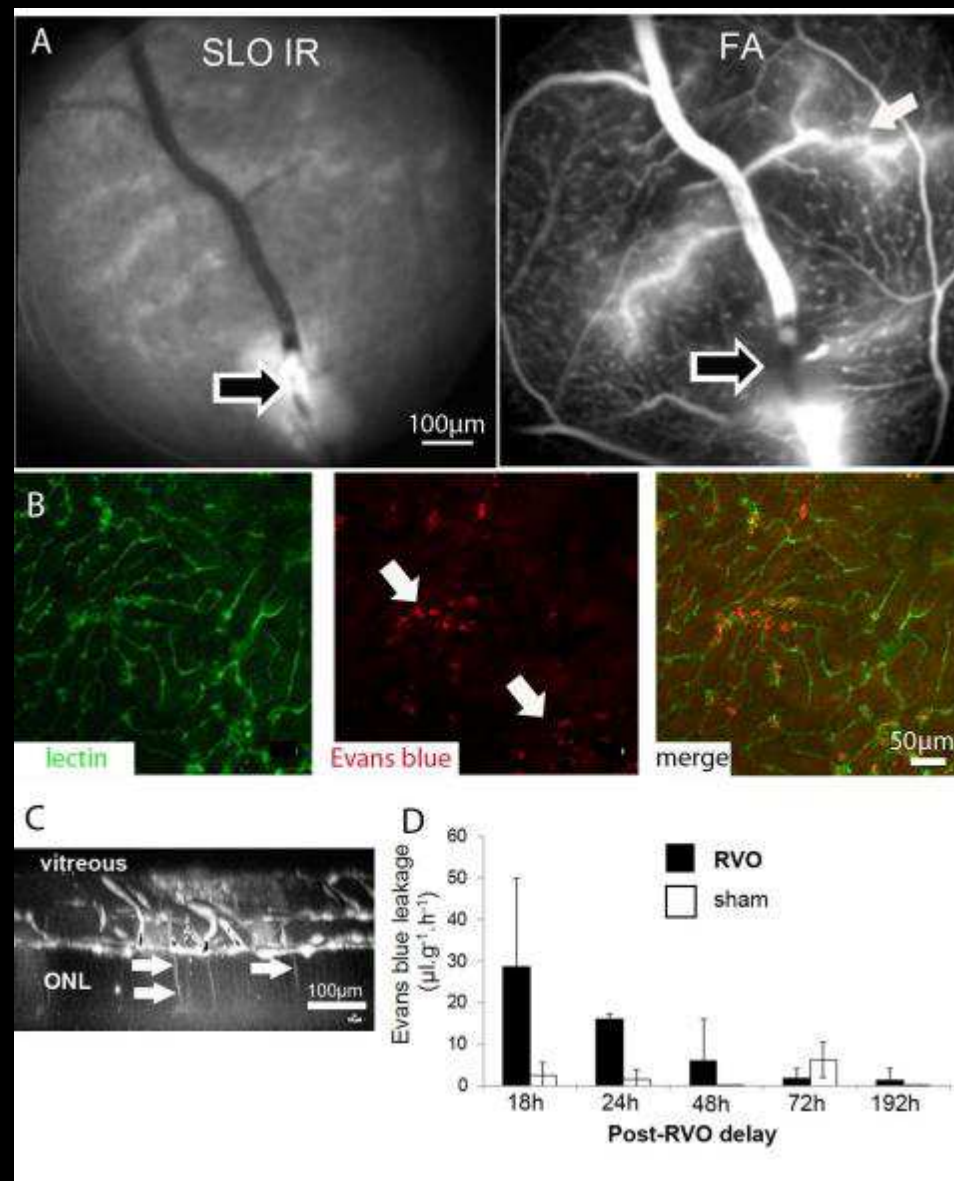
- Wang et coll. Gaefe 2018; Freund et coll, JAMA ophth 2018

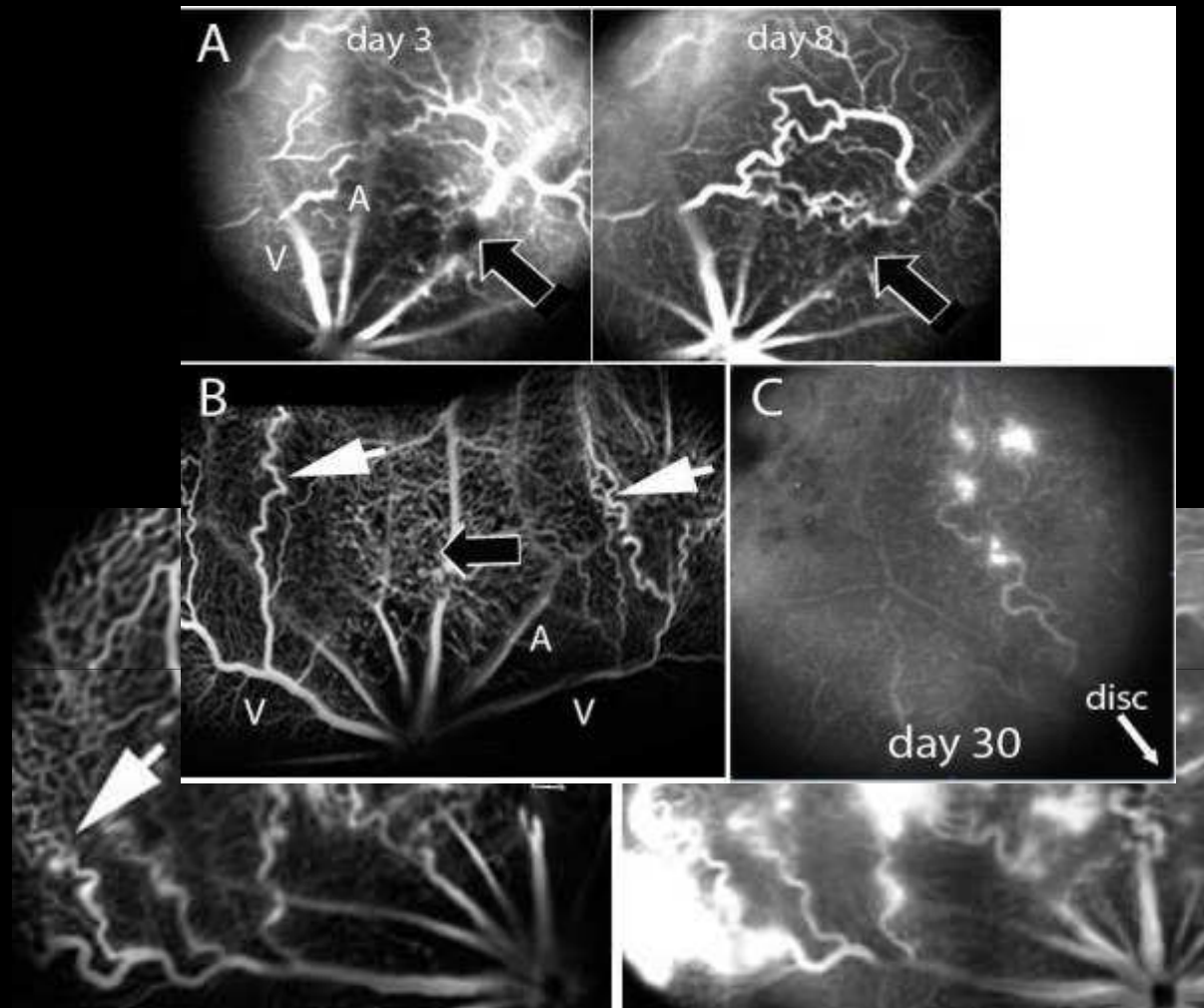


Etudes expérimentales



HRA 17/07/2014 , OS, AutoFluo 30°Composite 71°x41° (31)
Occlusions, Veineuse, 12/05/2008, #
Heidelberg Engineering GmbH





Néo-vascularisation

- Survient dans les formes non perfusées (40 à 50% des OBVR)
 - Sévérité proportionnelle à la surface non perfusée
 - Néo-vascularisation sur la papille si non perfusion approche 1/4 de la surface rétinienne
 - Apparaît rarement avant 4 mois
- 20 à 30% des OBVR auraient des NVx avec hémorragie intravitréenne, sans laser.
- La néovascularisation est néanmoins inconstante
 - Rôle possible du DPV



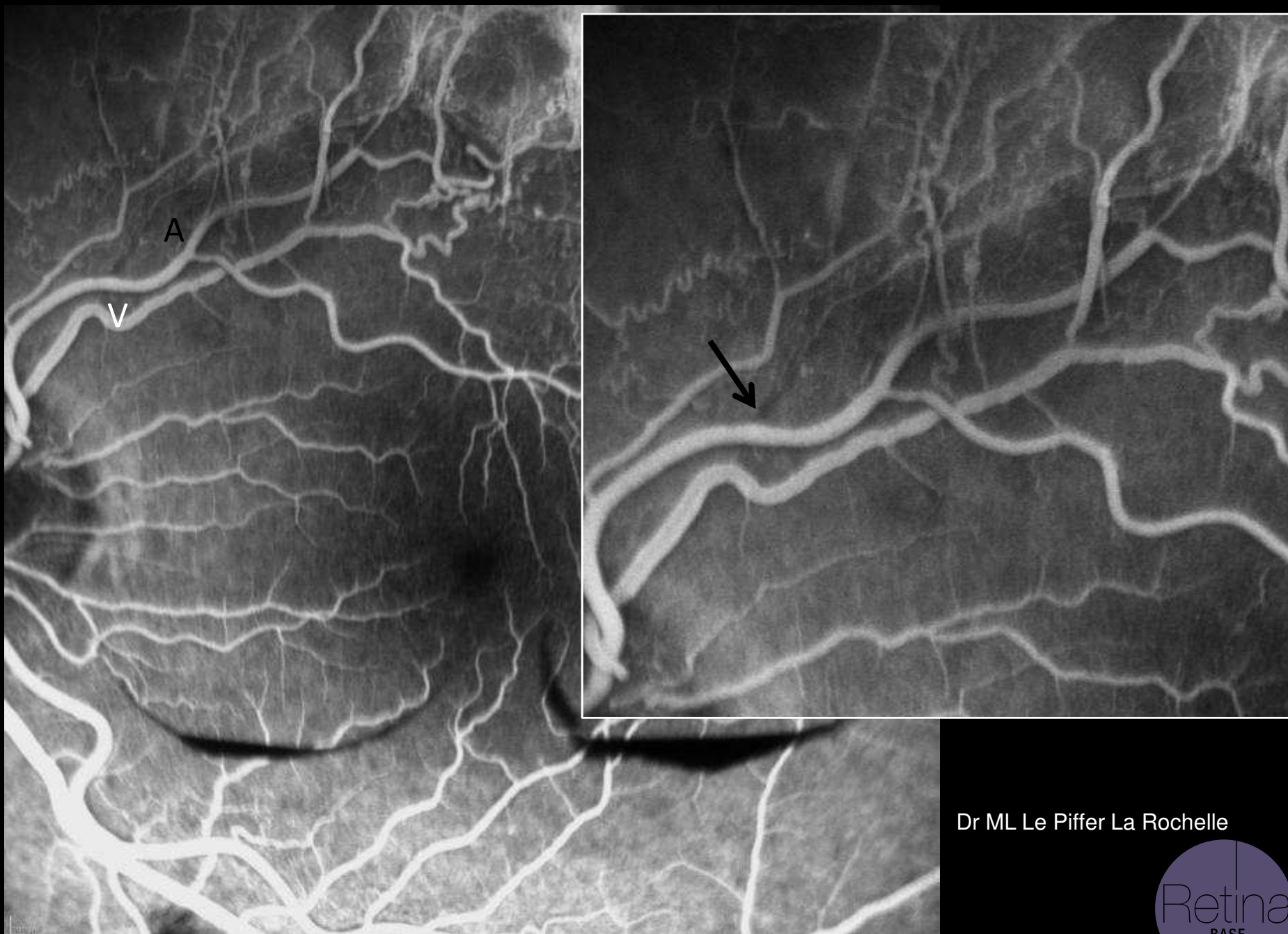
Dr ML Le Piffer La Rochelle



Dr ML Le Piffer La Rochelle

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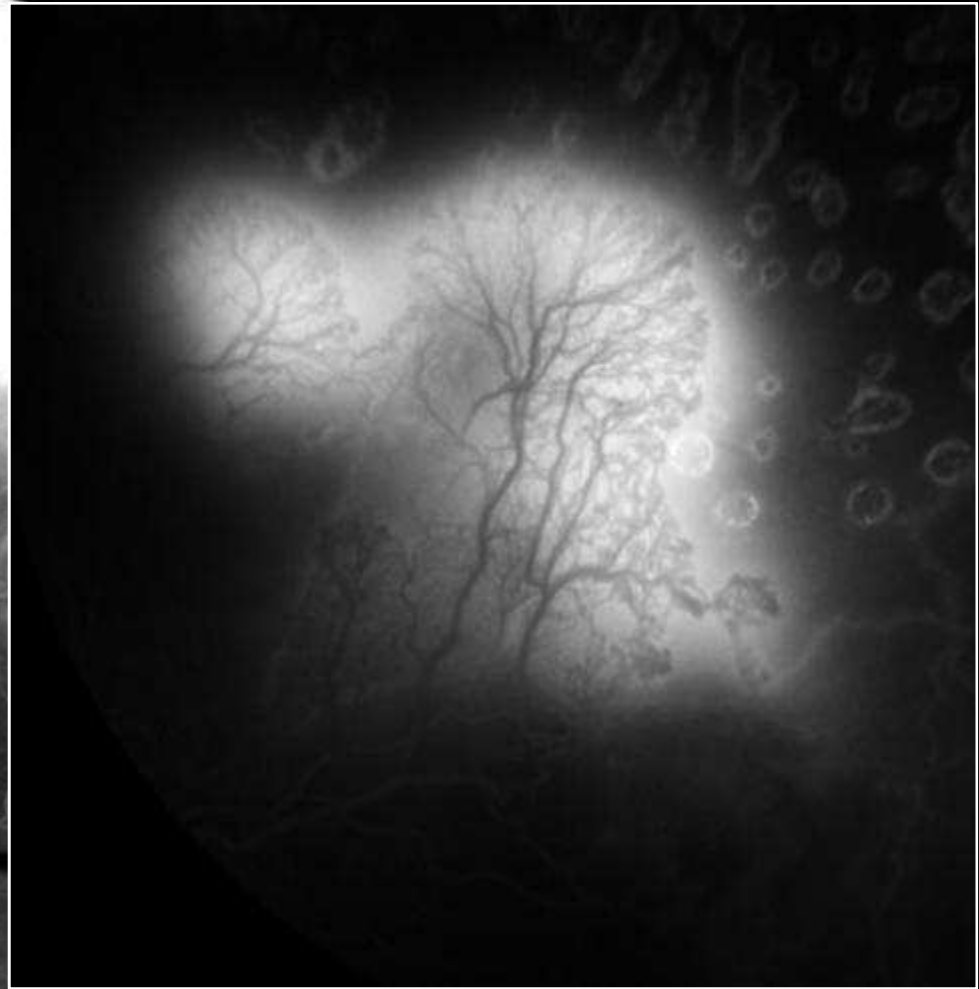




Dr ML Le Piffer La Rochelle



DU IMAGERIE ET PATHOLOGIE RETINIENNES HÔPITAL LARIBOISÈRE
UNIVERSITÉ PARIS 7

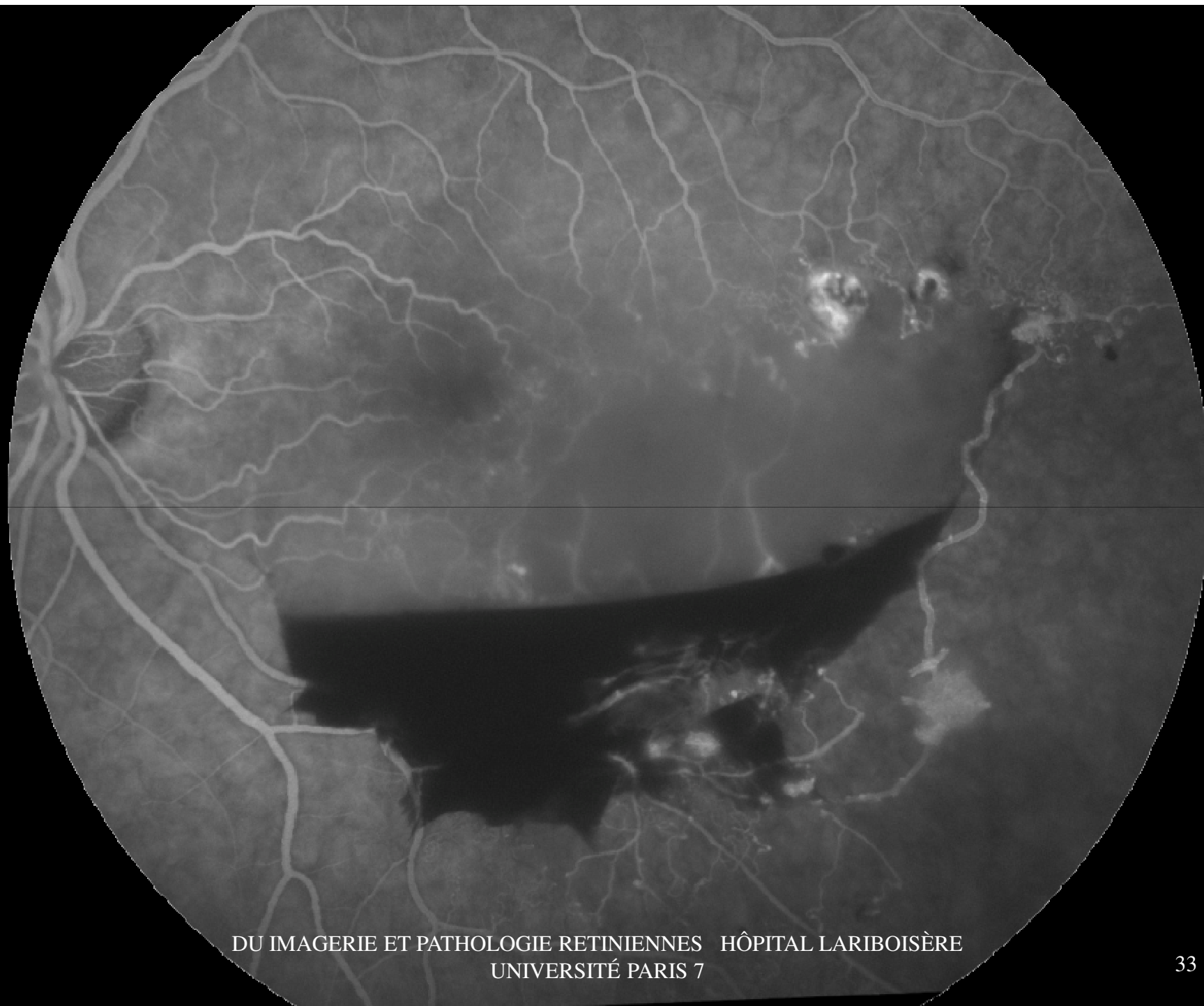


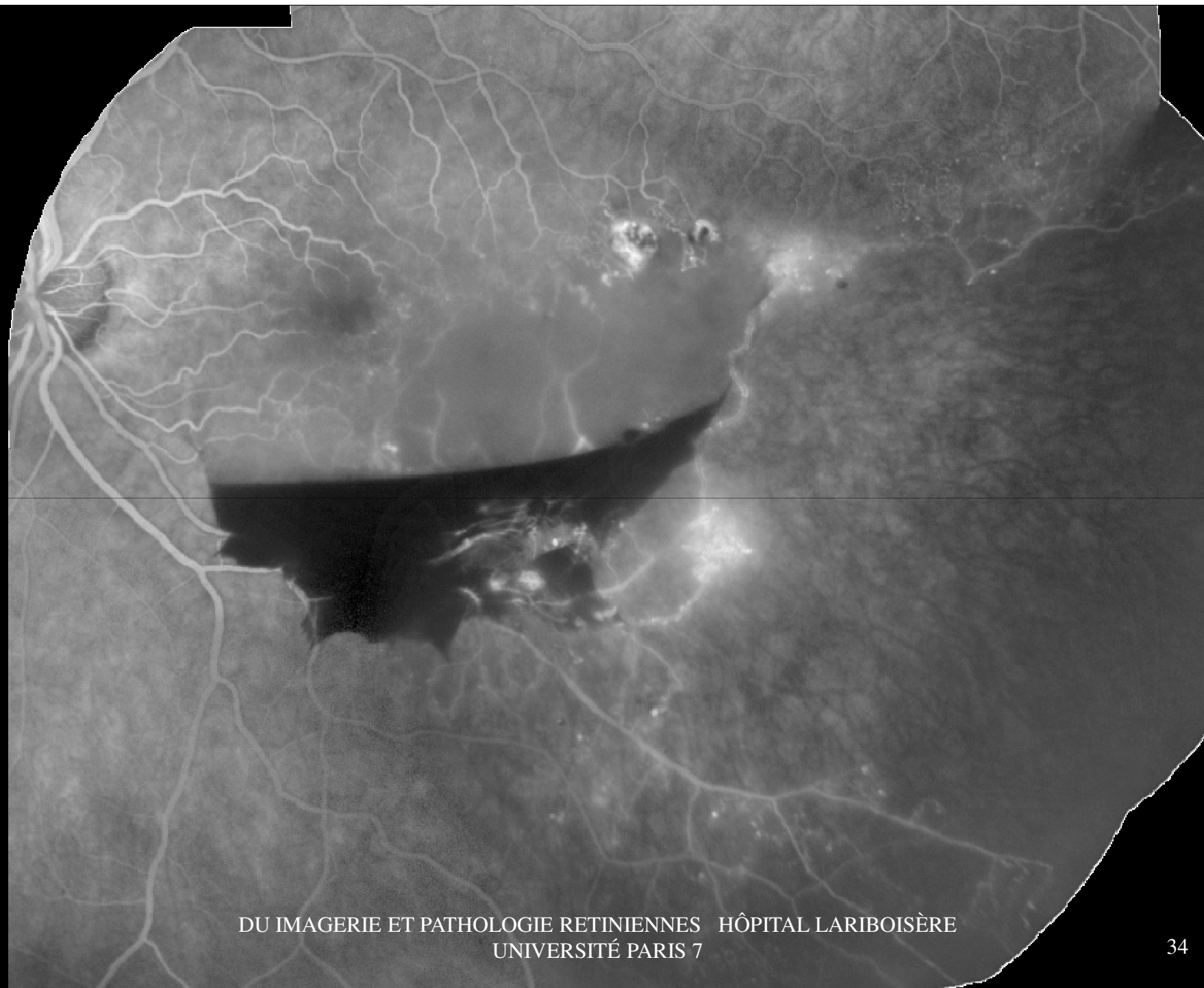
DU IMAGERIE ET PATHOLOGIE RETINIENNES HÔPITAL LARIBOISÈRE
UNIVERSITÉ PARIS 7

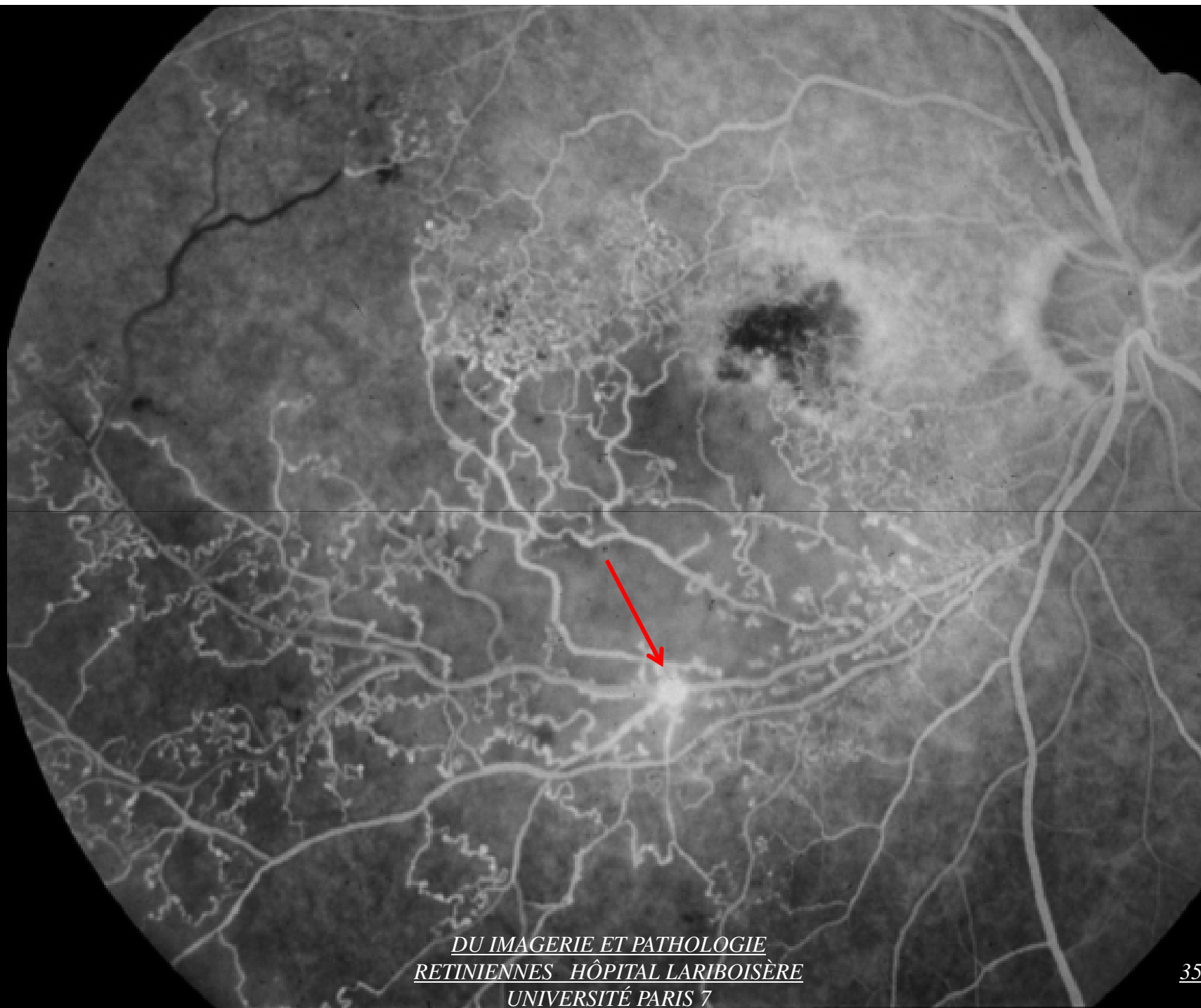
Dr ML Le Piffer La Rochelle



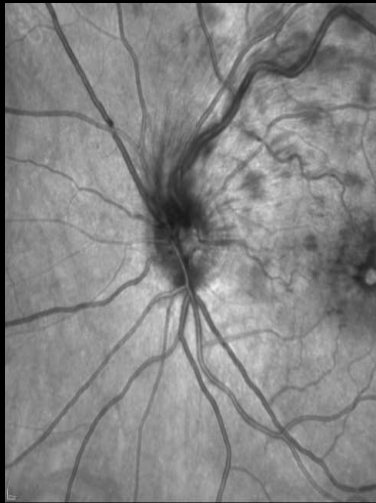




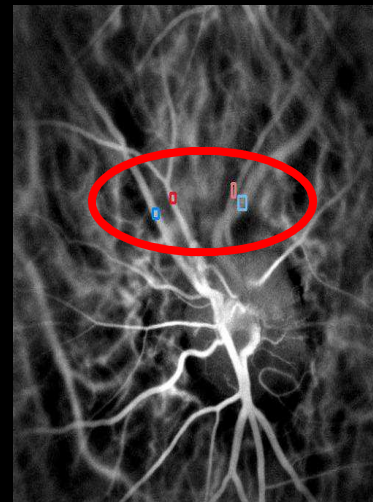
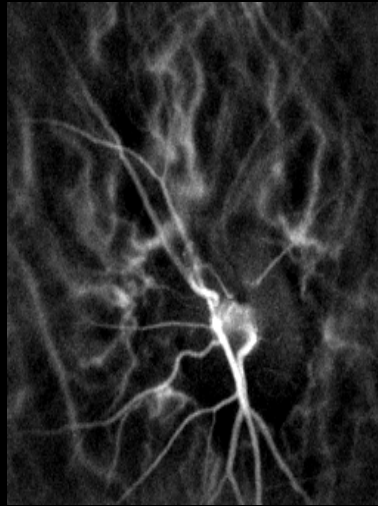




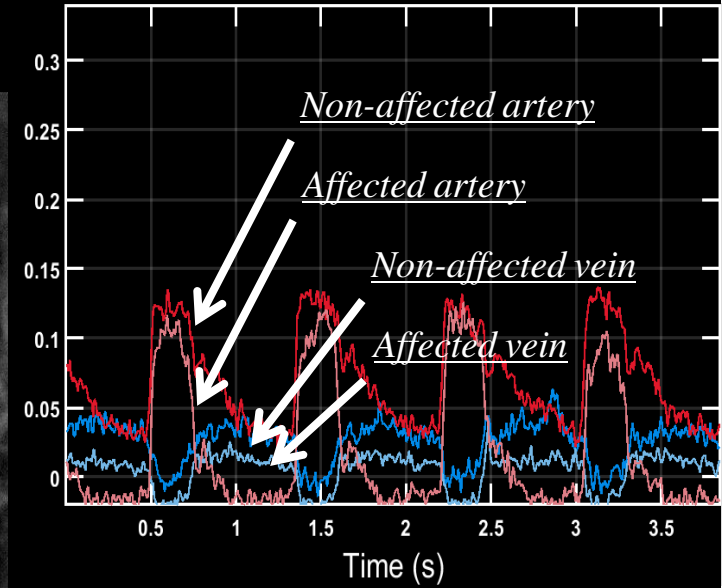
- Power Doppler movie, 6-33 kHz



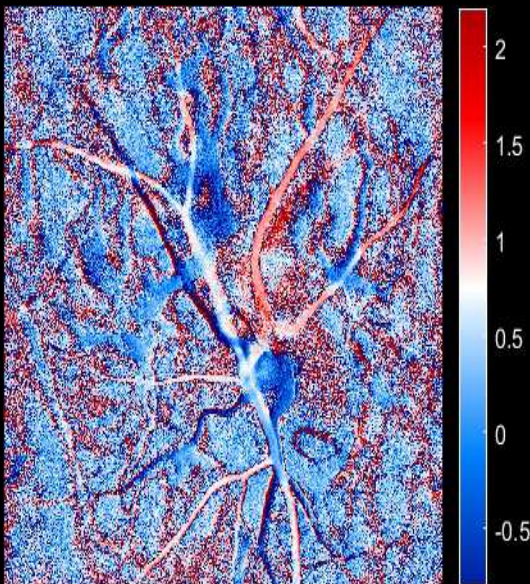
- Power Doppler, 1-33 kHz



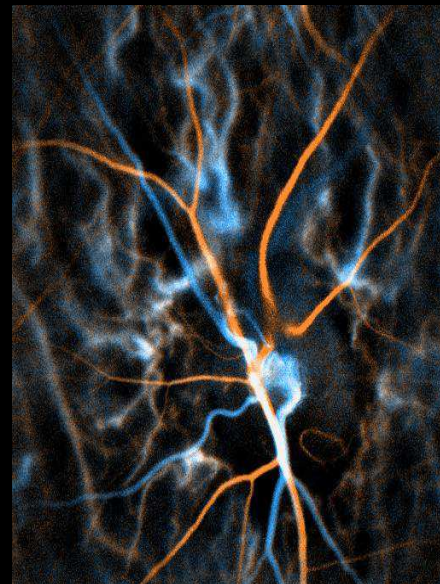
- Power Doppler variations, 6-33 kHz **V5**



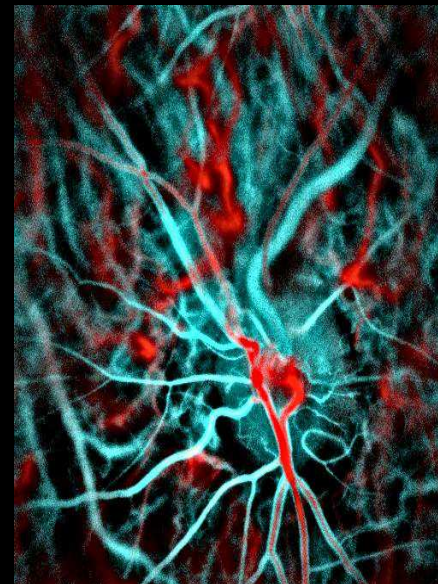
- Resistivity, 6-33 kHz



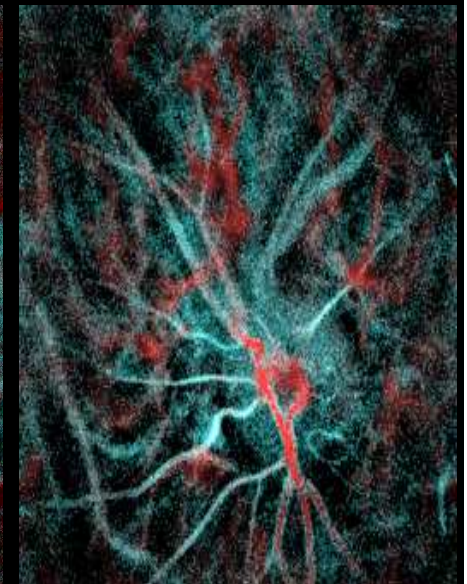
Systole / Diastole



Low flow / high flow



- Composite movie



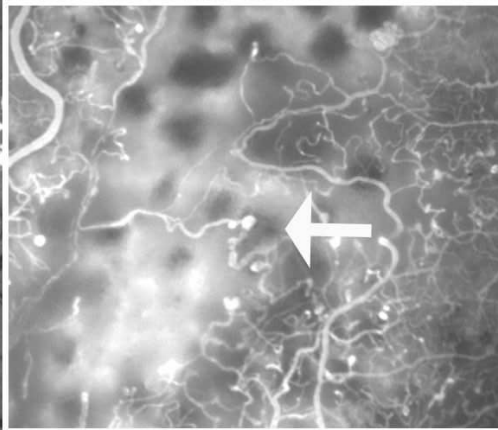
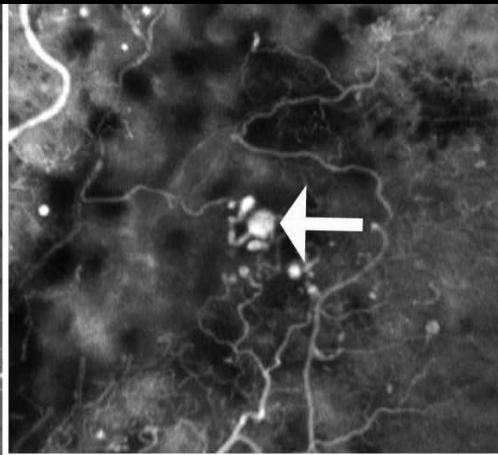
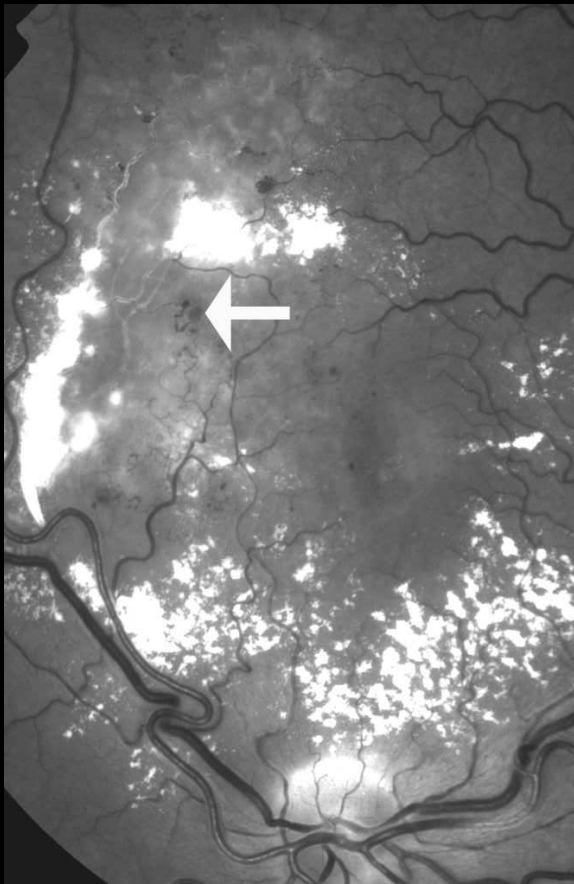
D0

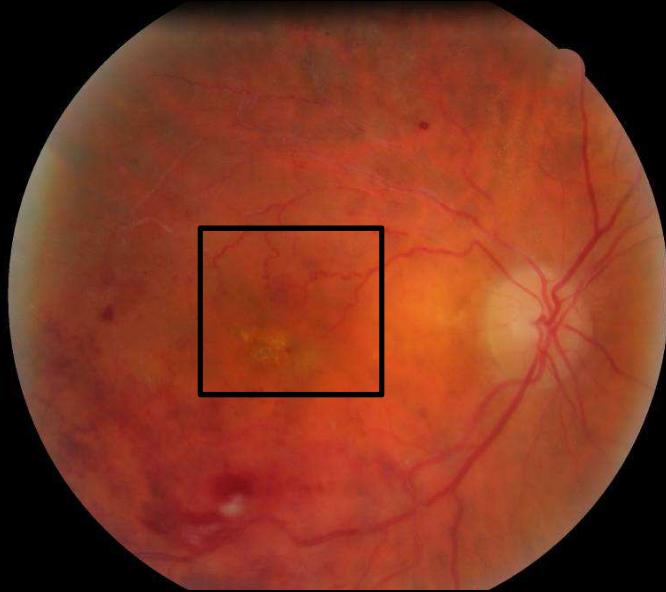
D27

D31

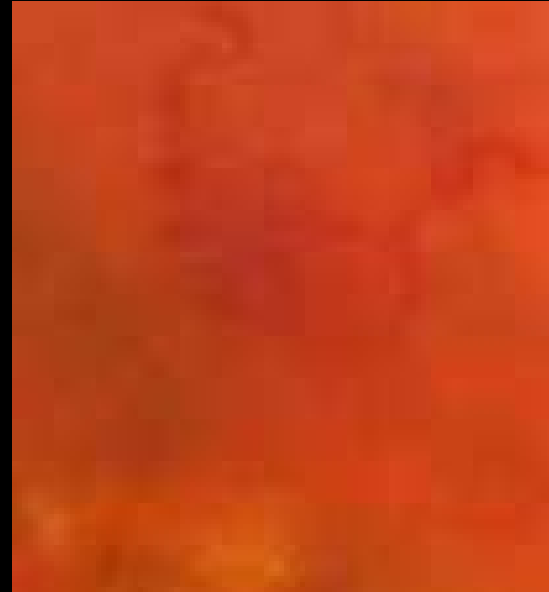


OBVR et macroanévrismes

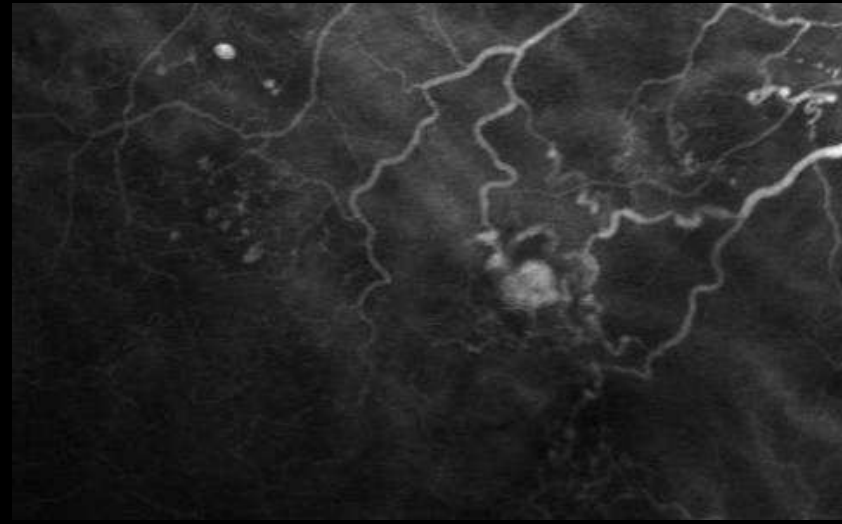
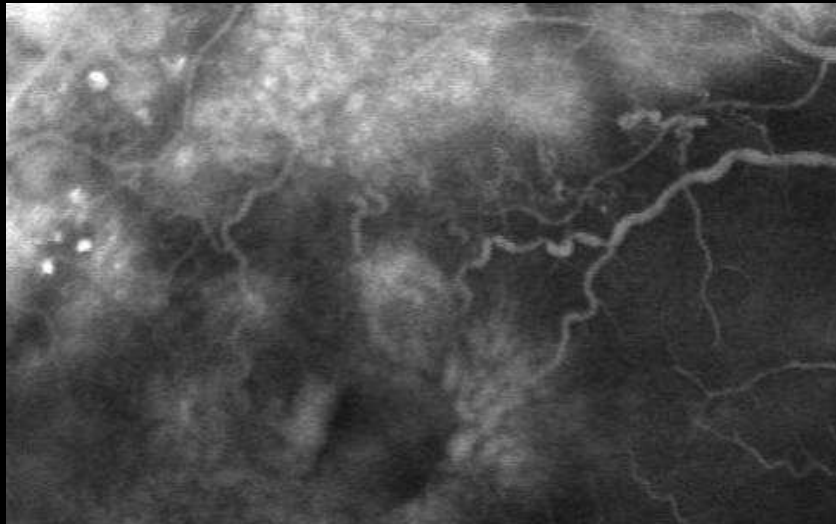




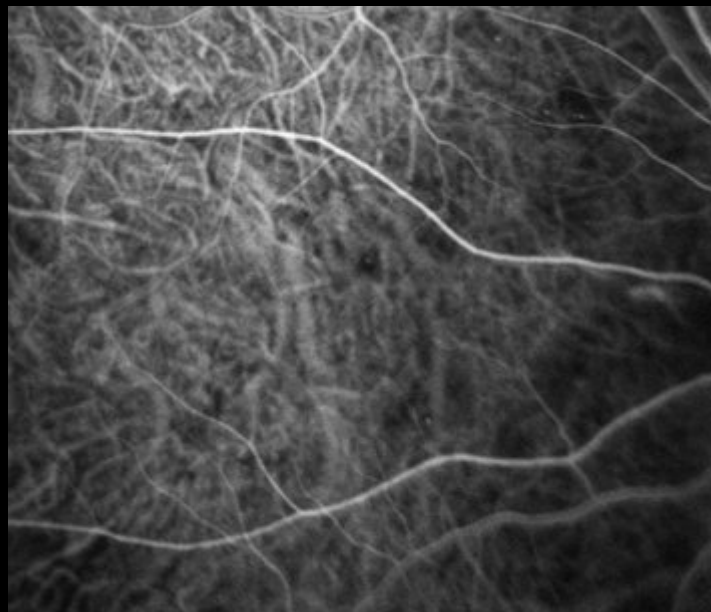
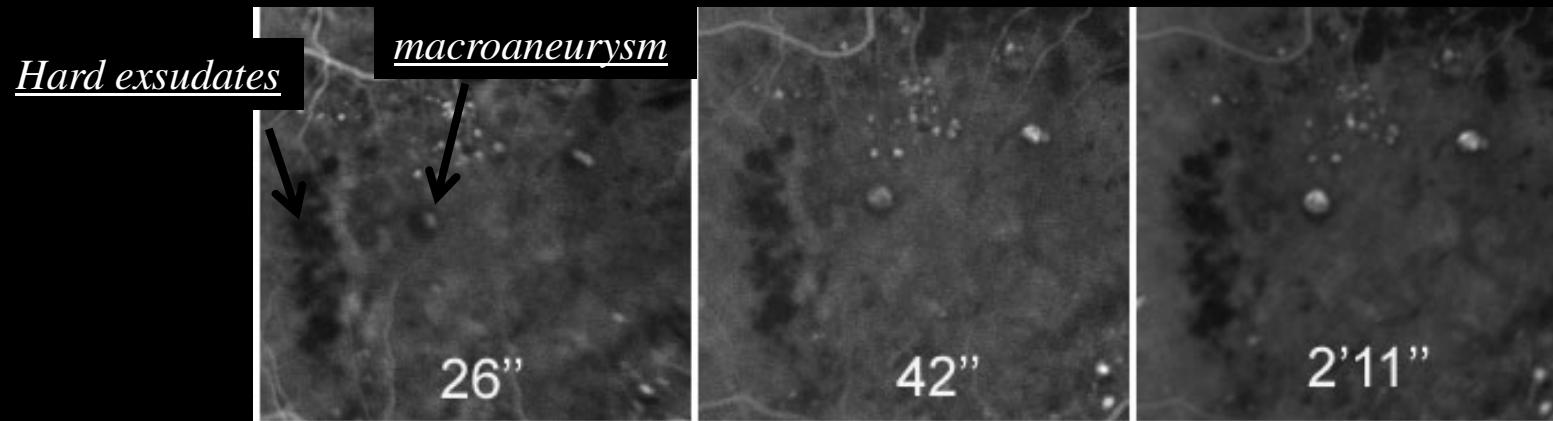
Fluorescein

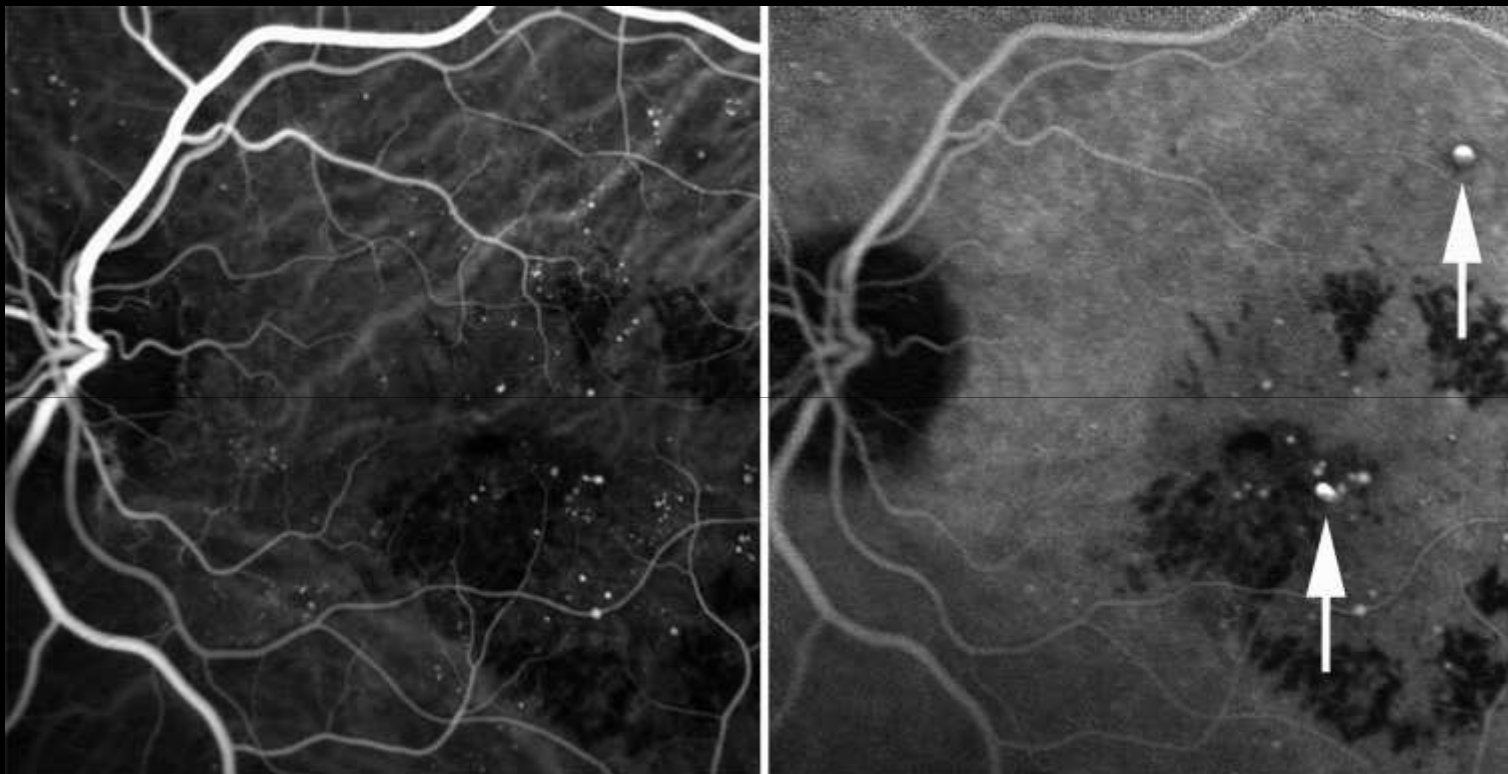


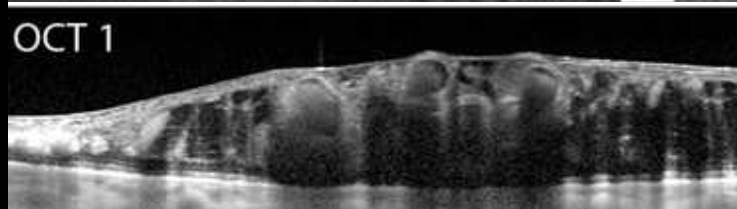
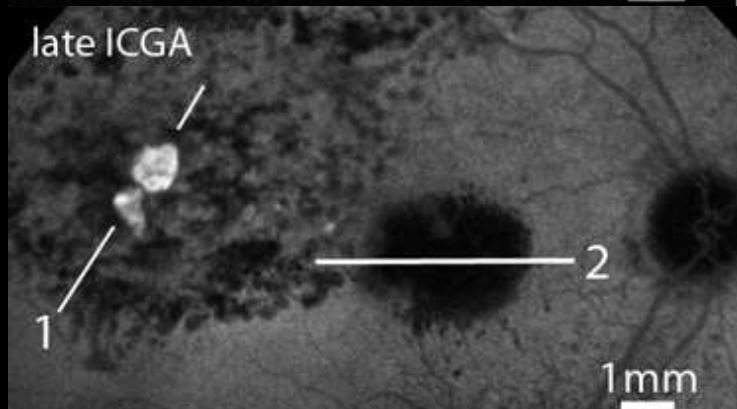
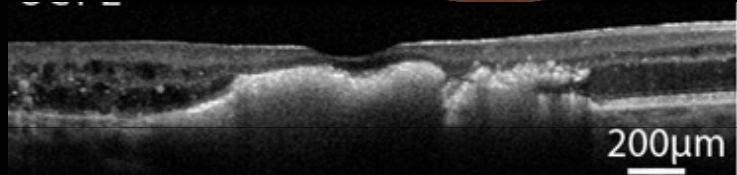
Indocyanine green



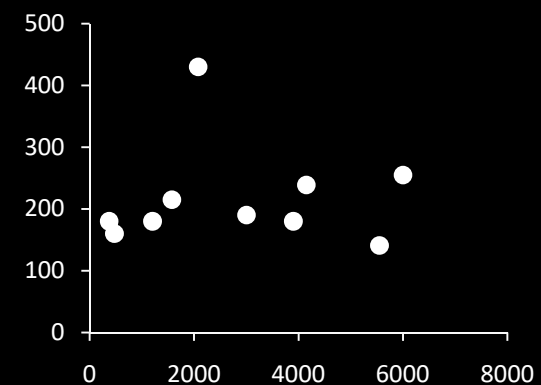
The amphiphilic nature of indocyanine green probably explain the progressive impregnation of fibrin and/or lipids within the lumen





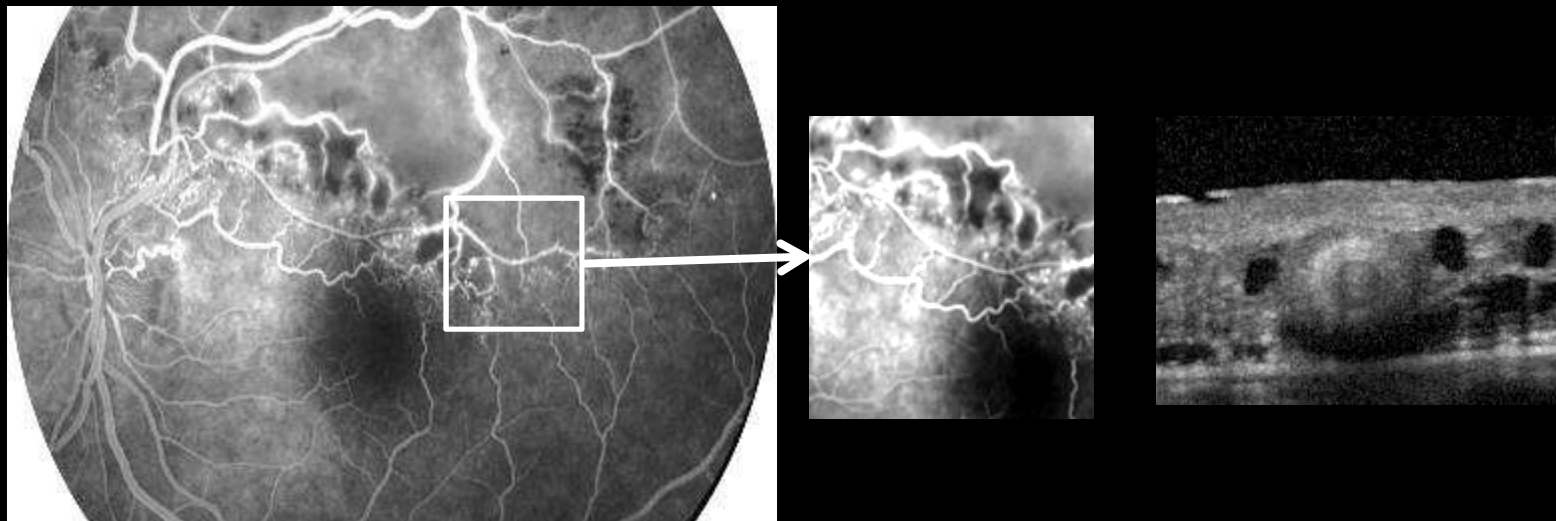


Diameter (μm)

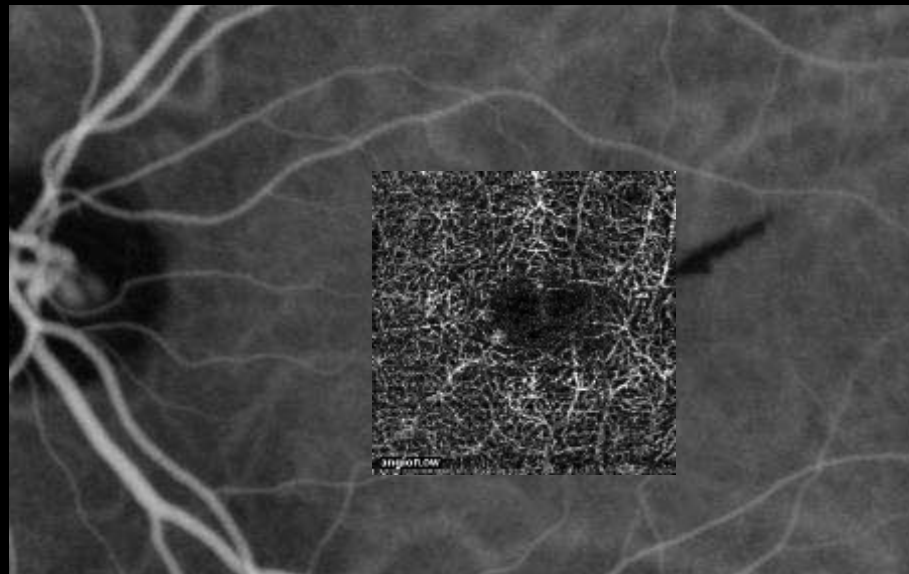


Distance to
fovea (μm)

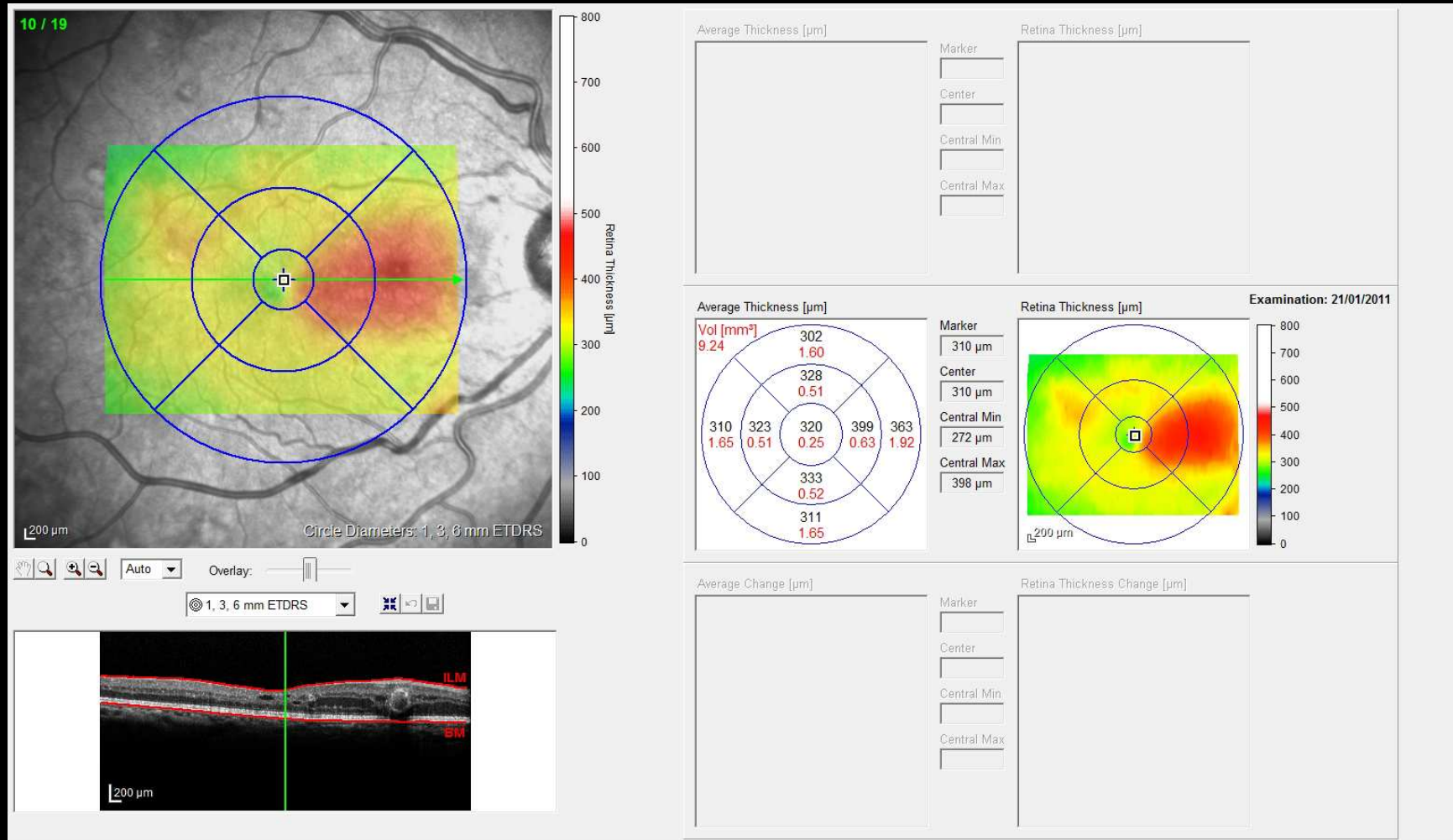
OCT shows parietal thickening and intraluminal material



OCTA is poorly contributive because there is a very slow blood flow



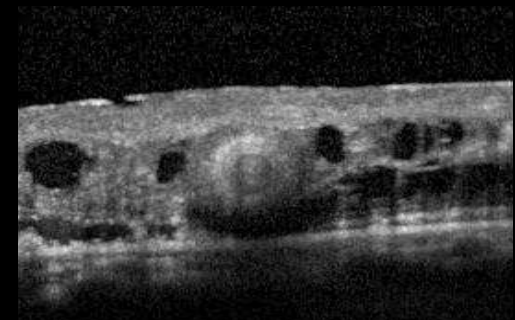
The mapping is of interest to identify a TelCap



- The incidence of macroaneurysms increases with both the duration and severity of macular edema
 - In RVO of >12 months duration,
 - BRVO: 37% (n=27)
 - CRVO: 24% (n=18)
- > 90% of eyes with hard exudates*

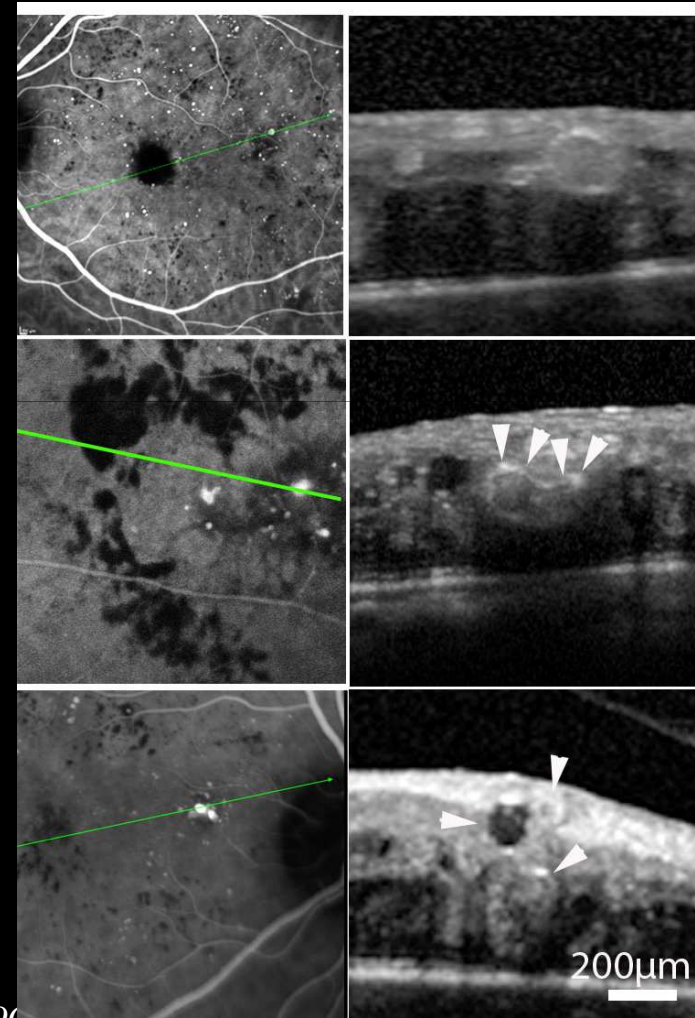
Histology

- All macroaneurysms show parietal thickening (which may be even thicker than the lumen itself)
 - Histology suggests that thickening occurs through the deposition of plasma material
 - Asymptomatic macroaneurysms show limited wall thickening
 - Hence, parietal thickening may be directly correlated to the damage to the blood-retinal barrier, and may help to identify photocoagulation targets. This may also explain why hard exudates are strong indicators of the presence of macroaneurysms.
- Most macroaneurysms show intraluminal material
- → most of the volume of the macroaneurysm is occupied by noncirculating elements, hence flow is reduced, hence its poor visibility by OCTA



Comment nommer ces lésions?

- Le terme « macroanévrisme » prête à confusion avec les macroanévrismes artériels
- Ces lésions peuvent se présenter sous la forme d'*agrégats* coloré par l'ICG
- Il s'agit histologiquement de télangiectasies
- Le terme « *telangiectatic capillaries* » (*TelCaps*) paraît plus adapté



Occlusions de branche veineuses

- Occlusion d'une partie du réseau veineux
- Différences avec une OVCR
 - Le site d'occlusion est bien visible
 - Pas de type A
 - La macula est au bord de la zone oedémateuse, et non pas au centre
 - Plus de capacités de collatéralisation
 - Pas de reperfusion de la veine occluse
 - Plus de TelCaps
 - Pas de glaucome néovasculaire



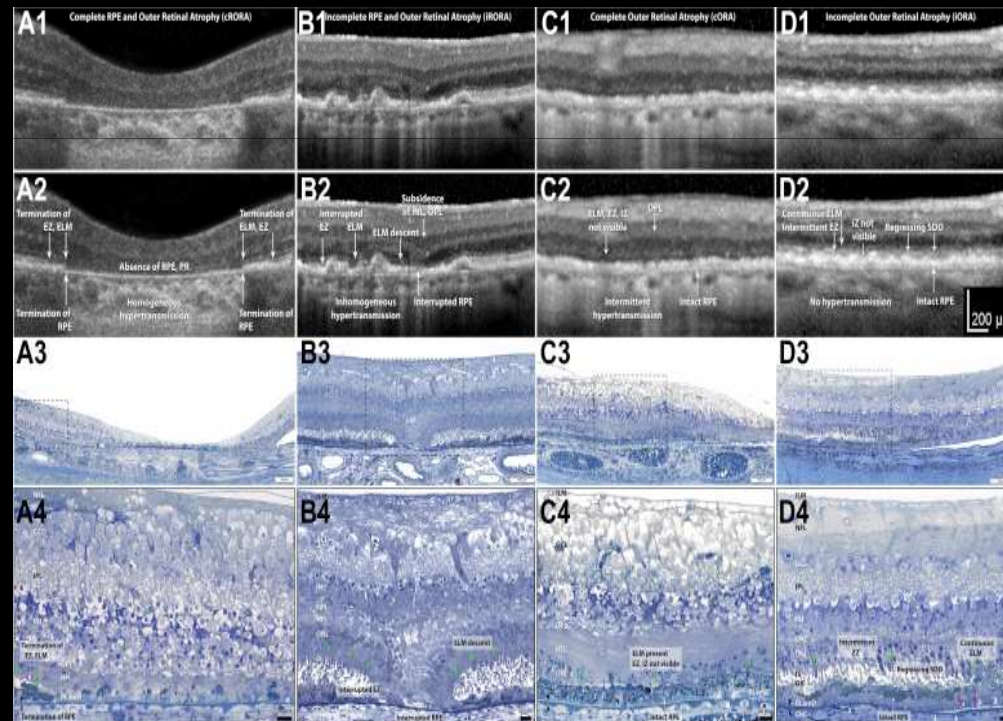
Confocal microscopy of telangiectatic capillaries (TelCaps) following retinal vein occlusion: Implications for in vivo imaging

Michel Paques, MD, PhD; Daniela Castro Farias MD, MSc; Anna

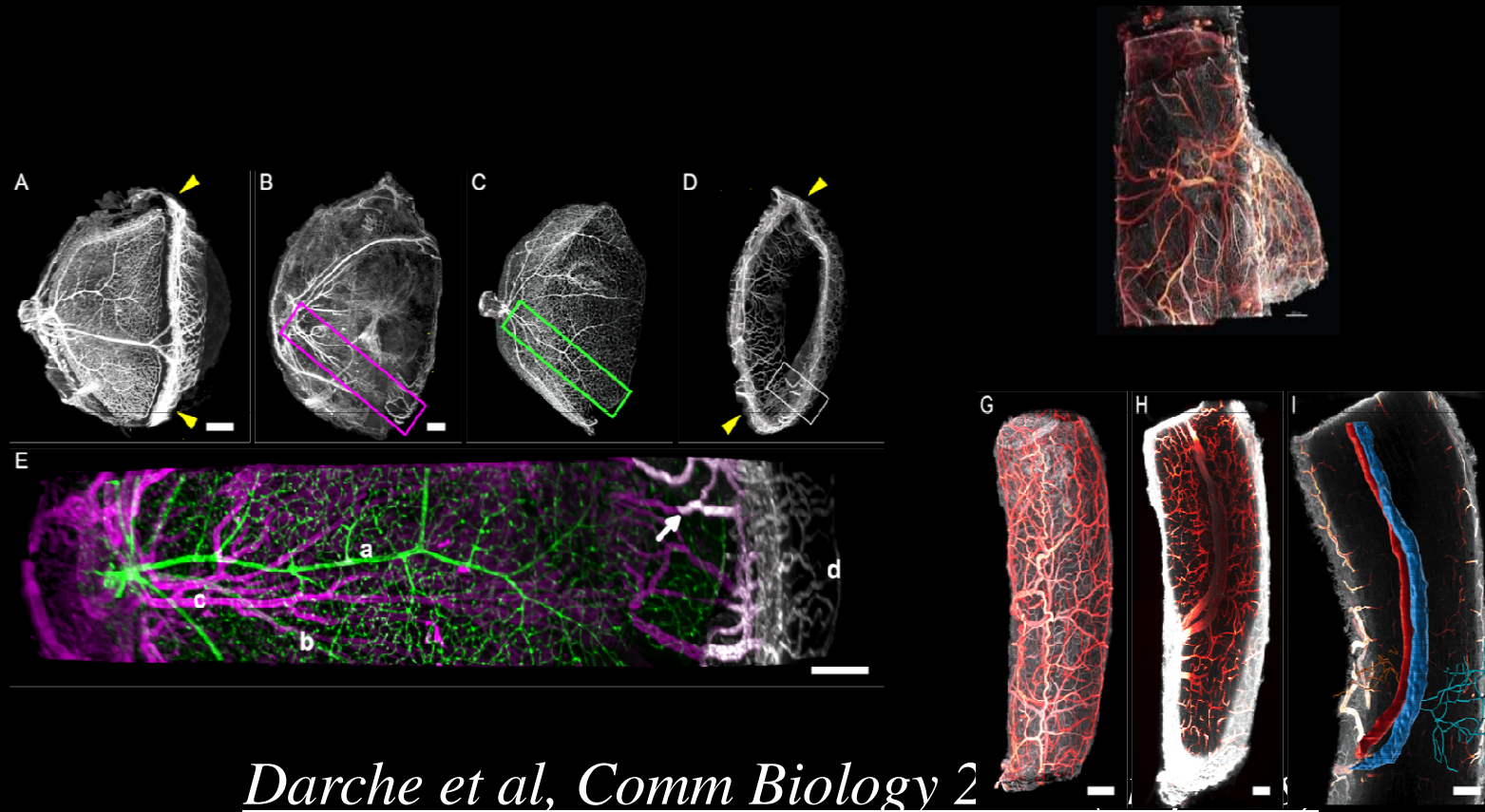
Verschueren, PhD; Ysé Borella, MD, PhD; Maire Darche, Eng

No conflict of interest

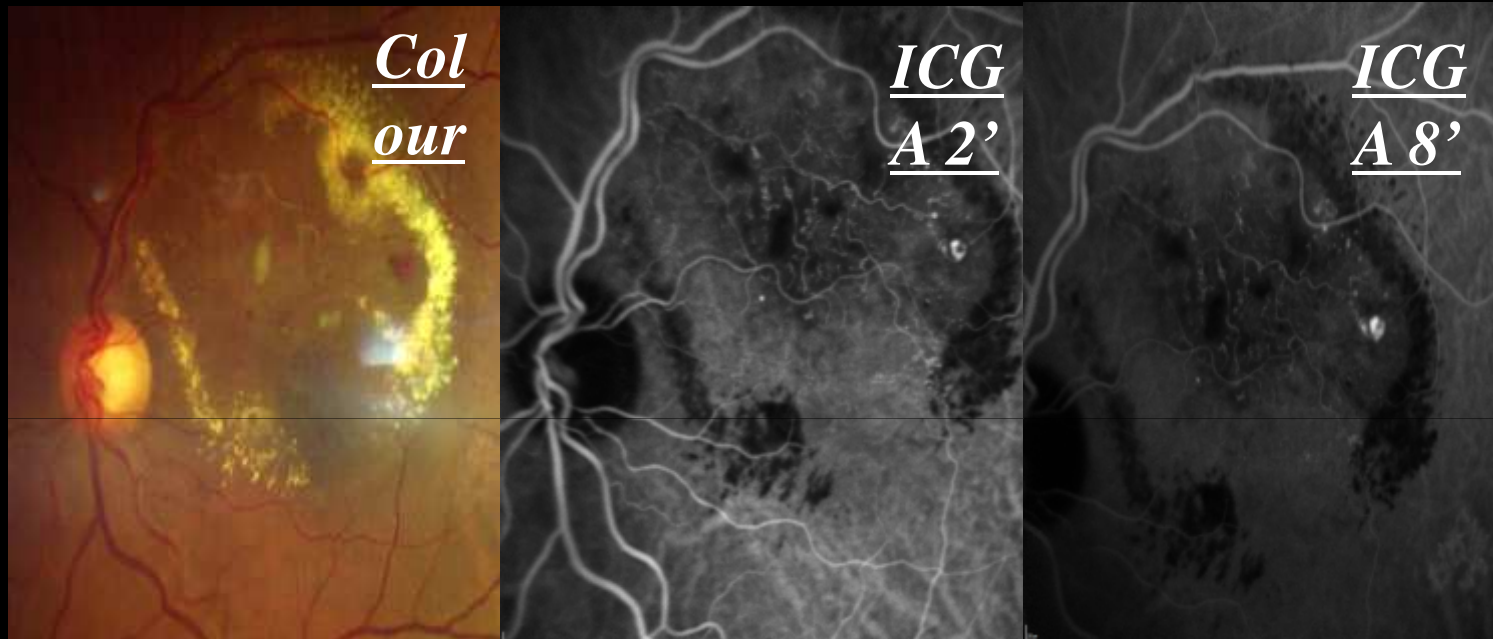
- In ophthalmology, the dialogue between histology and *in vivo* imaging is a rich domain, mutually beneficial and which is still ongoing because both *in vivo* imaging and histology techniques progress
 - Recently illustrated by AMD studies by Curcio team
- Such interaction both answers questions... and may raise new issues



Clearing and light-sheet fluorescence microscopy



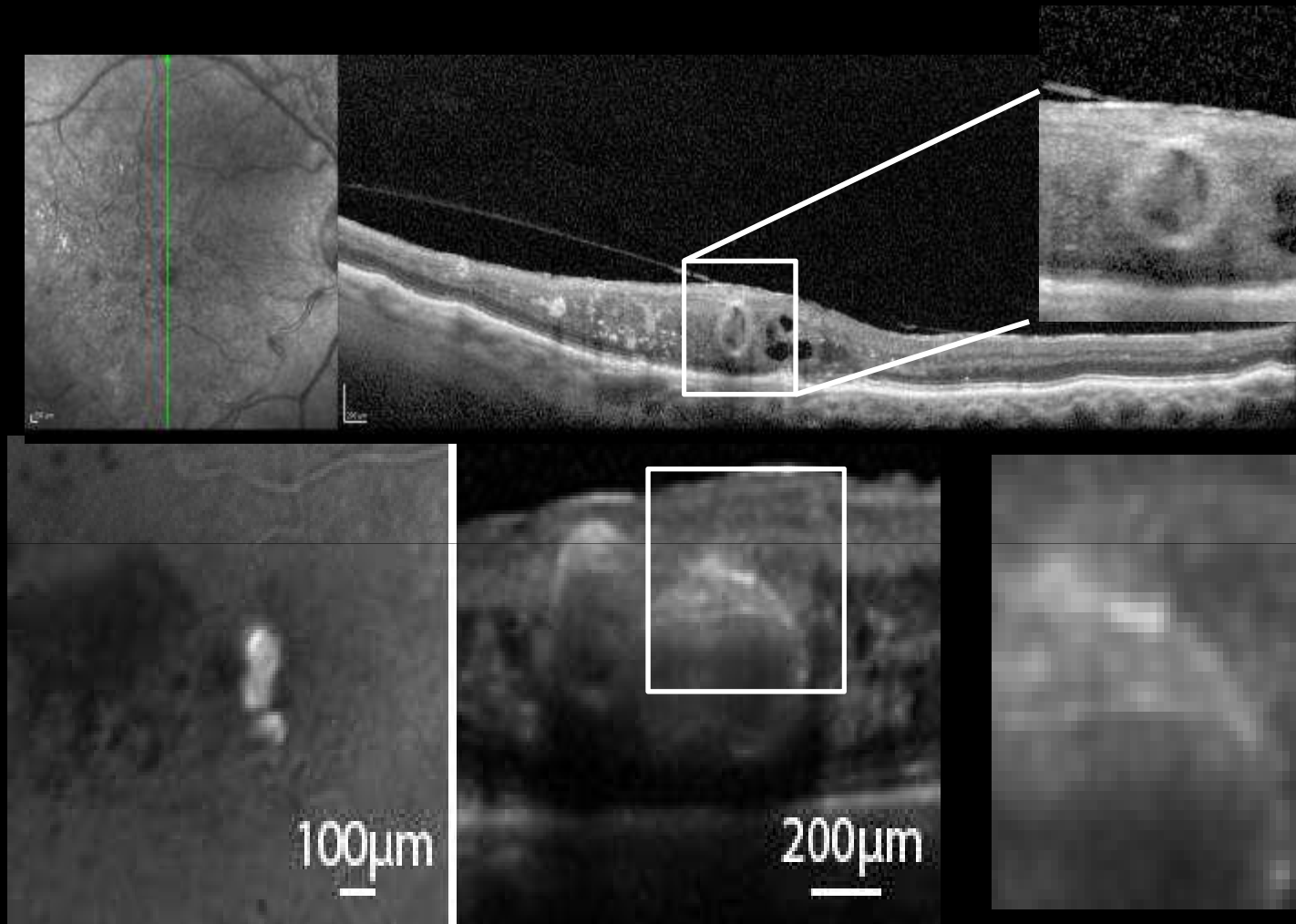
Telangiectatic capillaries (TelCaps) are commonly associated with chronic macular oedema



Effect of
targeted laser

Bourhis A, Girmens JF, Boni S, Pecha F, Favard C, Sahel JA, **Paques M**. Imaging of macroaneurysms occurring during retinal vein occlusion and diabetic retinopathy by indocyanine green angiography and high resolution optical coherence tomography. Graefes Arch Clin Exp Ophthalmol. 2010;248:161-6

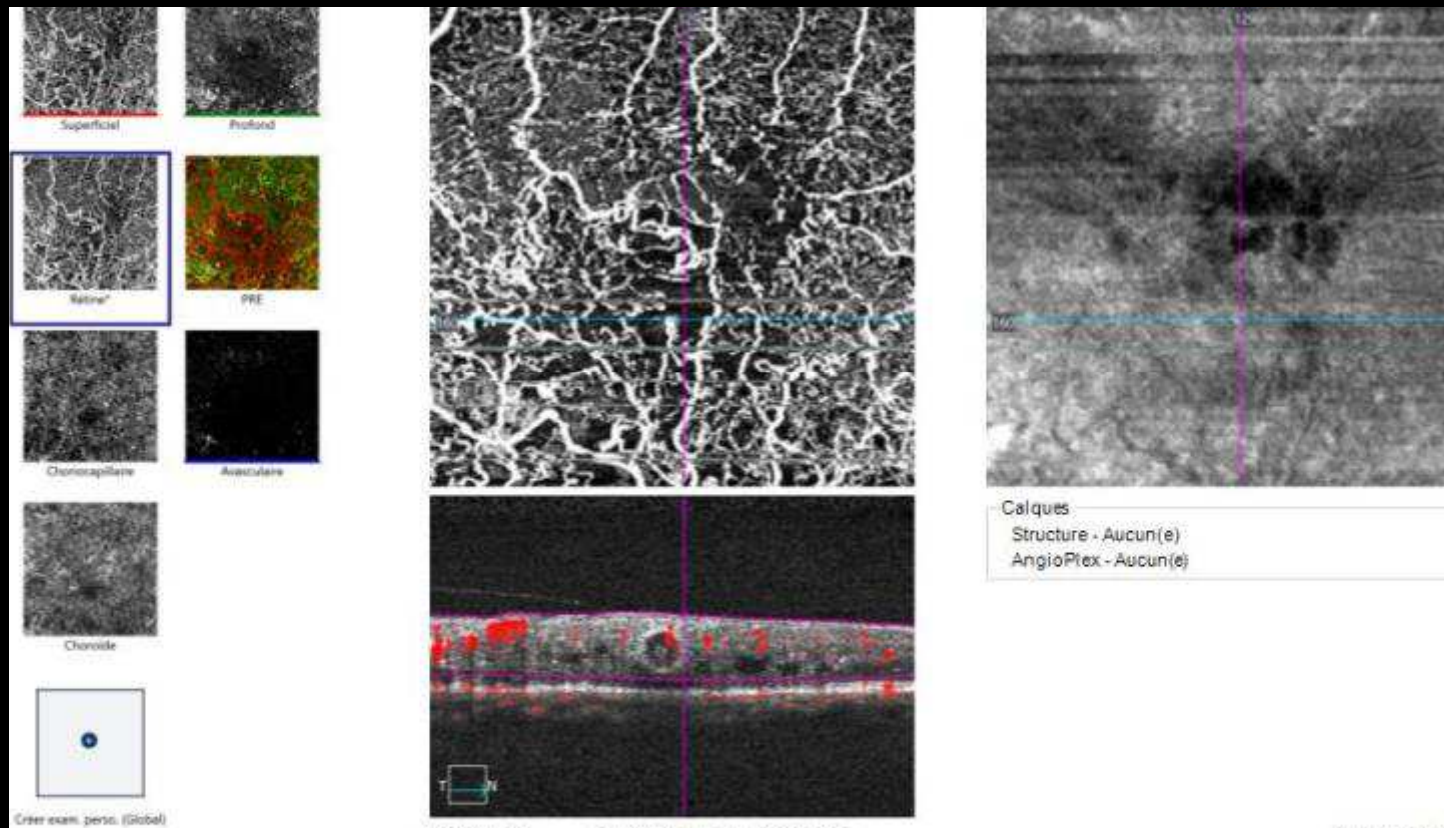
Unlike arterial macroaneurysms, TelCaps commonly show a thick wall



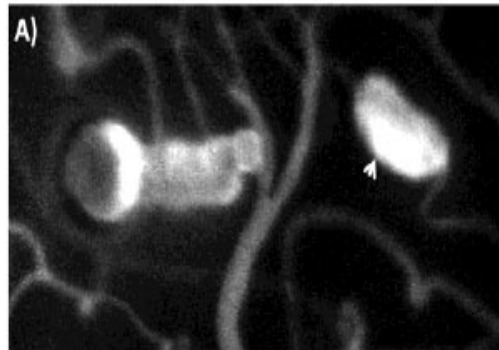
Paques M, Philippakis E, Bonnet C, Falah S, Ayello-Scheer S, Zwillinger S, Girmens JF, Dupas B. Indocyanine green-guided targeted photocoagulation of capillary macroaneurysms in macular edema: a pilot study. *Br J Ophthalmol.* 2017 Feb;101(2):170-174

Castro Farías D, Matsui Serrano R, Bianchi Gancharov J, de Dios Cuadras U, Sahel J, GraueWiechers F, Dupas B, Paques M. Indocyanine green angiography for identifying telangiectatic capillaries in diabetic macular oedema. *Br J Ophthalmol.* 2020 Apr;104(4):509-513. doi: 10.1136/bjophthalmol-2019-314355. Epub 2019 Jul 29. PMID: 31358497.

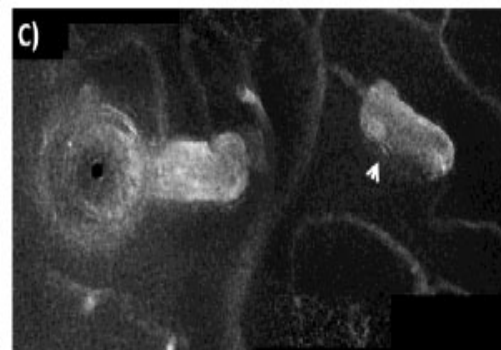
OCTA is poorly contributive to their diagnosis



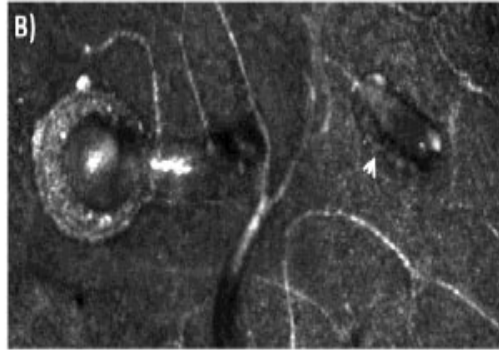
AOSLO FA Perfusion Map



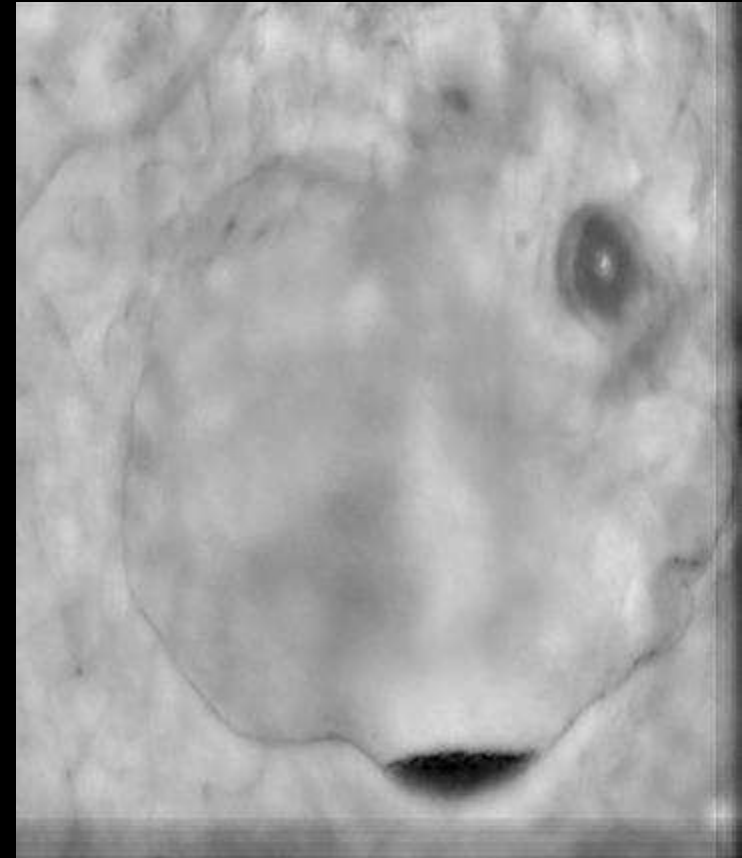
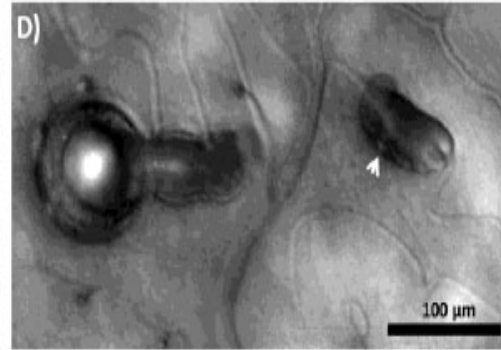
AOSLO OP Perfusion Map



AOSLO Confocal Structural Image



AOSLO OP Structural Image

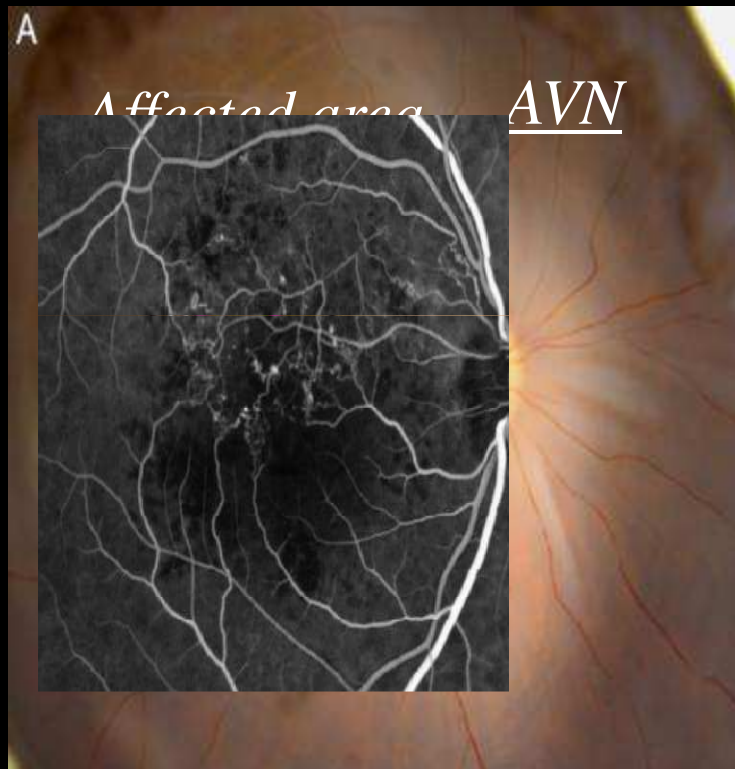


Chui Rosen

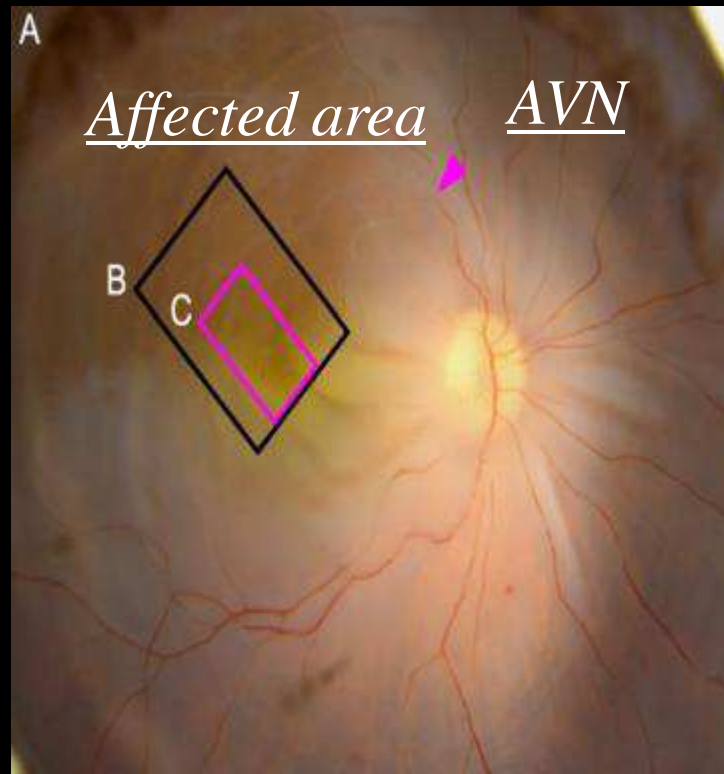
questions

- Are TelCaps a specific lesion or are included within a continuum from « micro » to « macro » capillary bulges?
- What makes TelCaps stain with ICG?
- Is size a defining feature of TelCaps?
- What is the background on which these lesions occurs?
- What is the thickened wall made of?

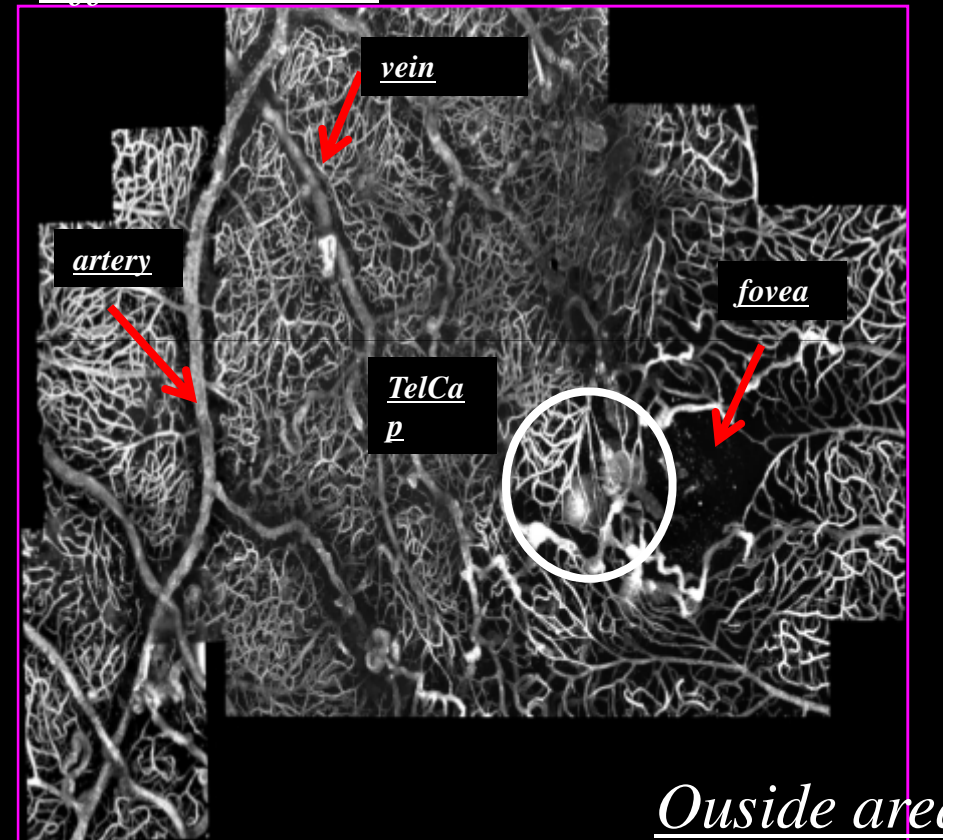
Donor eye of a 91 y/o woman with longstanding BRVO → Confocal microscopy with anti coll4 staining



Donor eye of a 91 y/o woman with longstanding BRVO → Confocal microscopy with anti coll4 staining

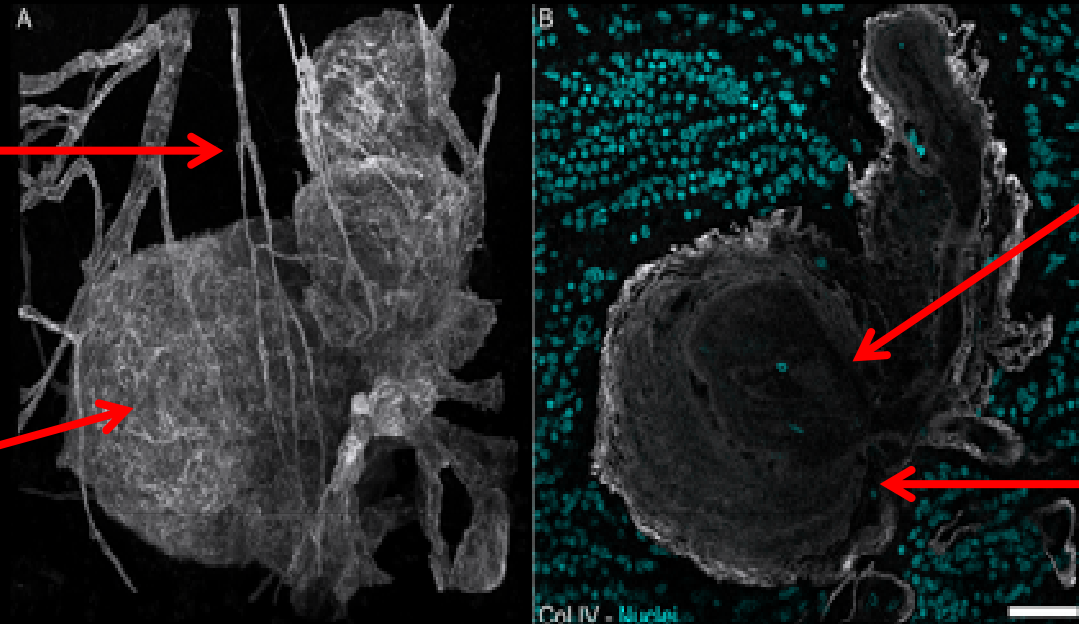


Affected area



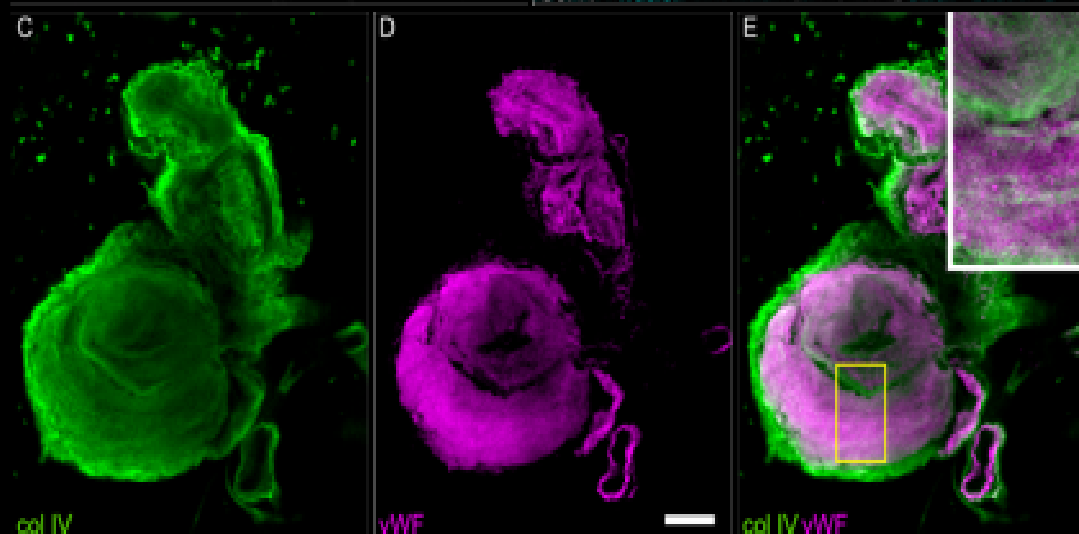
« Phantom »
(occluded) capillary

Deposition of
collagen IV



Few nuclei

Thickened wall



Intertwining of
collagen and vWF
(=association of
extracellular matrix
and plasma proteins)

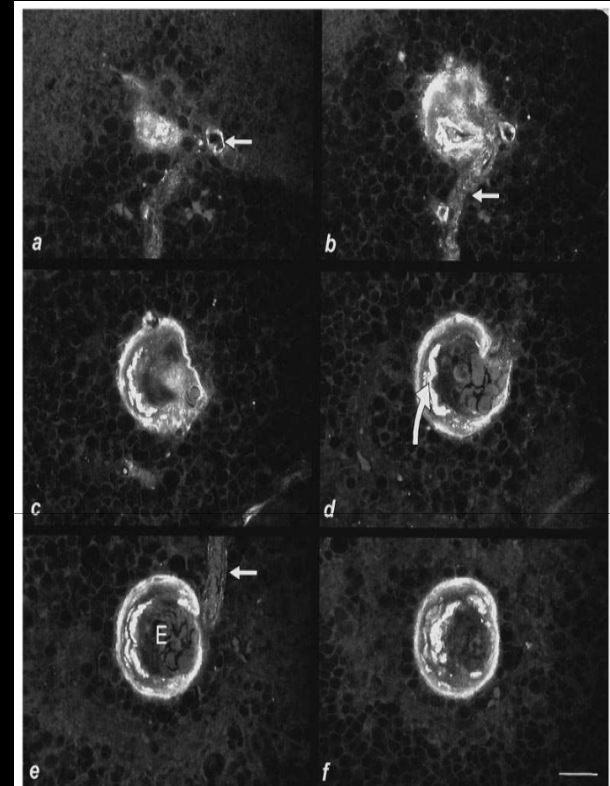
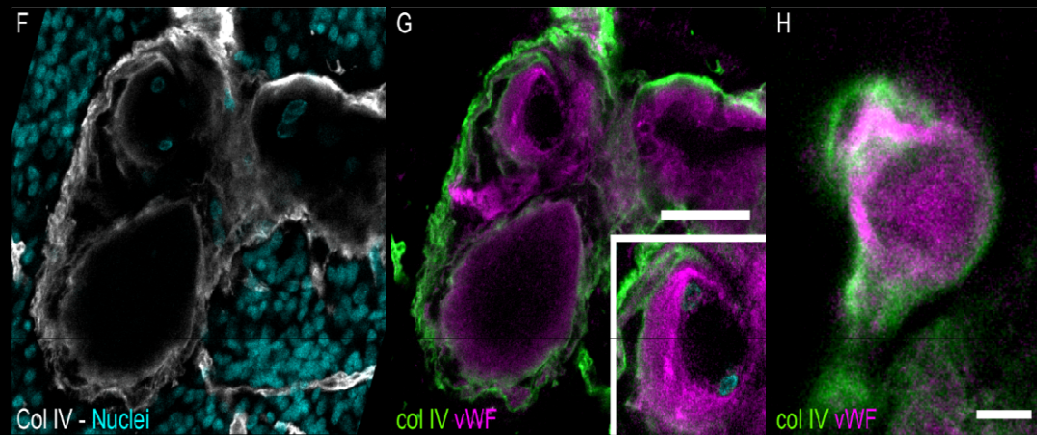
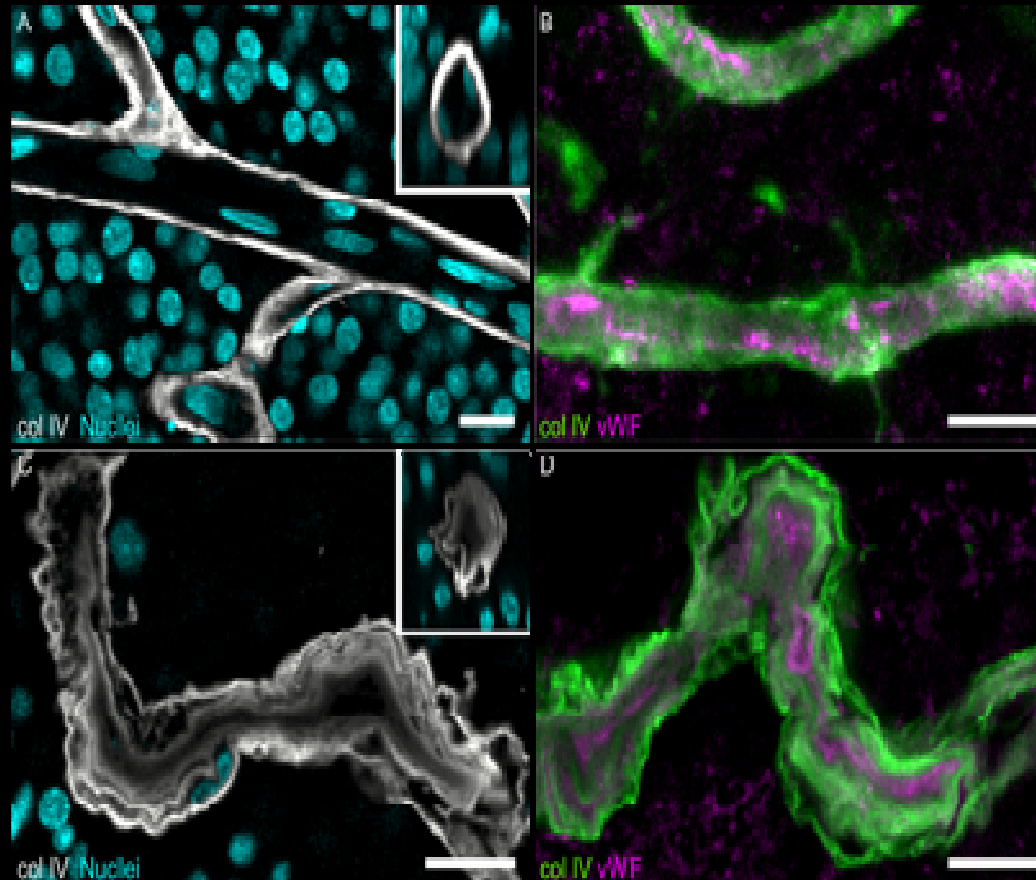


Fig. 3. Montage of images from a confocal z series captured through a sacular microaneurysm stained for von Willebrand factor; each optical section is separated by 4.5 μ m. Images were captured, using the $\times 60$ objective lens, from the inner edge of the microaneurysm (a) to the outer edge of the microaneurysm (f). Staining of the microaneurysm wall appears much more intense than that of its associated vessels (small arrows) and layers of intense staining are prominent at one side (large curved arrow). The microaneurysm is packed with erythrocytes (E). Nuclei of the surrounding extravascular tissue are visible by virtue of being unstained. Bar, 25 μ m.

Moore 1999

Capillaries in
non-affected area



Capillaries in
affected area

NORMAN ASHTON



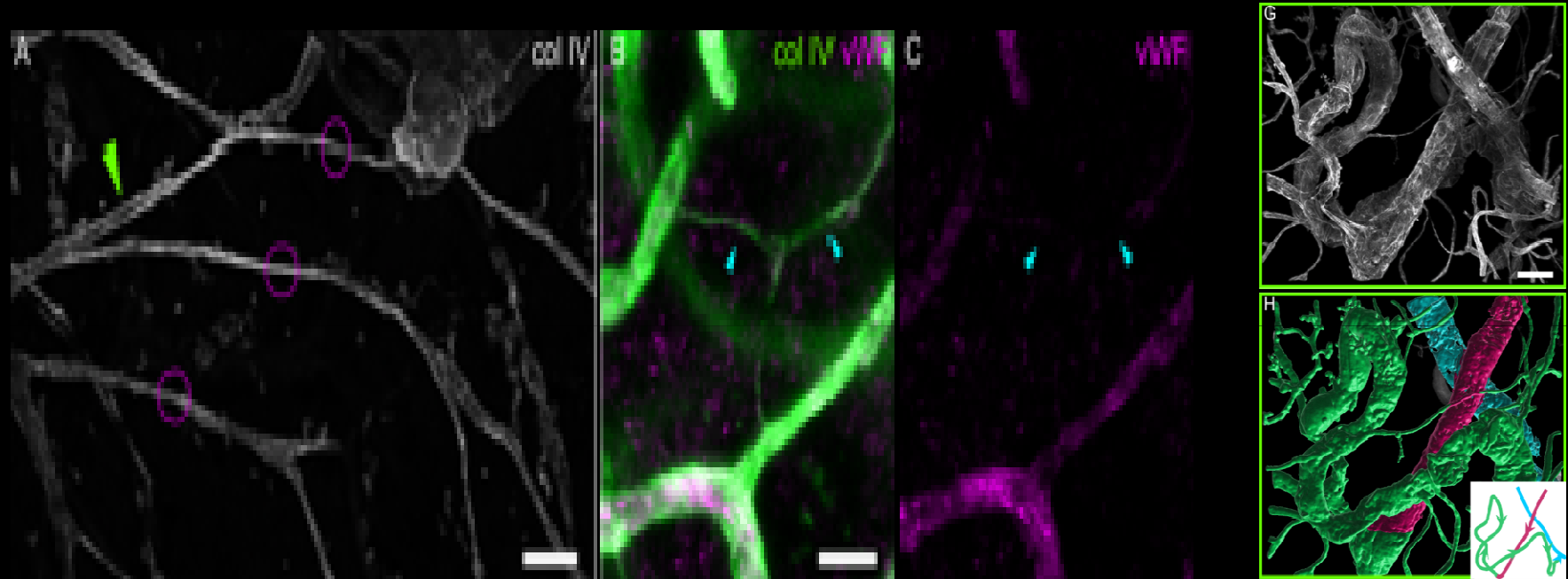
FIG. 6.—Diabetic retina, showing aggregation of endothelial cells within a microaneurysm. Digest preparation. P.A.S.-H. $\times 280$.



FIG. 7.—Endothelial migration in region of diabetic microaneurysm, showing how endothelial cells may come to collect within the aneurysm. Digest preparation. P.A.S.-H. $\times 440$.

Ashton 1963

Non-perfused capillaries: « phantom capillaries »



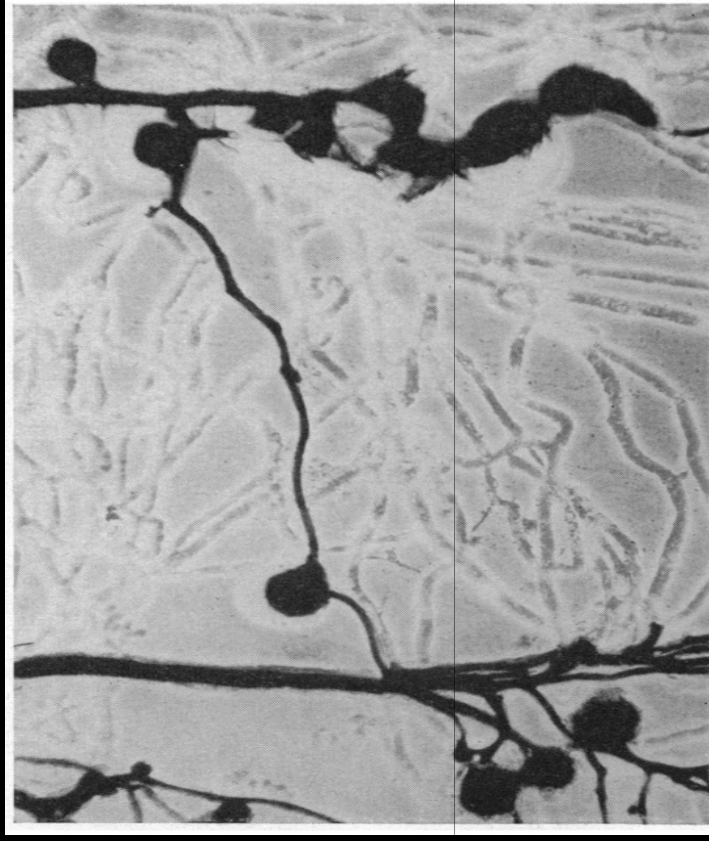
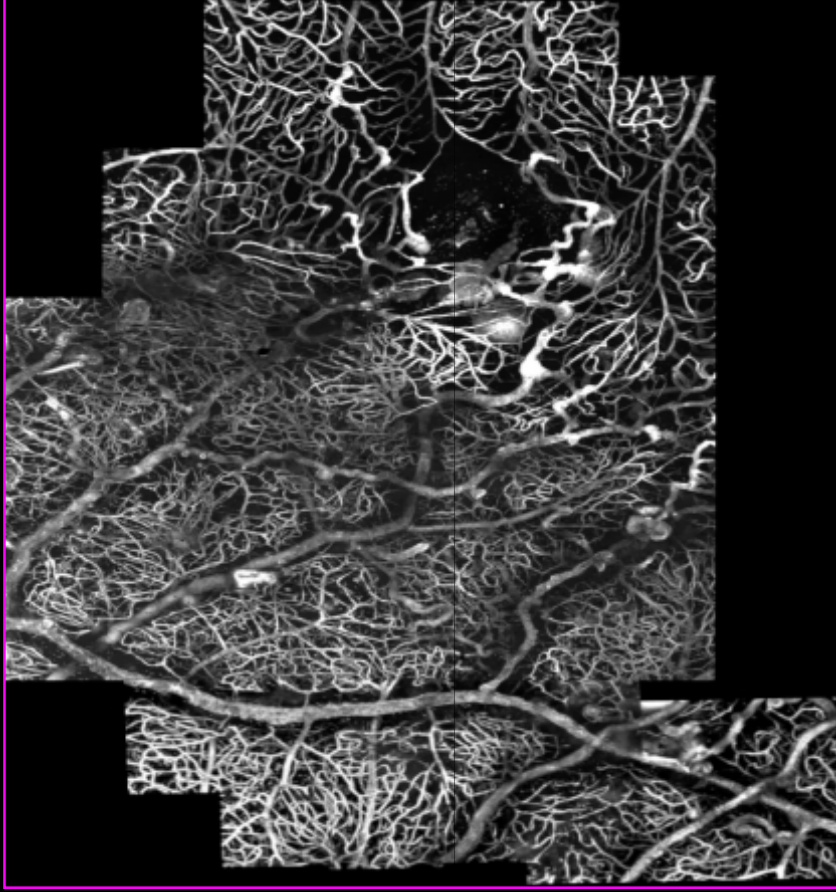
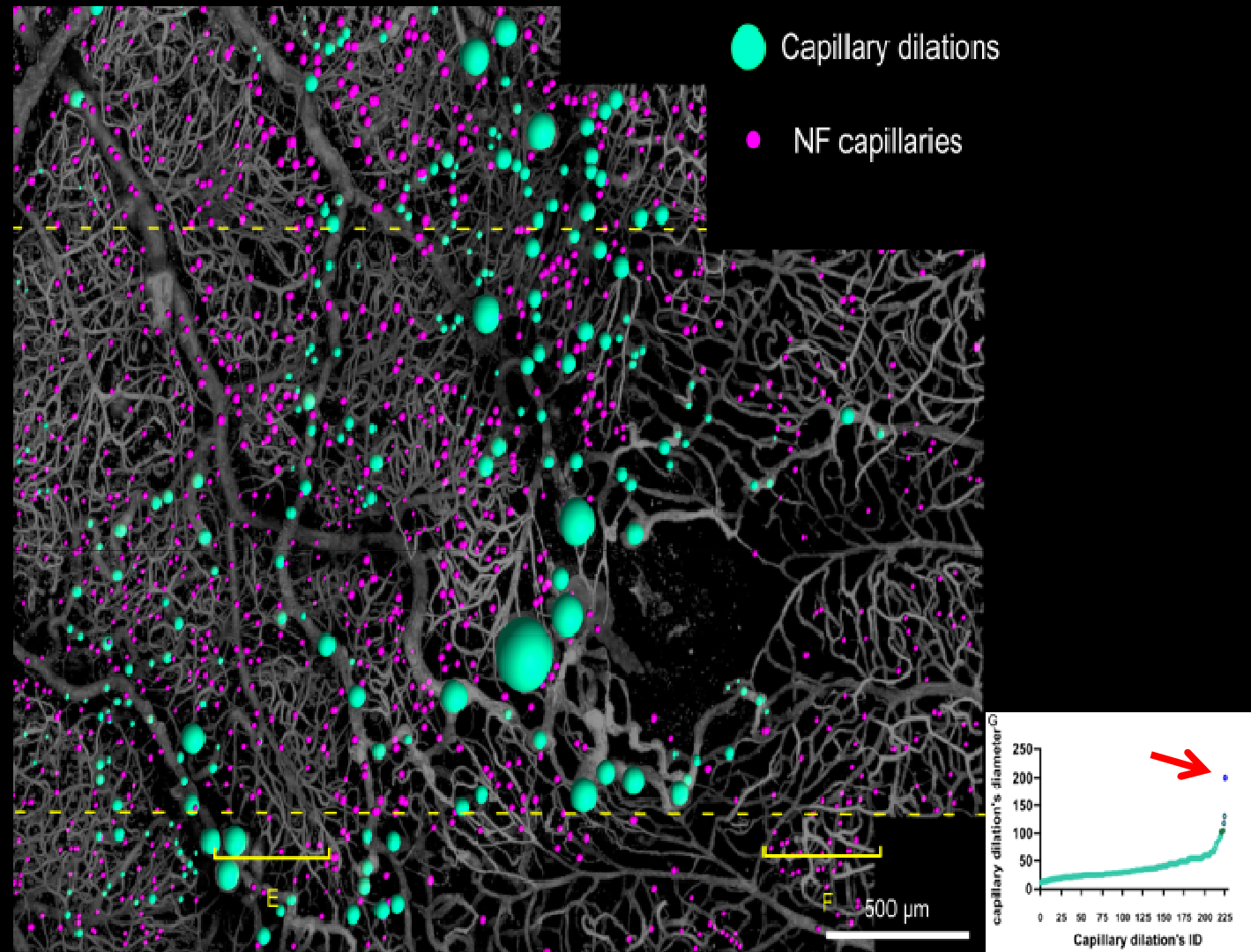
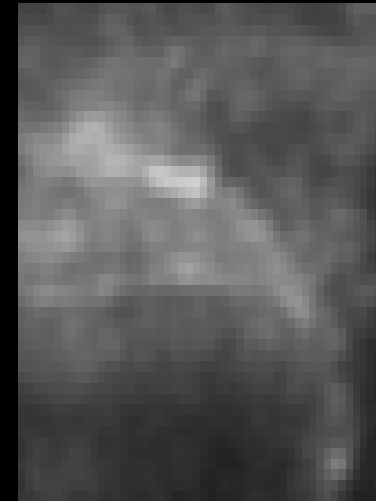
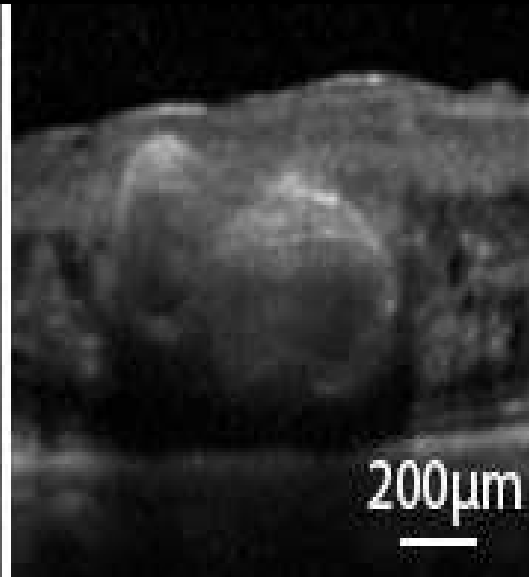
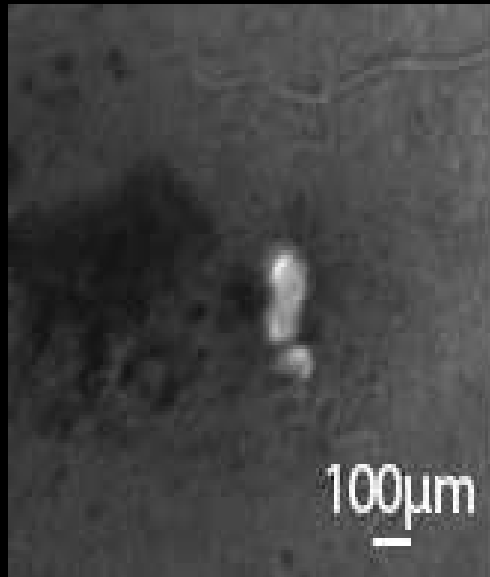


FIG. 11.—Diabetic retinopathy. The aneurysms are largely confined to patent capillaries, while the closed (uninjected) capillaries, although devoid of all cells and consisting only of basement membrane tubes, are mostly free of aneurysms. Injected and digest preparation. Phase contrast. $\times 170$.

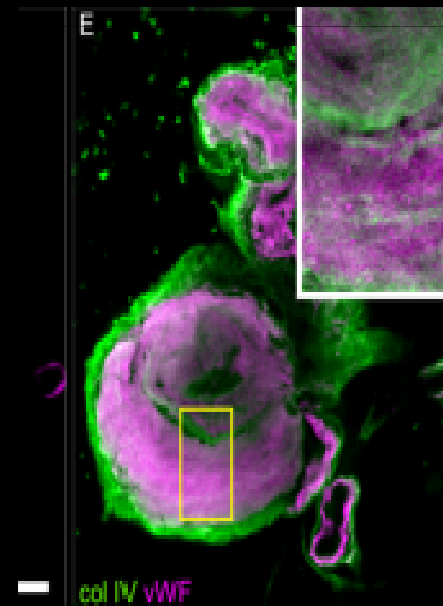


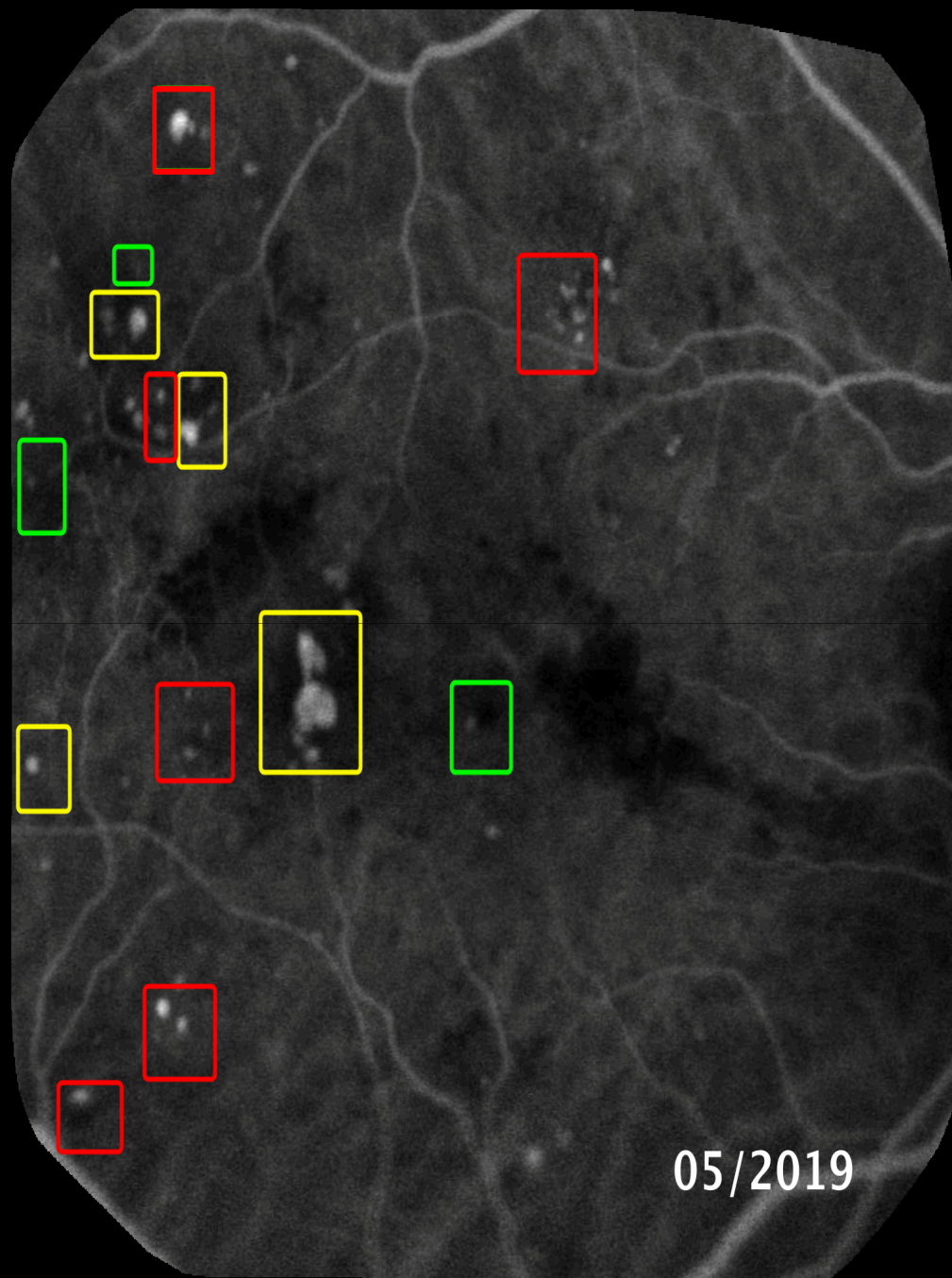
Non functional (« phantom ») capillaries were widely distributed; the TelCaps is an outlier compared to the size of the other capillary dilations, suggesting that TelCaps develop because of a specific

In vivo



Histology



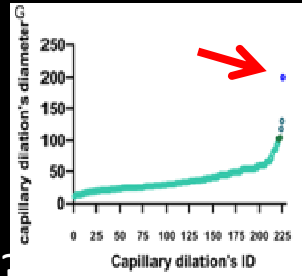


05/2019

D CastroFari

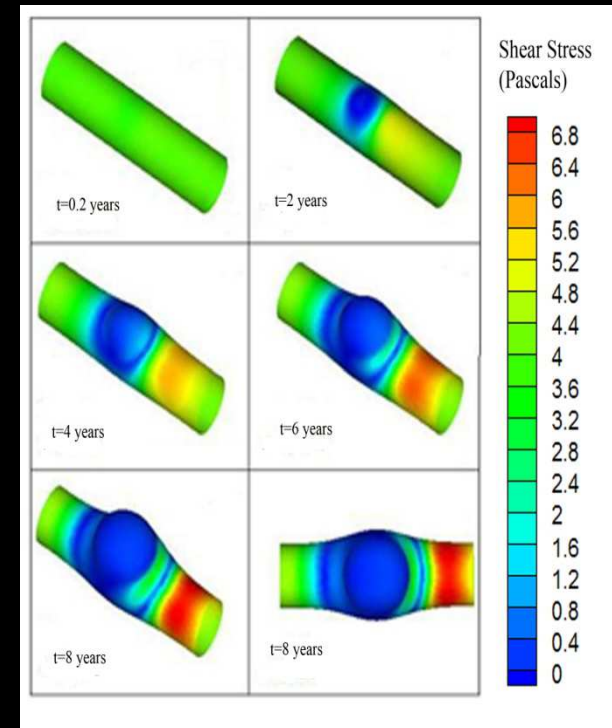
questions

- Are TelCaps a specific lesion or are included within a continuum from « micro » to « macro » capillary bulges?



- What makes TelCaps stain with ICG?
 - High protein content
- Is size a defining feature of TelCaps?
 - In this case, yes
- What is the background on which these lesions occurs?
 - Extensive capillary closure
- What is the thickened wall made of?
 - Mix of extracellular and plasma proteins

- Growth of arterial aneurysms affecting the aorta as been linked to parietal weakening
- Growth of TelCaps is probably not the same because the wall is actually thickened and full of collagen
- Maybe a dual process: first , lumen dilation then parietal thickening?



So...New questions

- There was scarce nuclear staining even in the least affected vessels, suggesting that endothelial cell death precludes the other features of microvascular remodelling
 - So what is the cause of extensive endothelial death?
- Are these features also found in diabetic TelCaps?
- The cause of parietal thickening is uncertain
 - Who synthesizes these proteins?
 - Future studies : in situ transcriptomics to detect synthesis of telcaps structural proteins

Considerations regarding *in vivo* imaging

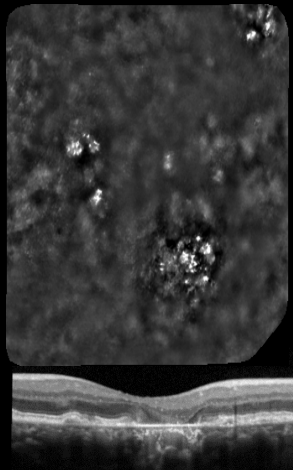
- Arterial duplication → may be detected by OCTA?
- Capillary nonperfusion → may be detected by comparing en face images of structural and angiography OCT
- Are deendothelialized vessels still carrying blood flow ?
 - If so, then what happens to blood-retinal barrier?
- Focal dilation of capillaries show reduced flow → may be less detected by OCTA hence may overestimate nonperfusion
- Dilated capillaries within nonperfused area : cause or consequence of nonperfusion?

Dont miss Ysé Borella's presentation Friday 2:30 pm

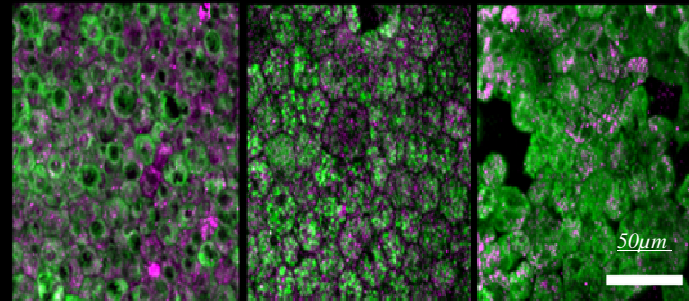
Physiopathology of dry AMD : deciphering the
cellular dynamics of atrophy progression



SD-OCT,
AO, TFI



Time lapse of
atrophy
progression



ATP synthase
RPE 65

(A. Verschuere)

Immunohistology of aging RPE





HistoPARIS team
Marie Darche
Anna Verschueren
Leyna Boucherit
Ysé Borella

Paris Eye Imaging, Paris

Michel Pâques
Celine Chaumette
Olivier Thouvenin
Céline Jaillard
Daniela Castro-Farias
Kate Grieve

And the entire Paris Eye Imaging group

Institut de la vision, Paris

Morgane Belle
Stephane Fouquet
And all the support staff ✨

Lion's gift of sight,
minnesota

Sung Lee

Ideogram Design
Jean baptiste Lebrun
Gabriel Balducci

Association contre
L'OVR

