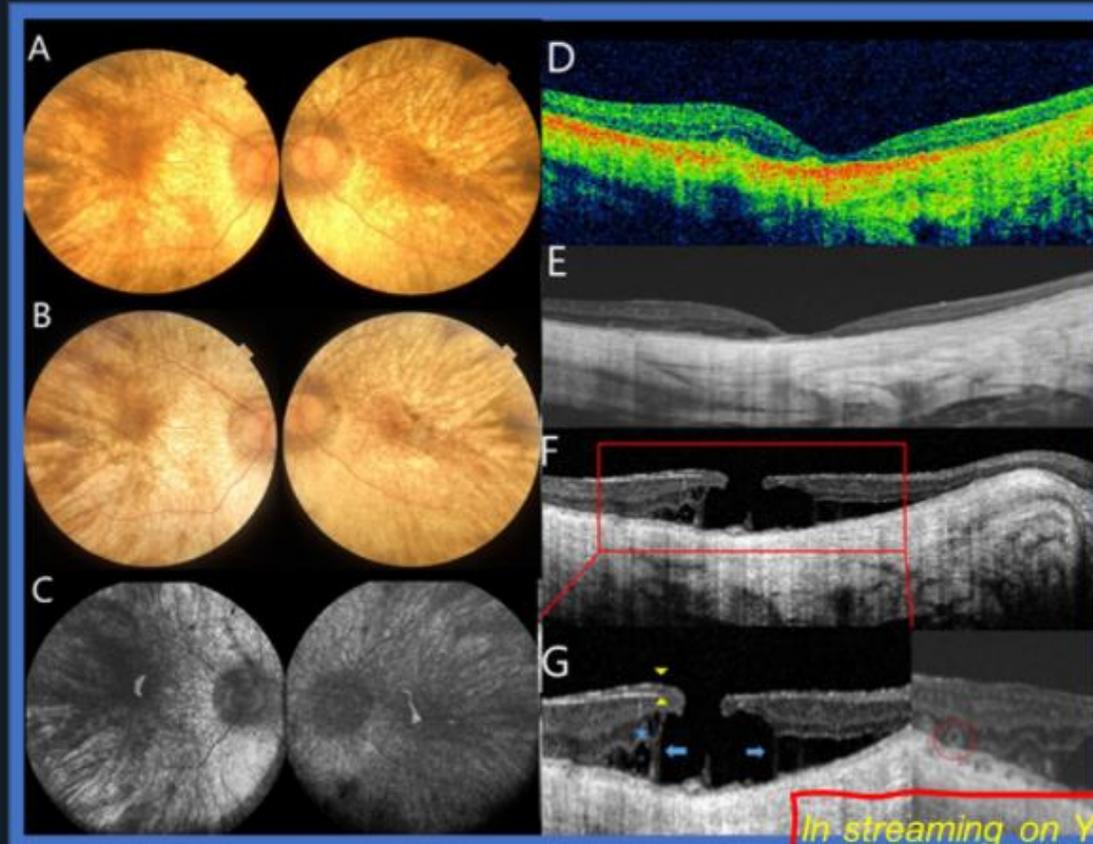


# OCT retinico

Vittoria Murro (UNIFI)

21/01  
15.00



In streaming on Youtube

Directed by  
**Giovanna Pacini**



<https://www.youtube.com/user/caffescienza>



**Light on Optics and Optometry**

Series of scientific, technological and tutorial webinars



Centro di Riferimento  
Regionale  
Degenerazioni  
Retiniche Ereditarie



---

La tomografia a Coerenza ottica è una tecnica diagnostica che consente un'analisi in vivo, non invasiva, e ad alta risoluzione degli strati corioretinici



OCT SLO  
Newtech spa



3D OCT 1000 Topcon



RTVue OCT  
OPTOVU



Copernicus OCT Polyoftalmica-New



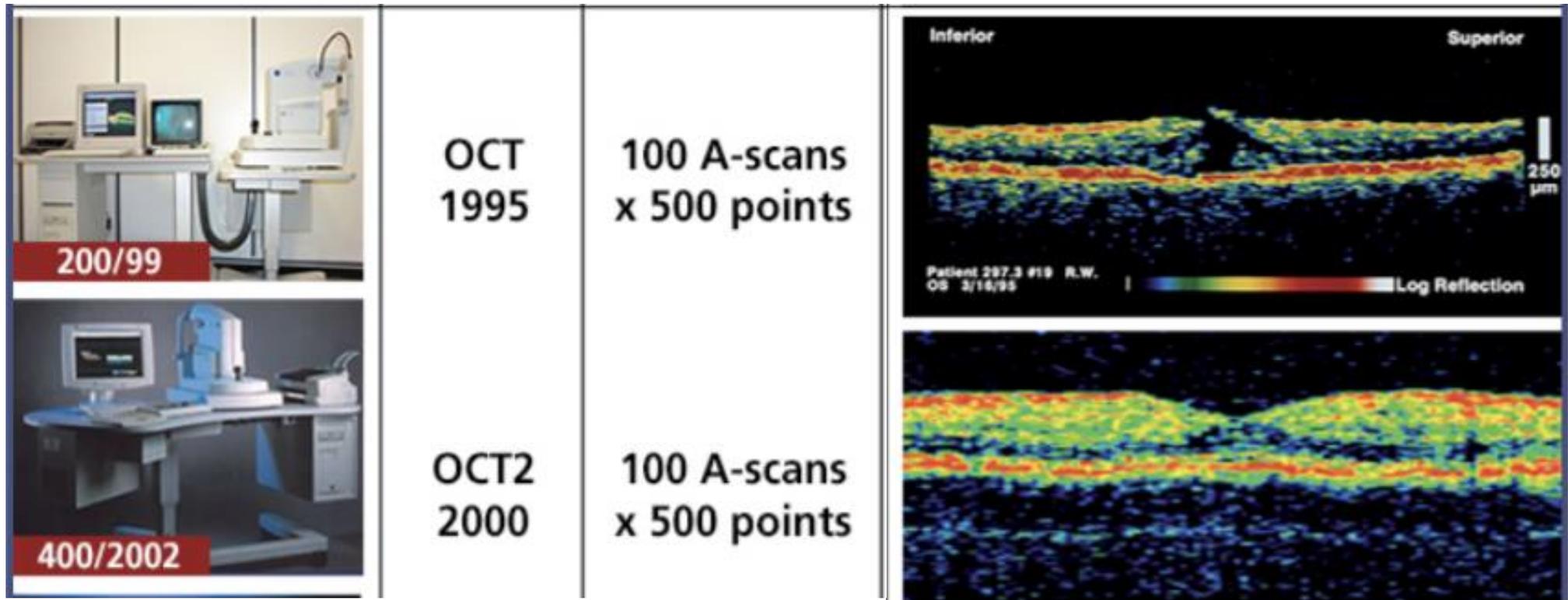
## Un po' di storia...

1992

La prima azienda a sviluppare una tecnologia OCT per applicazioni oftalmologiche nel 1992 è stata l'Advanced Ophthalmic Devices (AOD), fondata da James Fujimoto e Carmen Puliafito, inglobata un anno dopo nella ditta Humphrey, a sua volta acquistata dalla Carl Zeiss Medit

1995 e 2000

In commercio prima OCT strutturale (OCT1 nel 1995 e OCT2 nel 2000)  
Scarsa risonanza a causa della cattiva qualità e deficinizione delle immagini



2002

successo commerciale dello Stratus, terza ed ultima versione degli OCT Time Domain

2007  
SD-OCT

Messo in commercio il primo Spectral domain (SD-OCT- il Cirrus HD)

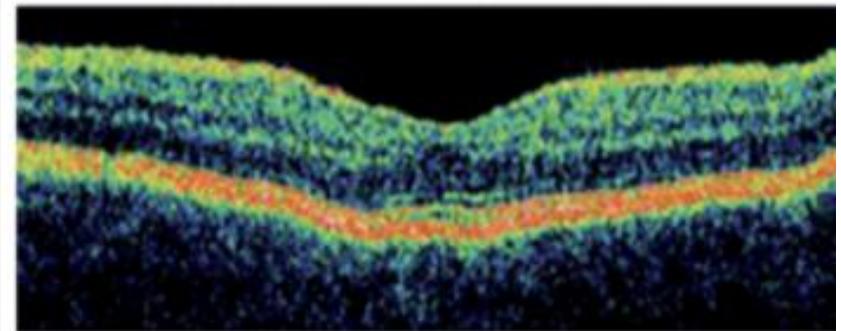
Lunghezza onda :circa 840 nm

L'aumentata velocità d'acquisizione degli A-scan sta alla base della migliore definizione delle immagini riducendo gli artefatti di movimento



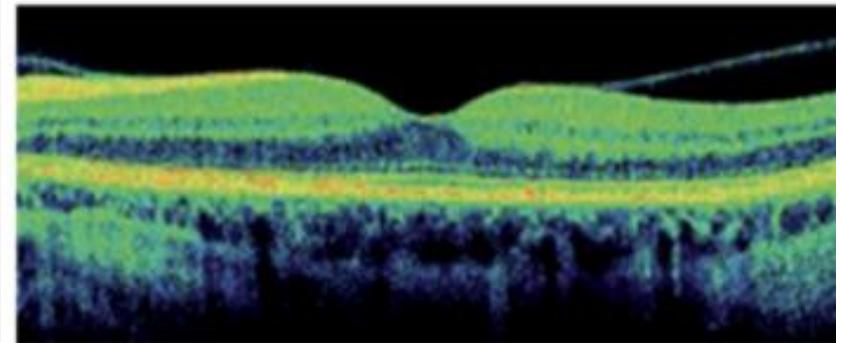
OCT3  
STRATUS  
2002

512 A-scans  
x 1024 points



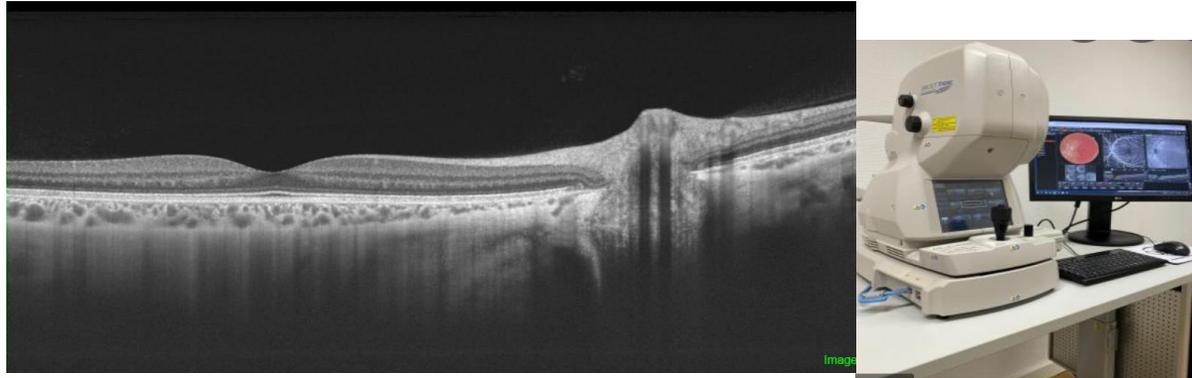
CIRRUS  
HD-OCT  
2007

4096 A-scans  
x 1024 points



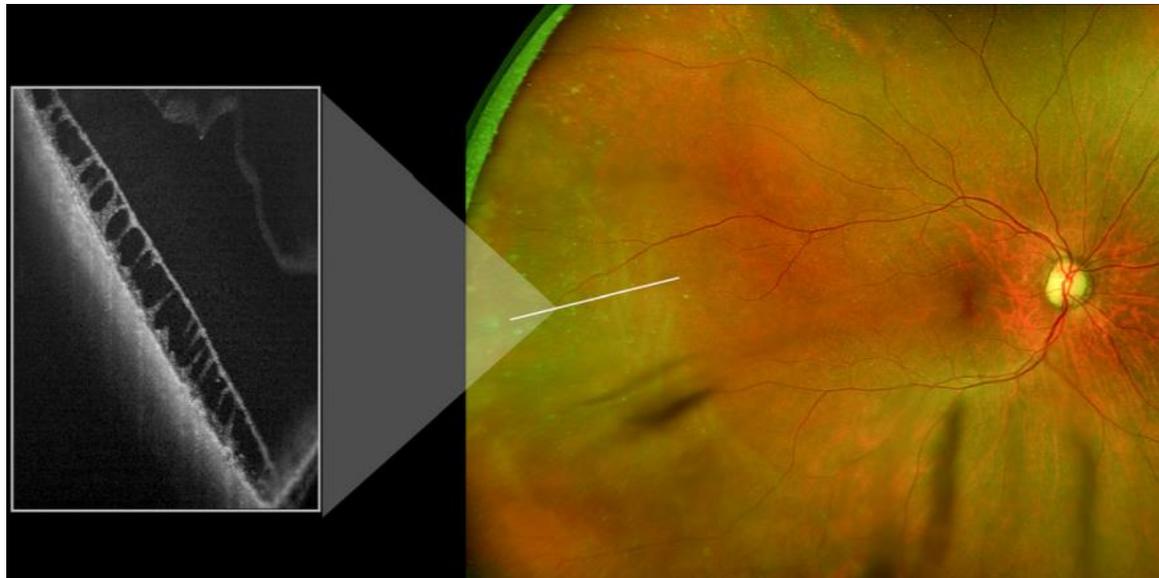
2012  
SS-OCT

Grazie alla lunghezza d'onda maggiore del laser (1.050nm), è possibile penetrare meglio in profondità nel tessuto dell'occhio ( superare lo scattering legato all'assorbimento dell'EPR)  
Lunghezza d'onda: 1050 nm scan per sec: 100.000 A-scan/sec  
Possibilità di scansione wide field (12x9)



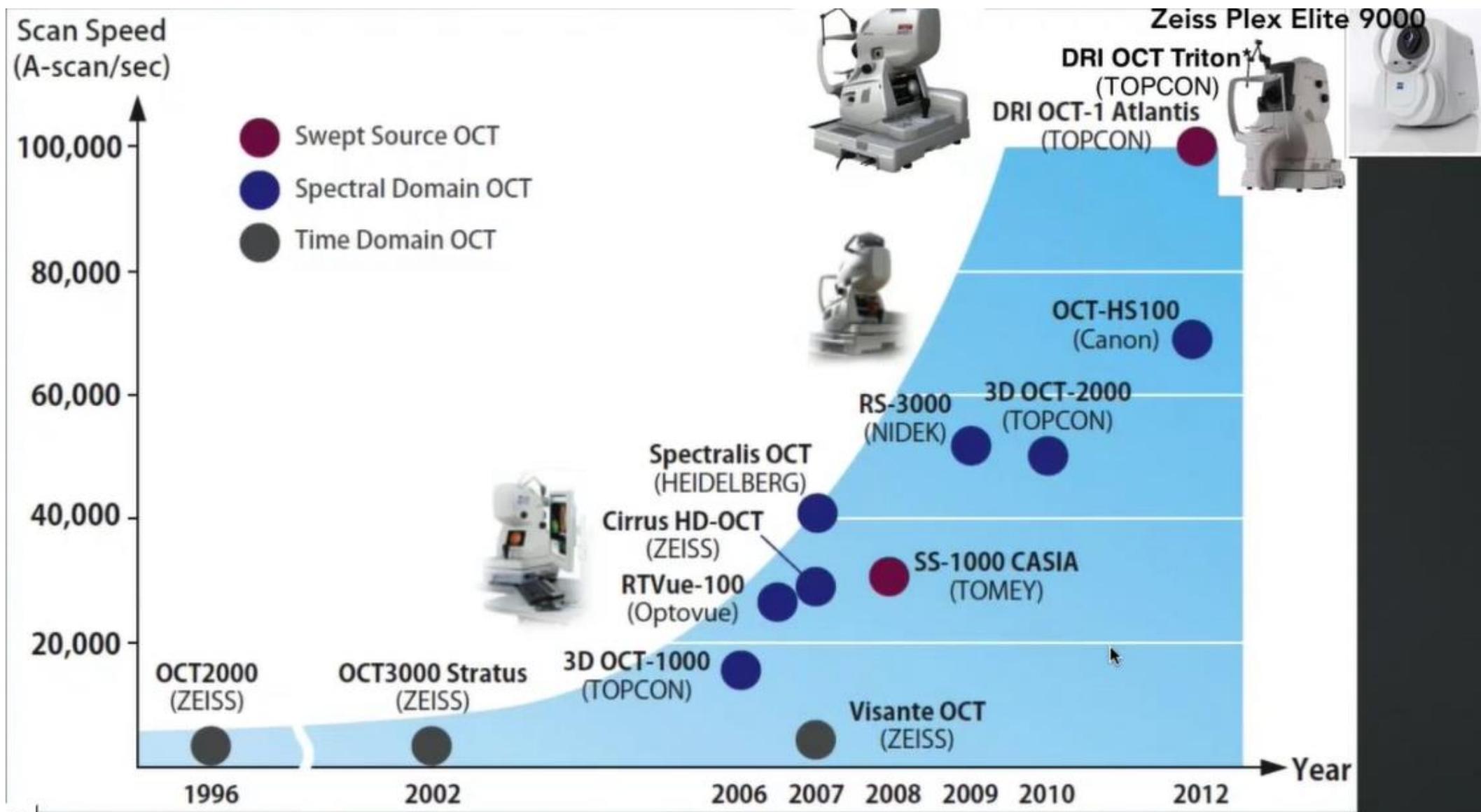
2019

Ultra wide field OCT permette di studiare la periferia retinica oltre le vene vorticosose

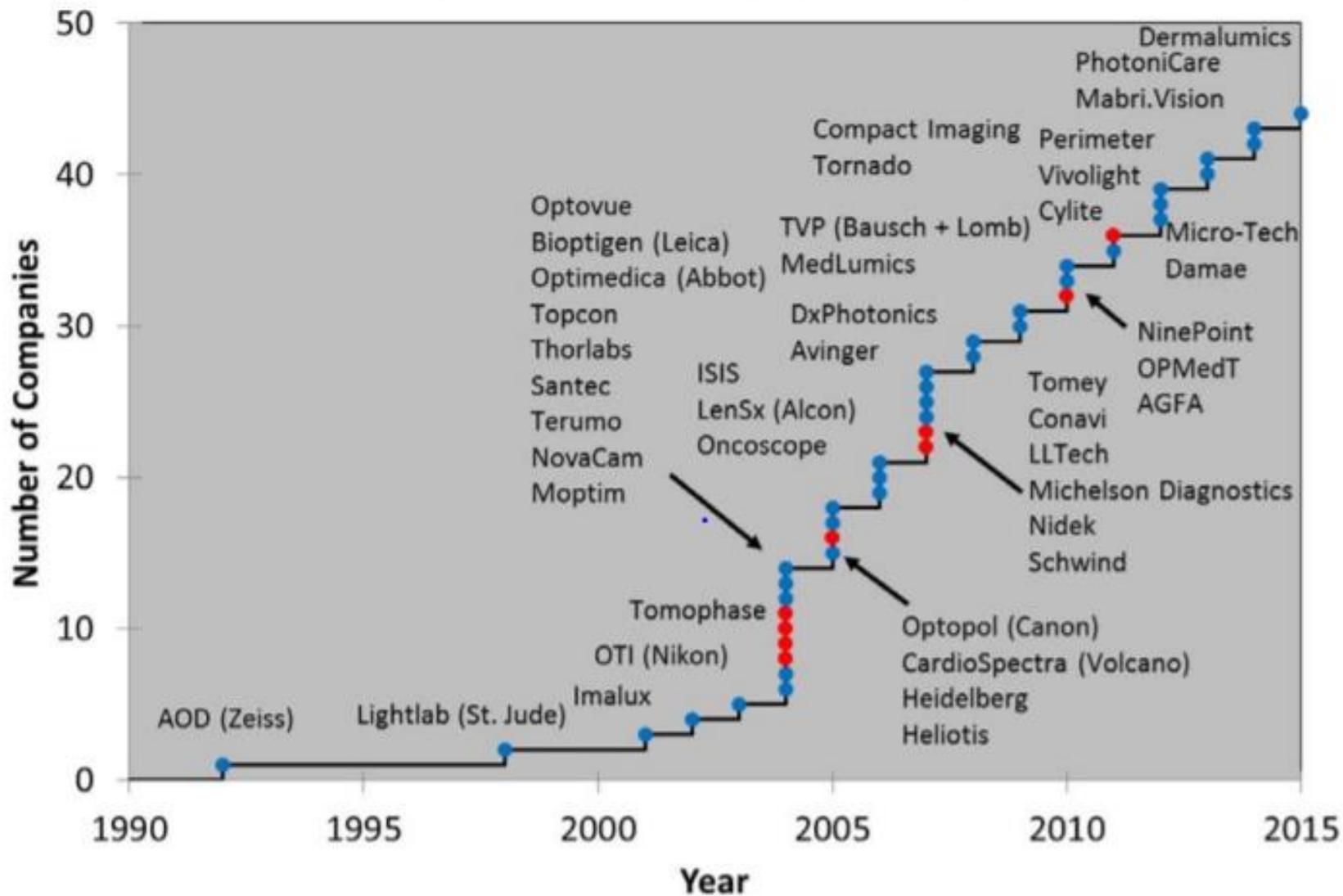


[A Brief History of OCT](#)  
By Joel S. Schuman, MD  
Annual Meeting 2019

# EVOLUZIONE TECNOLOGIA OCT

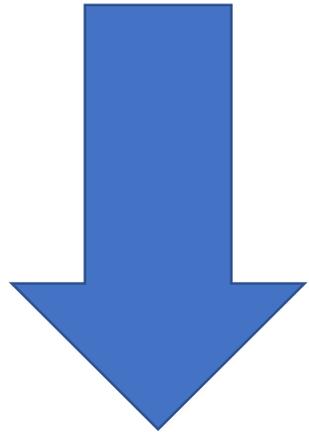
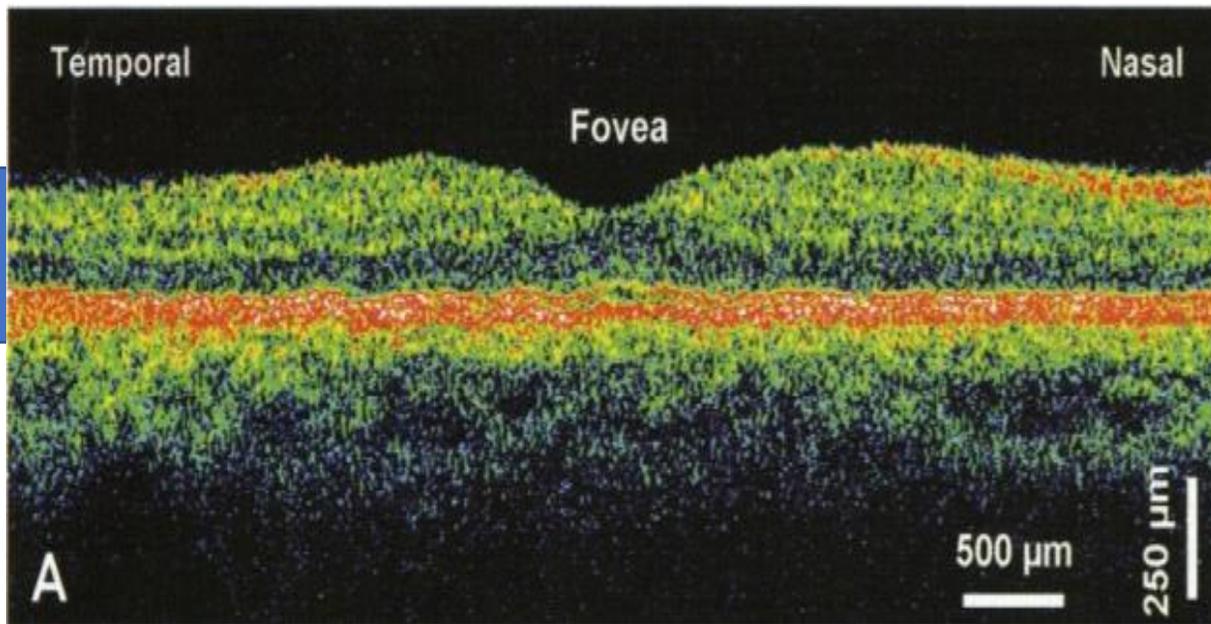


# Companies Developing OCT Systems

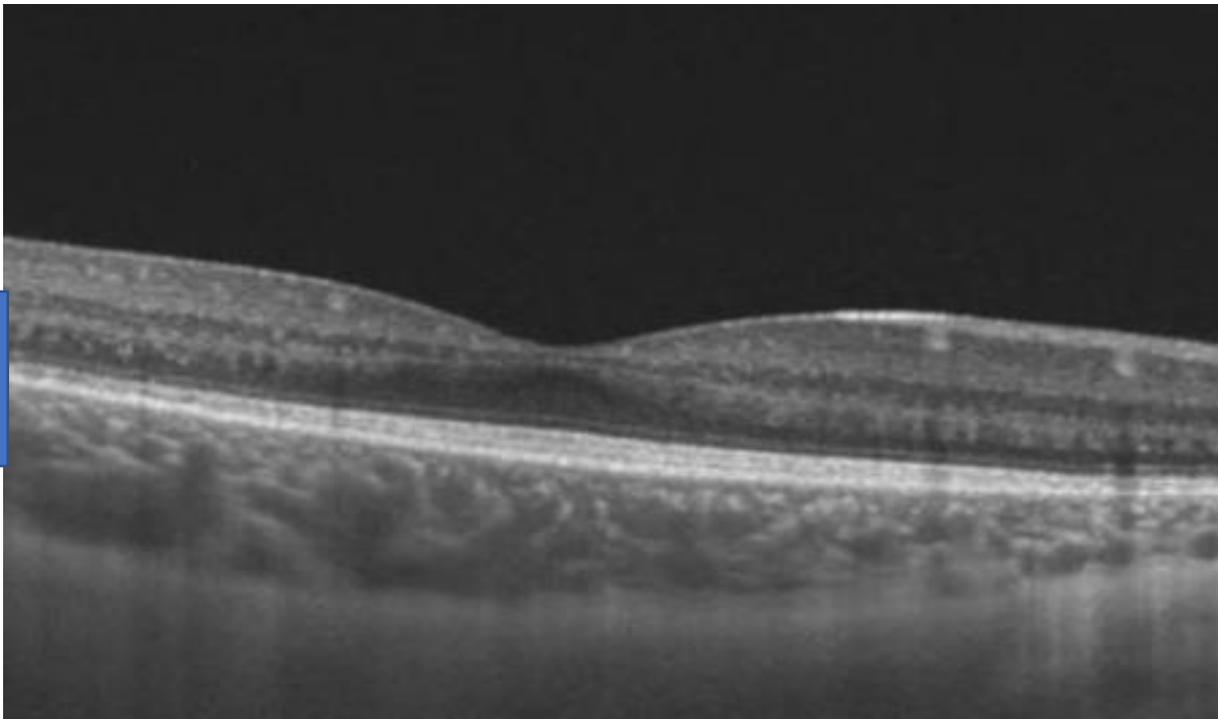


Fujimoto J, Swanson E. The Development, Commercialization, and Impact of Optical Coherence Tomography. *Invest Ophthalmol Vis Sci.* 2016;57(9):OCT1-OCT13. doi:10.1167/iovs.16-19963

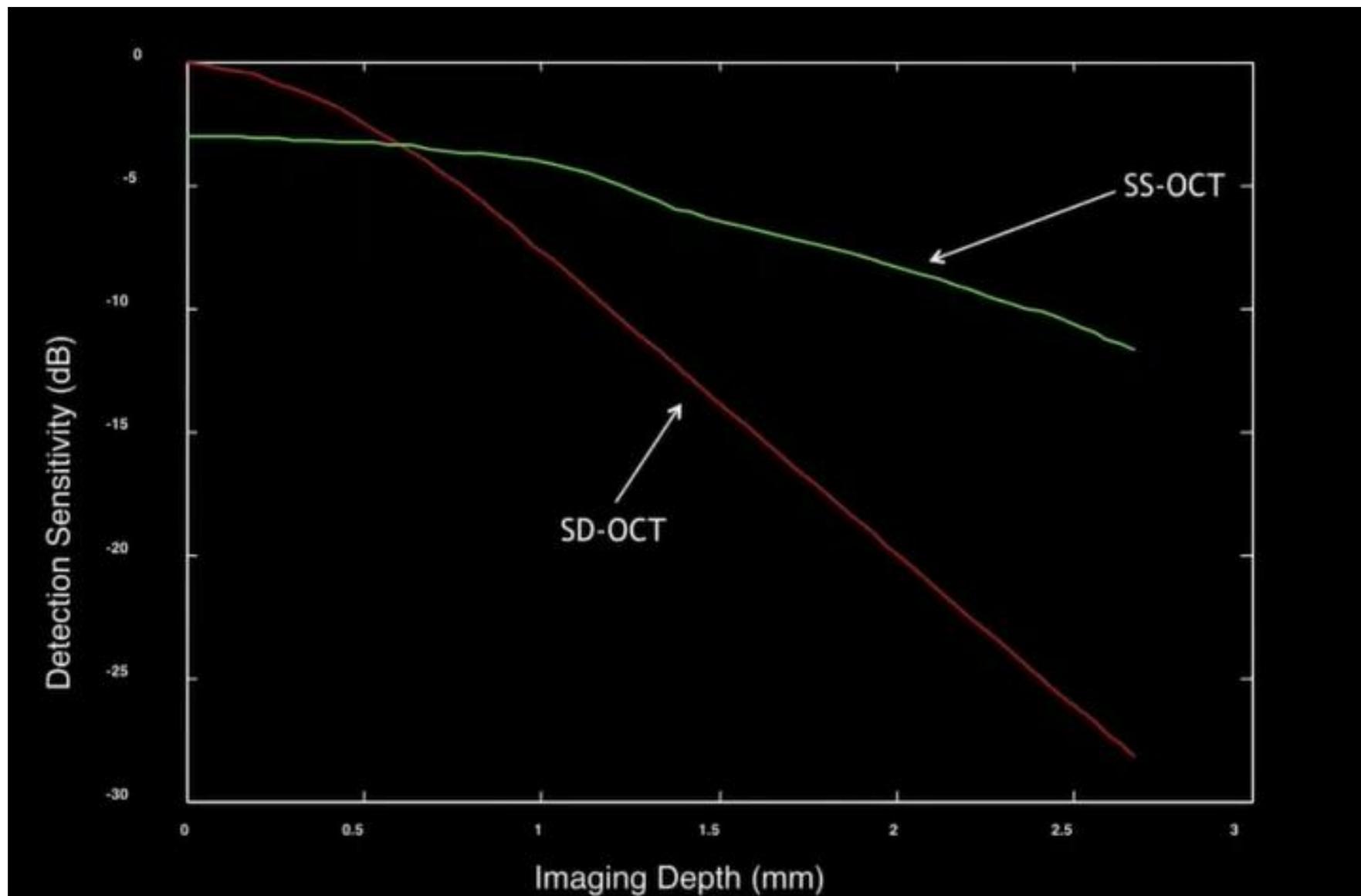
TD OCT  
Stratus OCT3



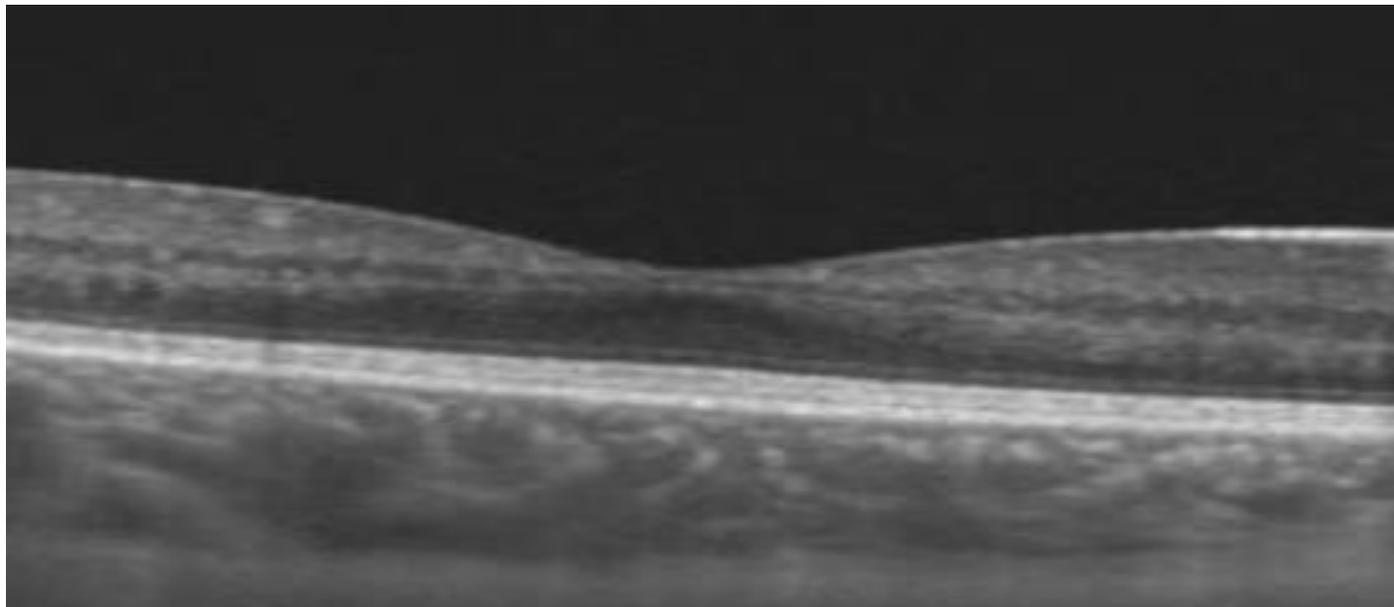
SS OCT  
HD line



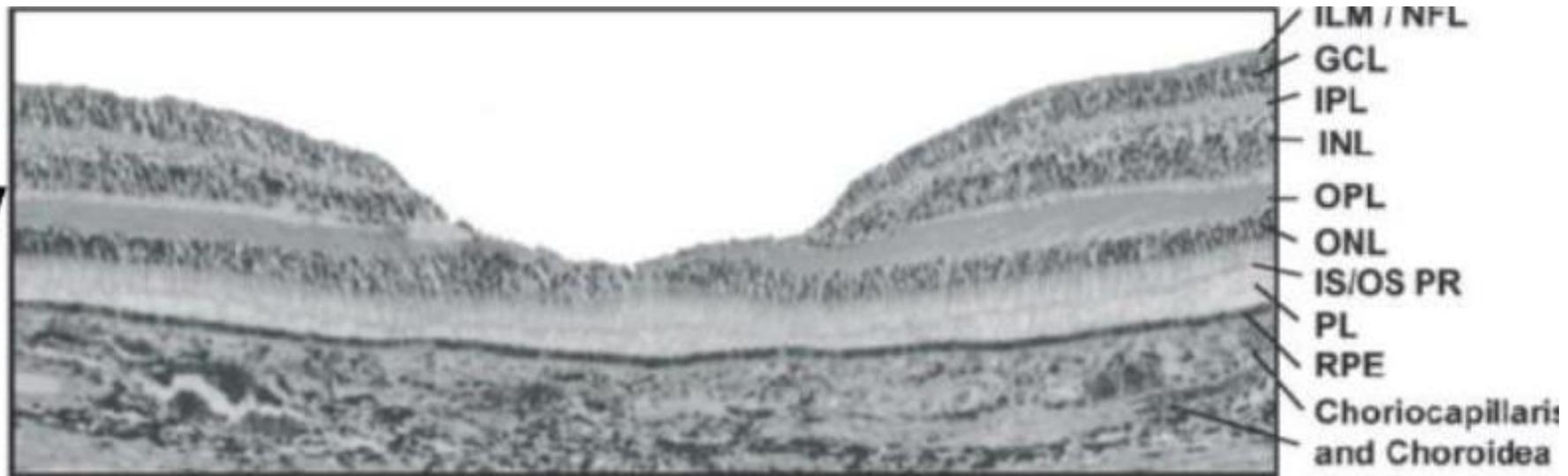
# *SD-OCT vs SS-OCT*



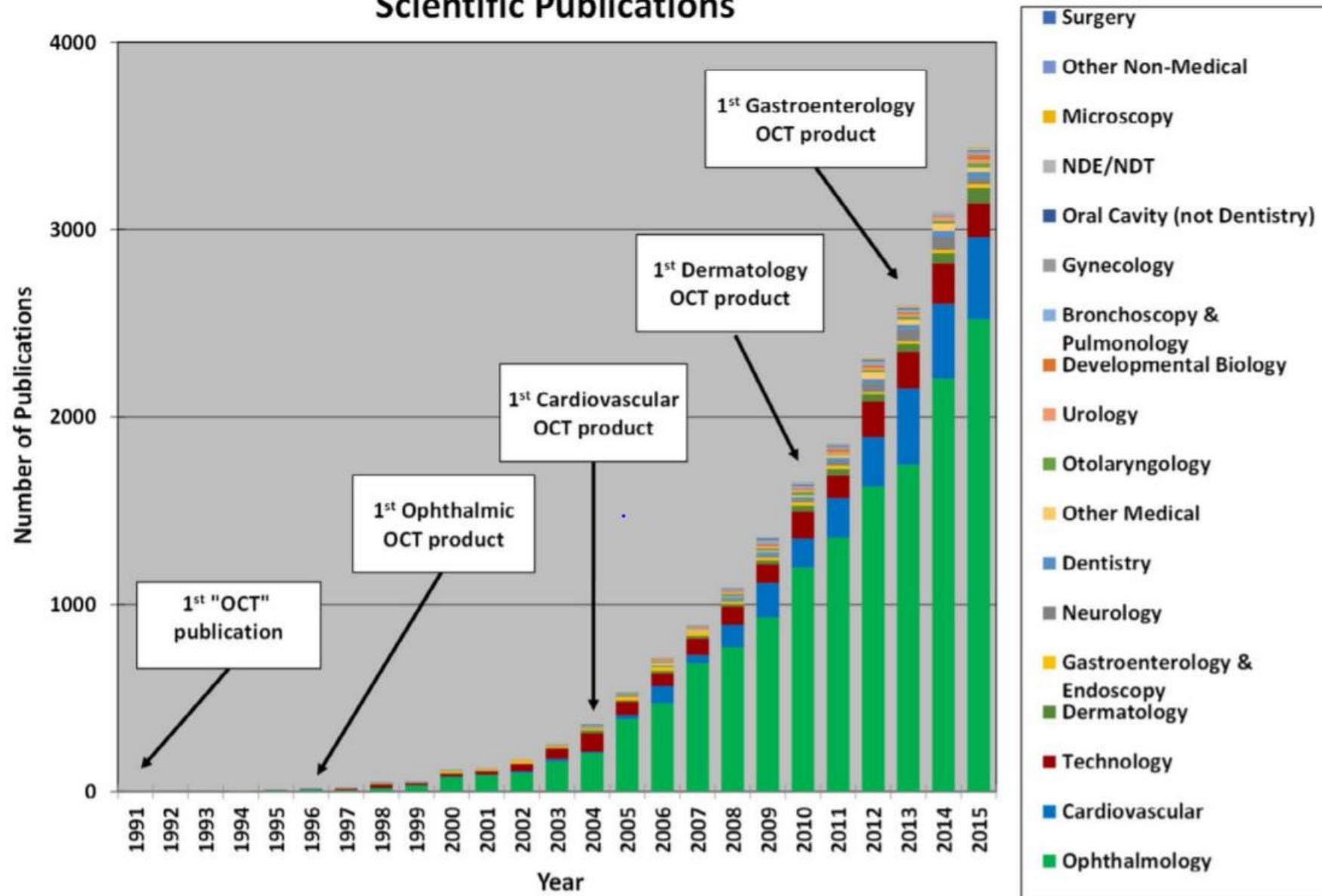
IMAGING IN VIVO  
DELLA REGIONE  
MACULARE



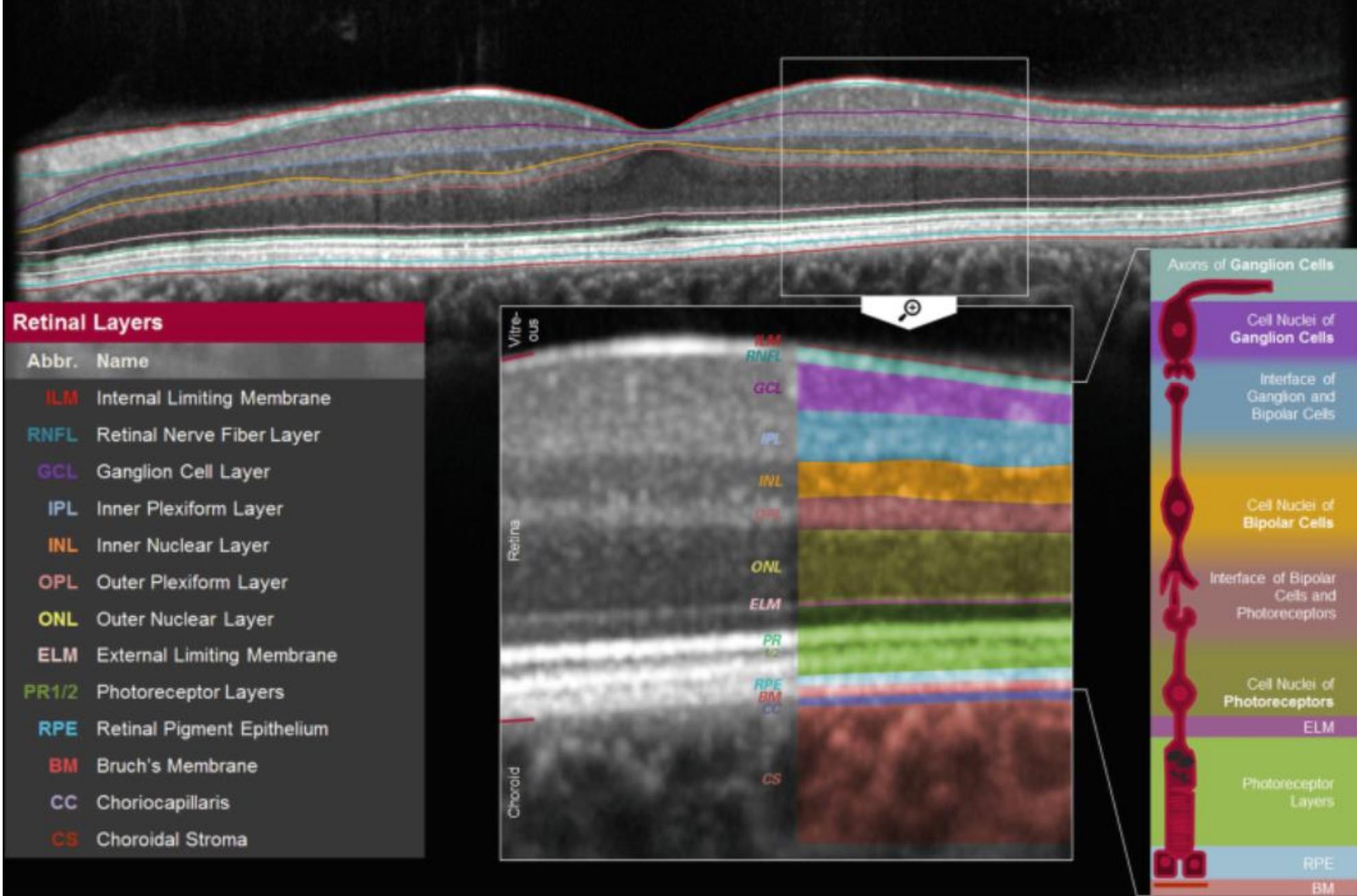
**Histology**



# Scientific Publications



Fujimoto J, Swanson E. The Development, Commercialization, and Impact of Optical Coherence Tomography. *Invest Ophthalmol Vis Sci.* 2016;57(9):OCT1-OCT13. doi:10.1167/iovs.16-19963



Aumann S., et al. (2019) Optical Coherence Tomography (OCT): Principle and Technical Realization. In: Bille J. (eds) High Resolution Imaging in Microscopy and Ophthalmology. Springer, Cham.

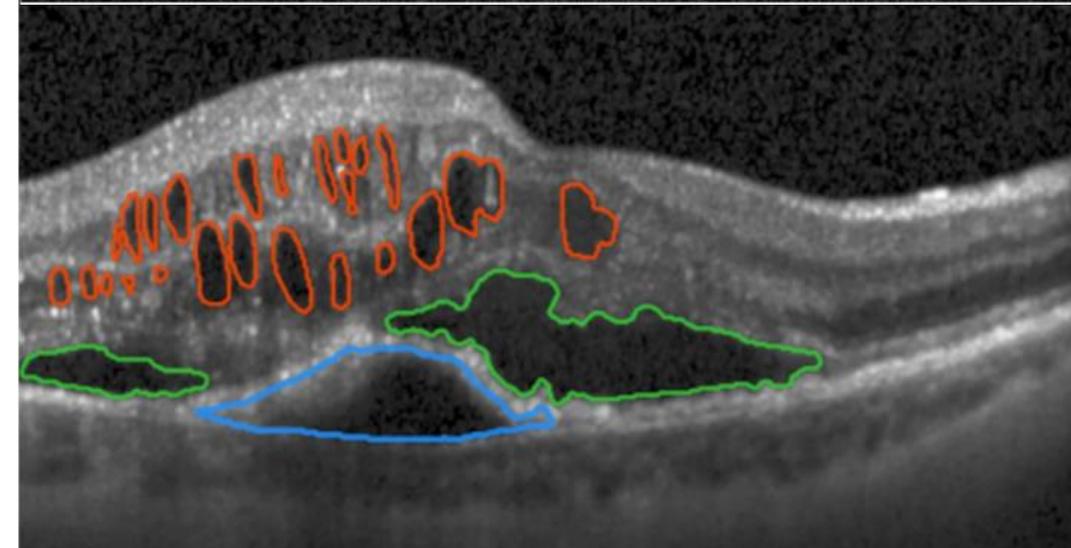
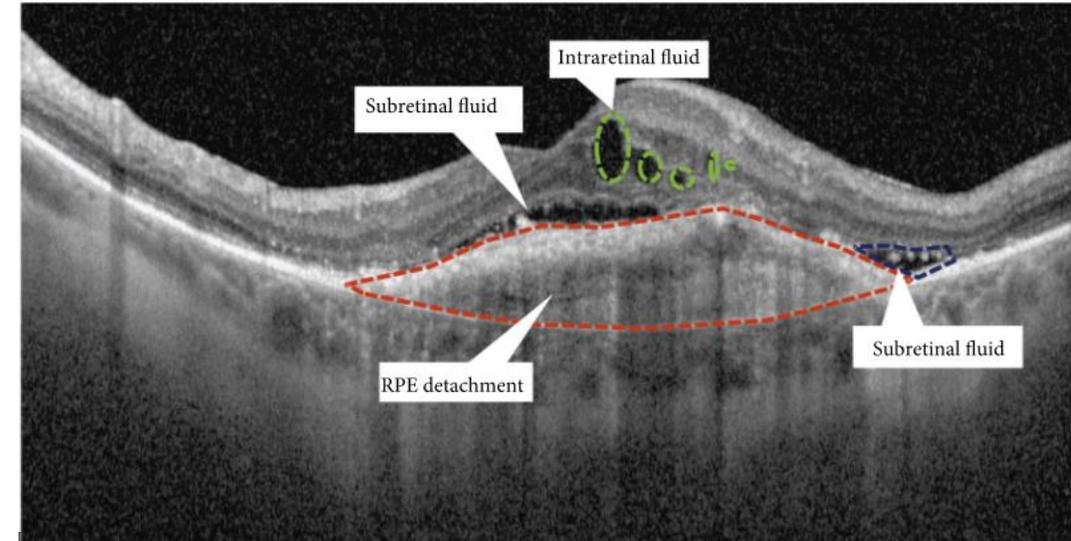
# Analisi dell'OCT strutturale

## QUALITATIVA

-MORFOLOGIA  
REFLETTIVITA': IPERIFLETTENTE, IPORIFLETTENTE

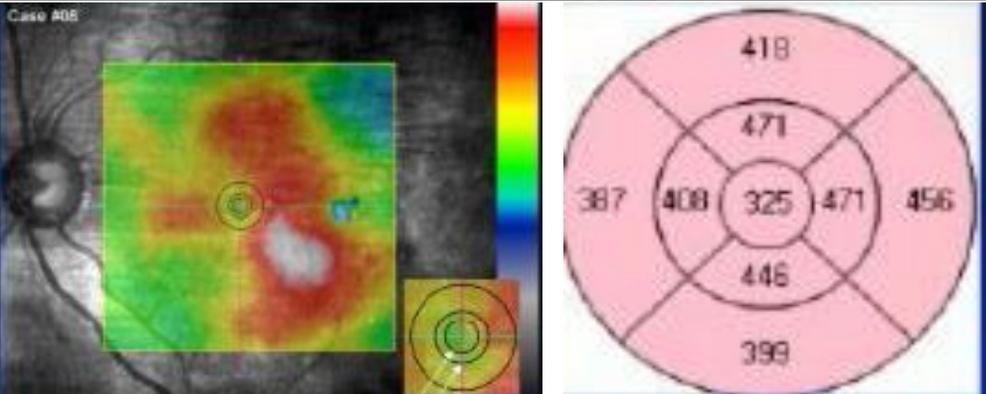
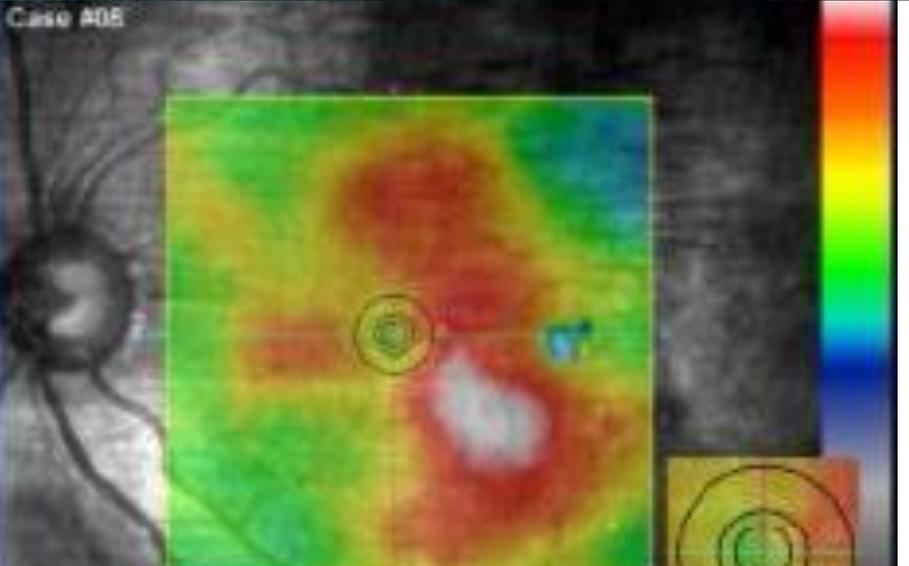
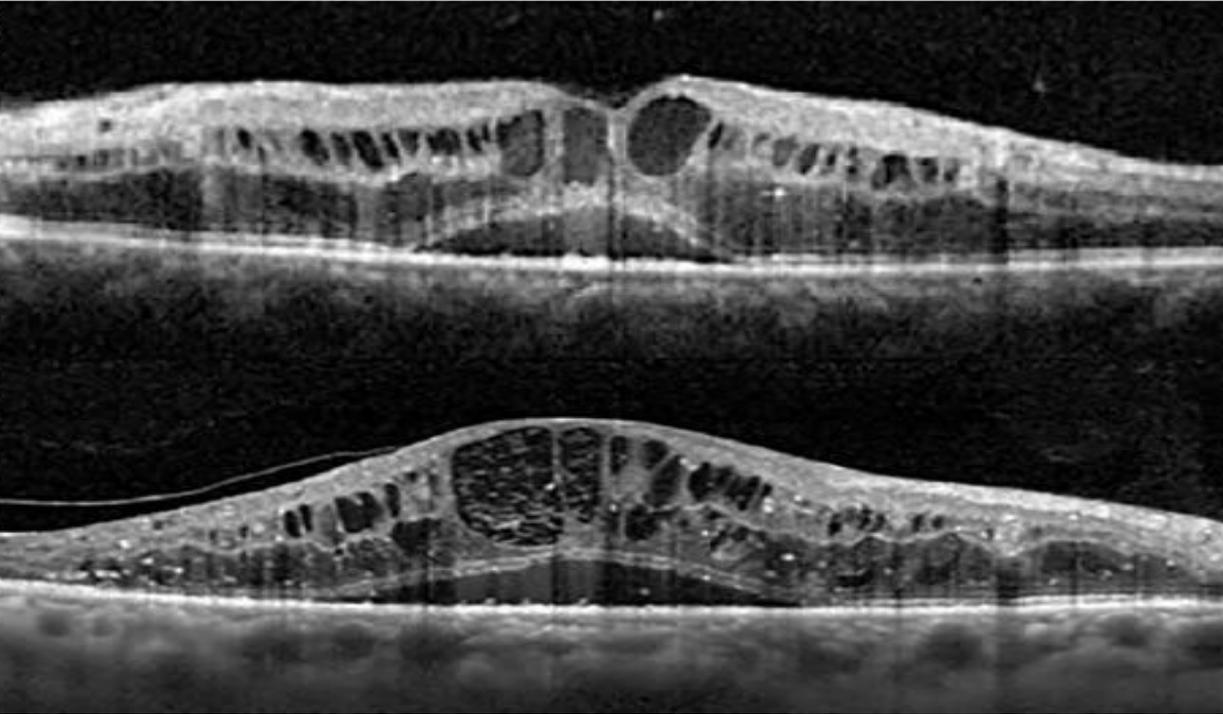
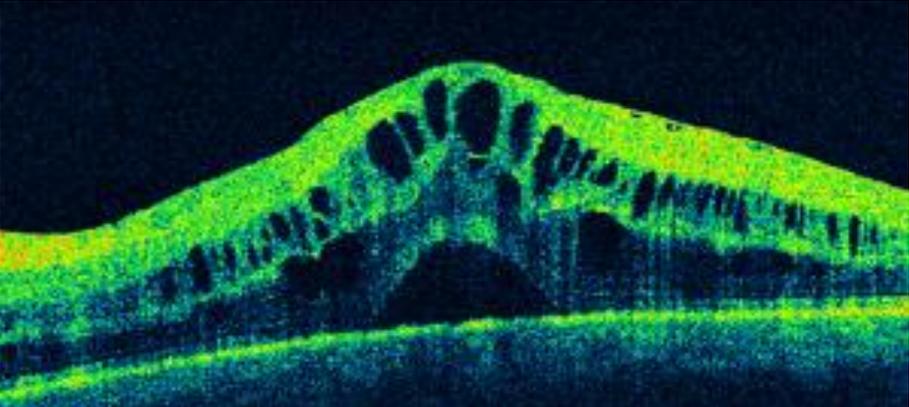
## QUANTITATIVA

-SPESSORE  
-VOLUME  
-AREA

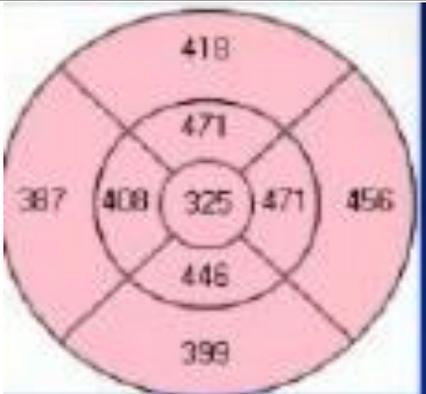


# Mappatura delle edema

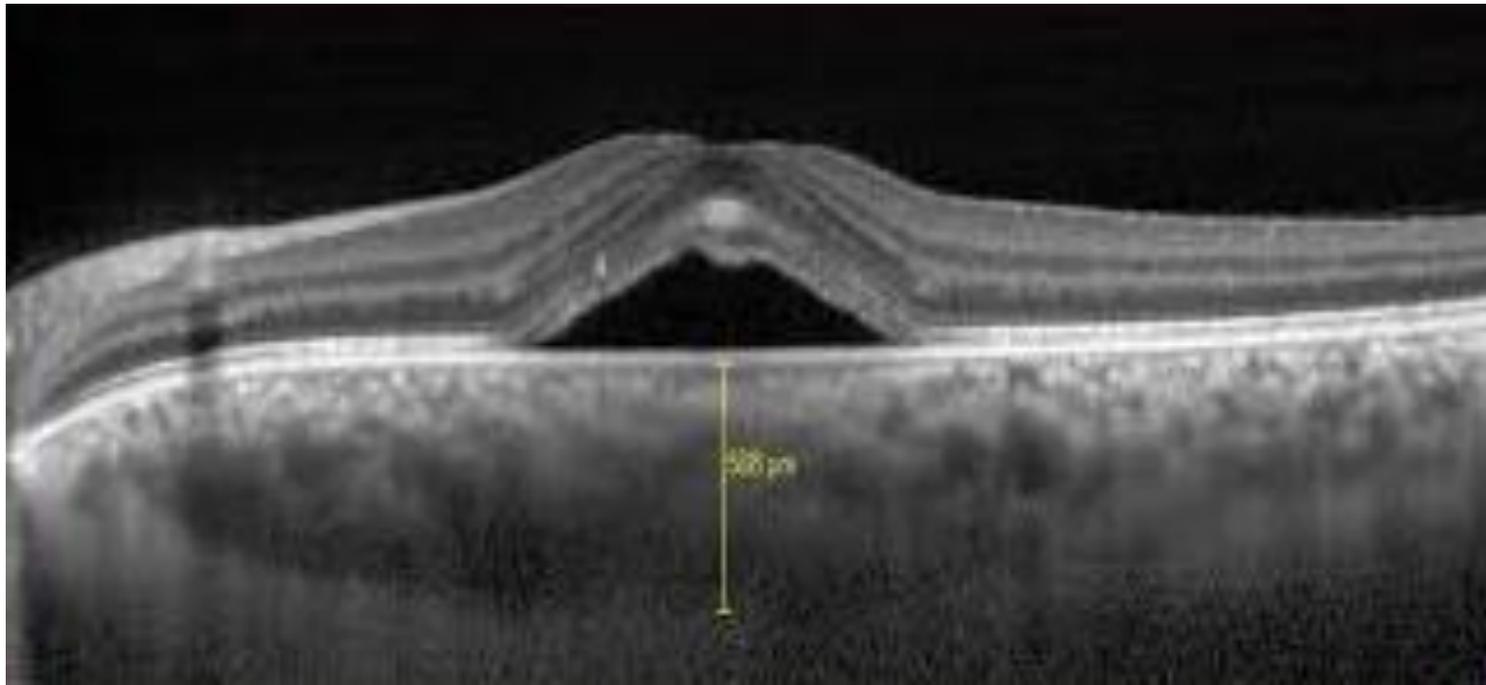
Con o senza coinvolgimento foveale centrale



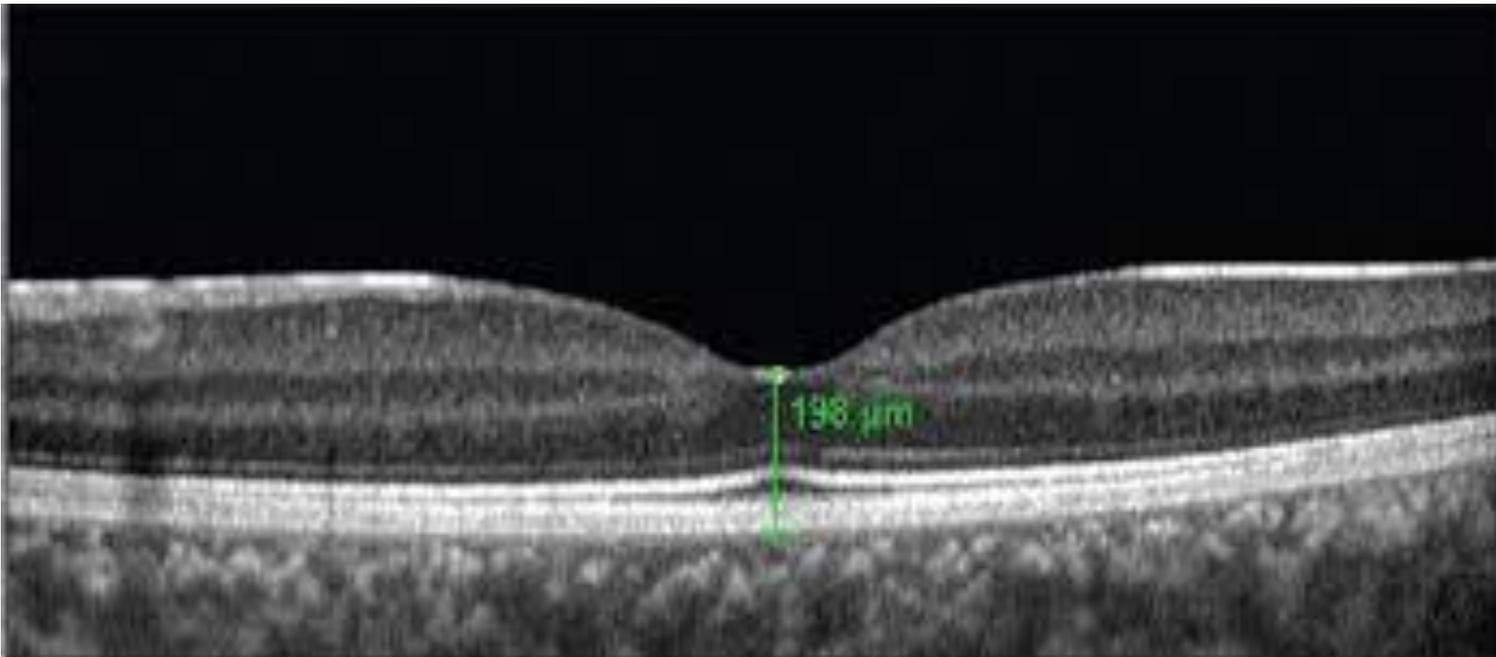
	Central Subfield Thickness ( $\mu\text{m}$ )	Cube Volume ( $\text{mm}^3$ )	Cube Average Thickness ( $\mu\text{m}$ )
ILM - RPE	325	14.7	409



Molte patologie retiniche sono state meglio comprese e dettagliatamente determinate nella loro fisiopatologia con l'uso di tale metodica.



**: SPESSORE COROIDEALE  
CENTRALE (CCT)**



**SPESSORE RETINICO  
CENTRALE (CRT)**

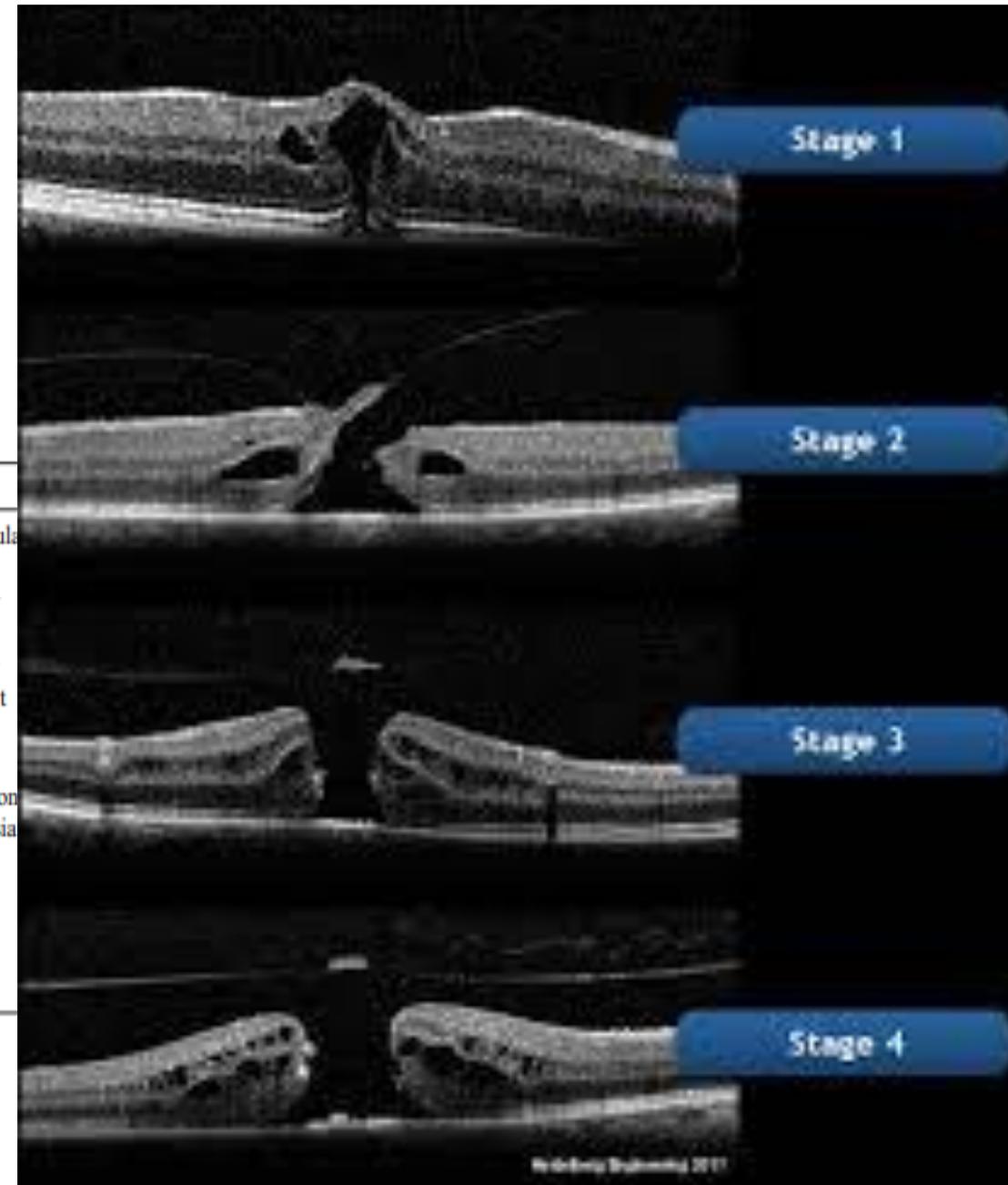
## Reappraisal of Biomicroscopic Classification of Stages of Development of a Macular Hole

J. DONALD M. GASS M.D.

..

**Table 1.** Characteristics of stage 1-4 macular holes.

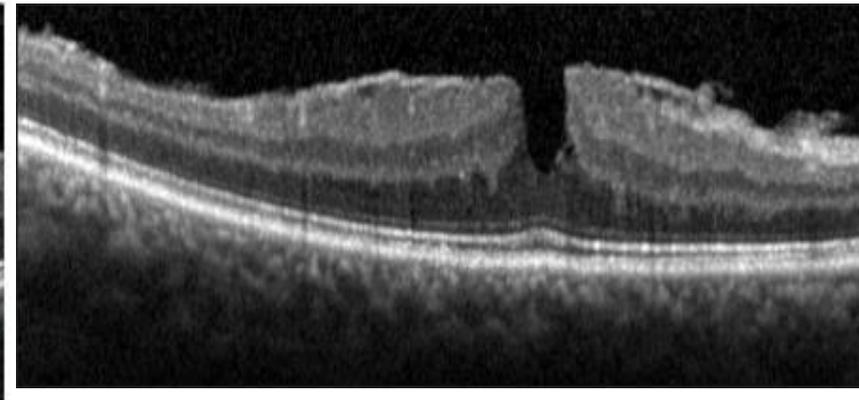
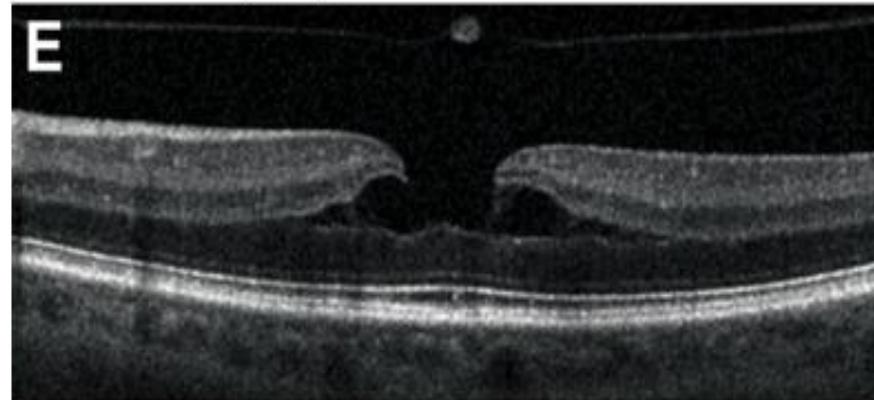
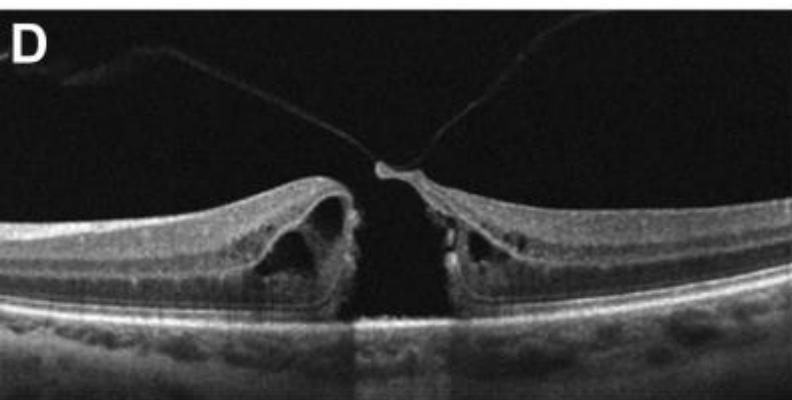
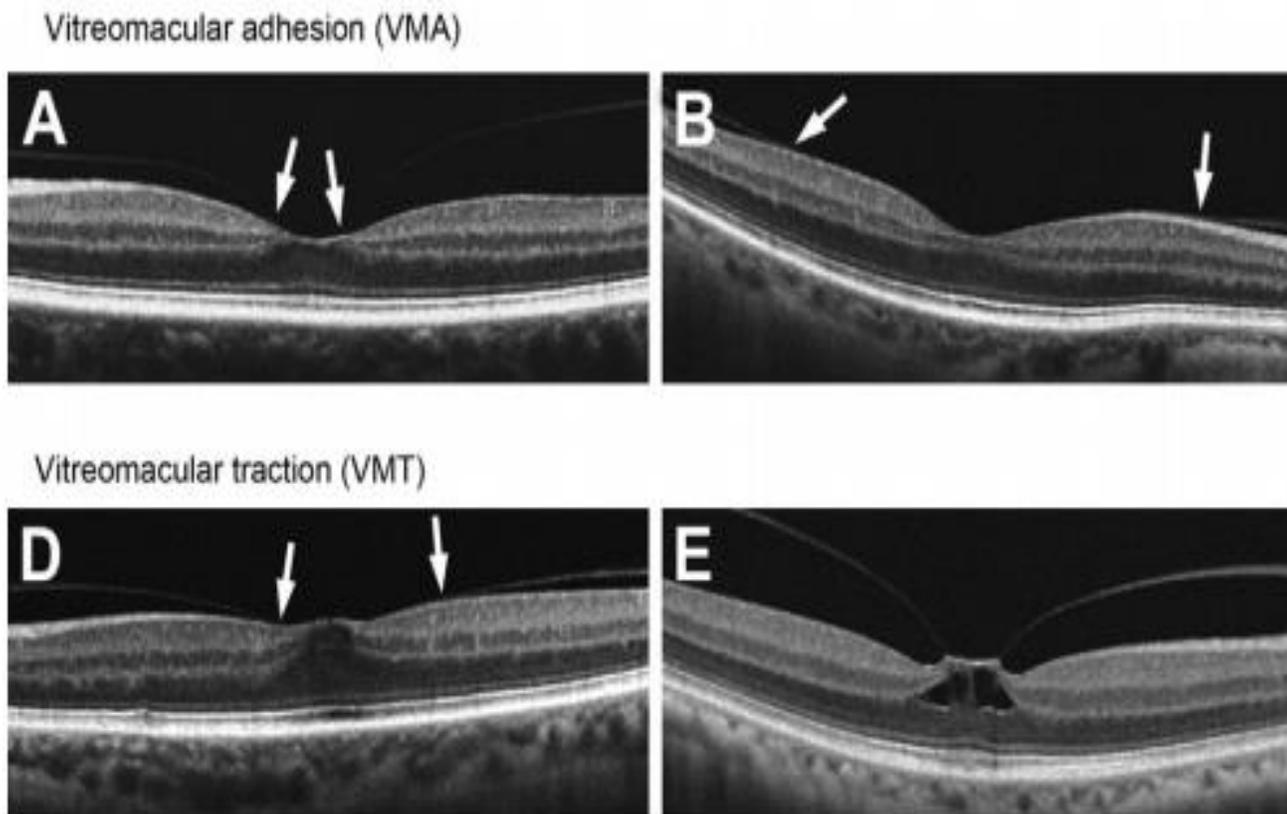
	Stage 1	Stage 2	Stage 3	Stage 4
Biomicroscopy	Yellow dot (stage 1a) or yellow ring (stage 1b)	Full thickness macular hole <400 μm in maximum diameter Round or oval Posterior vitreous attached	Full thickness macular hole >400 μm in maximum diameter Round Operculum may be seen Posterior vitreous attached	Full thickness macular hole >400 μm in maximum diameter Round Complete posterior vitreous detachment
Visual acuity	20/20-20/60	20/40-20/100	20/60-20/200	20/60-20/400
Symptoms	Asymptomatic or mild metamorphopsia	Metamorphopsia and loss of central vision	Loss of central vision and metamorphopsia	Loss of central vision and metamorphopsia
Prognosis	50% regress 40% progress to full thickness macular holes	15% close spontaneously 75% enlarge	< 5% close spontaneously 50% enlarge	<< 5% close spontaneously 20% enlarge
Candidacy for surgery	None	Excellent	Good	Possible



**TABLE 1**  
**Classification of Vitreomacular Interface Diseases\***

Classification	Description
VMA without a full-thickness hole	Perifoveal adhesion with normal retinal structure
VMT without a full-thickness hole	VMA with retinal structural abnormality
Impending macular hole	VMT in fellow eye of a FTMH
Lamellar hole	Partial-thickness foveal defect
Pseudohole	ERM with central foveal opening but no actual loss of retinal tissue
FTMH	Full-thickness retinal defect

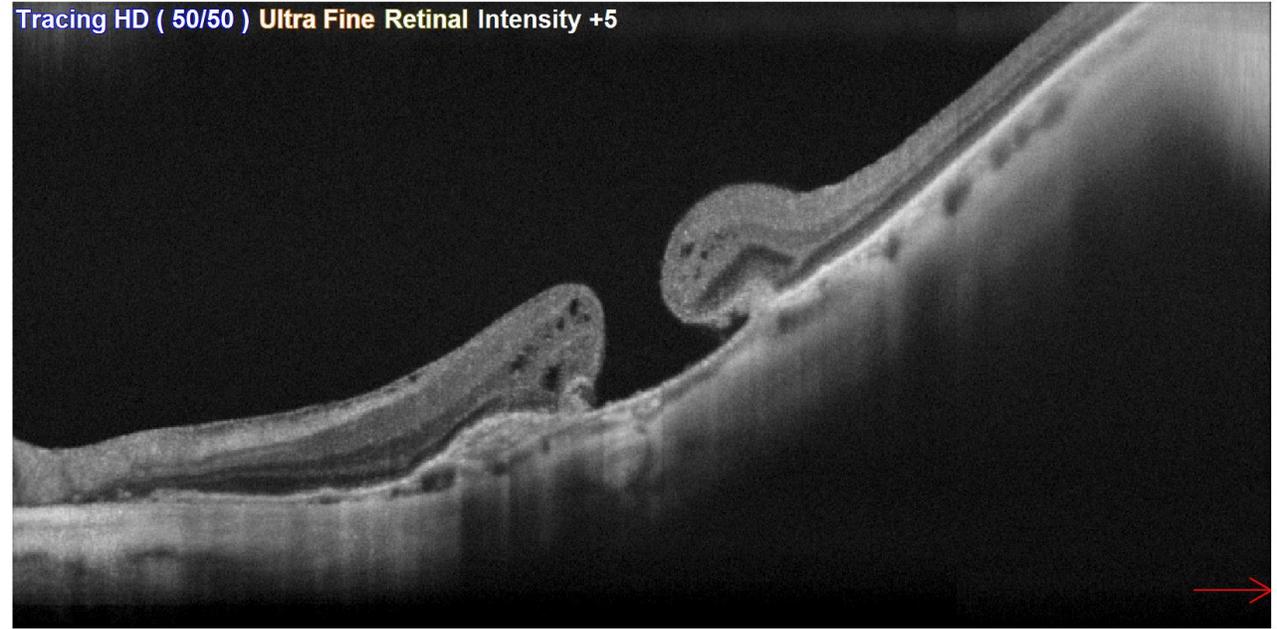
\* Based on the International Classification System for Vitreomacular Adhesion, Traction, and Macular Hole.<sup>13</sup>  
VMA = vitreomacular adhesion; VMT = vitreomacular traction; FTMH = full-thickness macular hole; ERM = epiretinal membrane



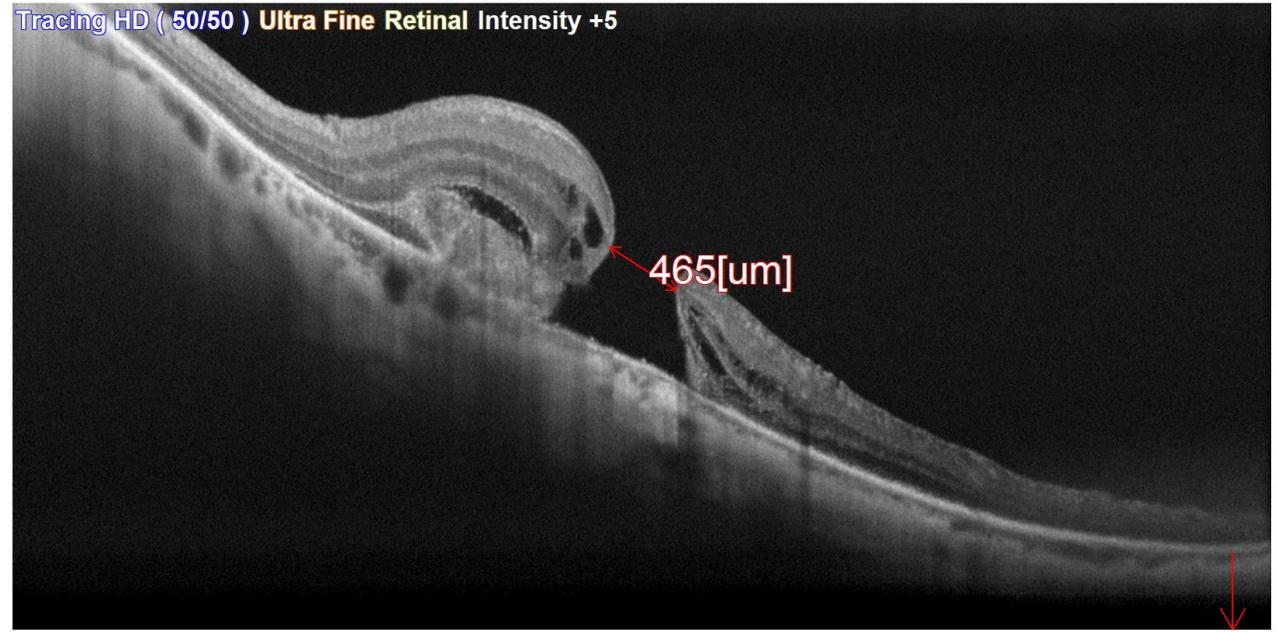
# etting:MACULA CROSS( 8,4mm[1024] )

S/N Version( F/S ) Date SQI SSI SLO Focus[D] Axial[mm]  
650086 21098/2.10.98 02/03/2017 17:57:46 4/5 7/10 Wide +1,75 Gullstrand

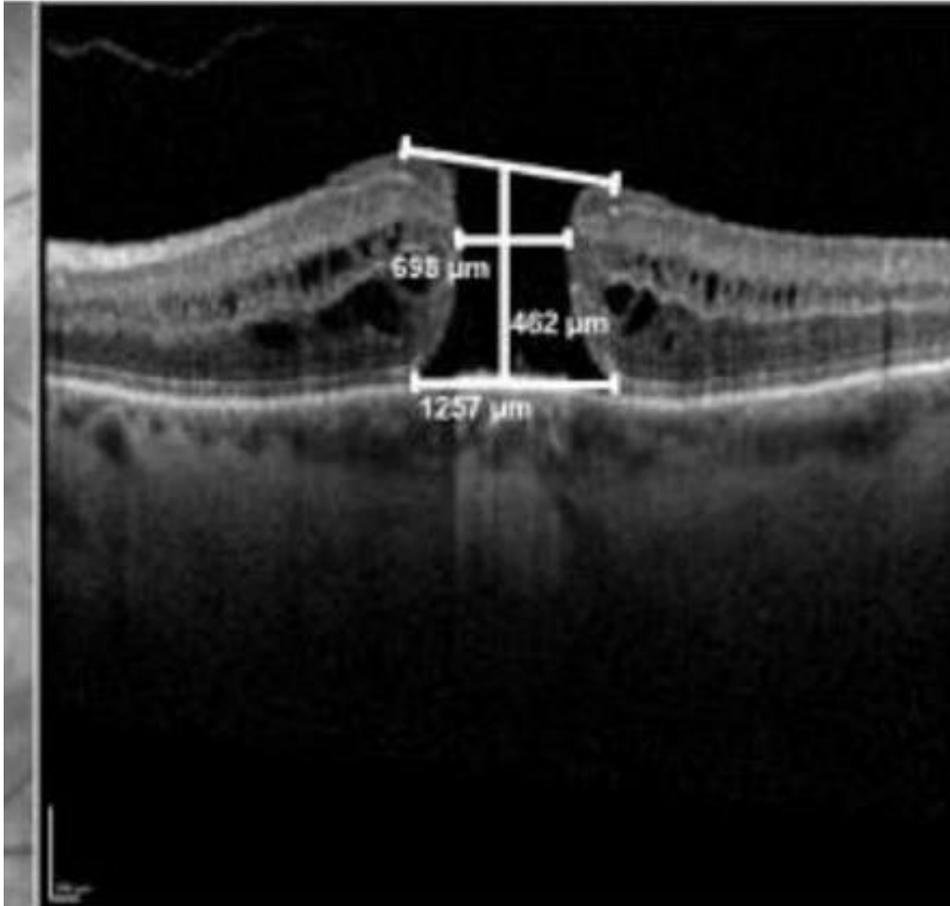
Tracing HD ( 50/50 ) Ultra Fine Retinal Intensity +5



Tracing HD ( 50/50 ) Ultra Fine Retinal Intensity +5



MISURARE IL DIAMETRO DI UN  
FORO MACULARE



## Diametro del foro → fattore prognostico di outcome chirurgico

> Br J Ophthalmol. 2009 Nov;93(11):1488-91. doi: 10.1136/bjo.2008.153189. Epub 2009 Jul 26.

### Predicting visual success in macular hole surgery

B Gupta <sup>1</sup>, D A H Laidlaw, T H Williamson, S P Shah, R Wong, S Wren

Anatomical outcomes of surgery for idiopathic macular hole as determined by optical coherence tomography.

Ip MS, Baker BJ, Duker JS, Reichel E, Bauman CR, Gangnon R, Puliafito CA.

Arch Ophthalmol. 2002 Jan;120(1):29-35. doi: 10.1001/archophth.120.1.29.

PMID: 11786054

> Br J Ophthalmol. 2002 Apr;86(4):390-3. doi: 10.1136/bjo.86.4.390.

### Macular hole size as a prognostic factor in macular hole surgery

S Ullrich <sup>1</sup>, C Haritoglou, C Gass, M Schaumberger, M W Ulbig, A Kampik

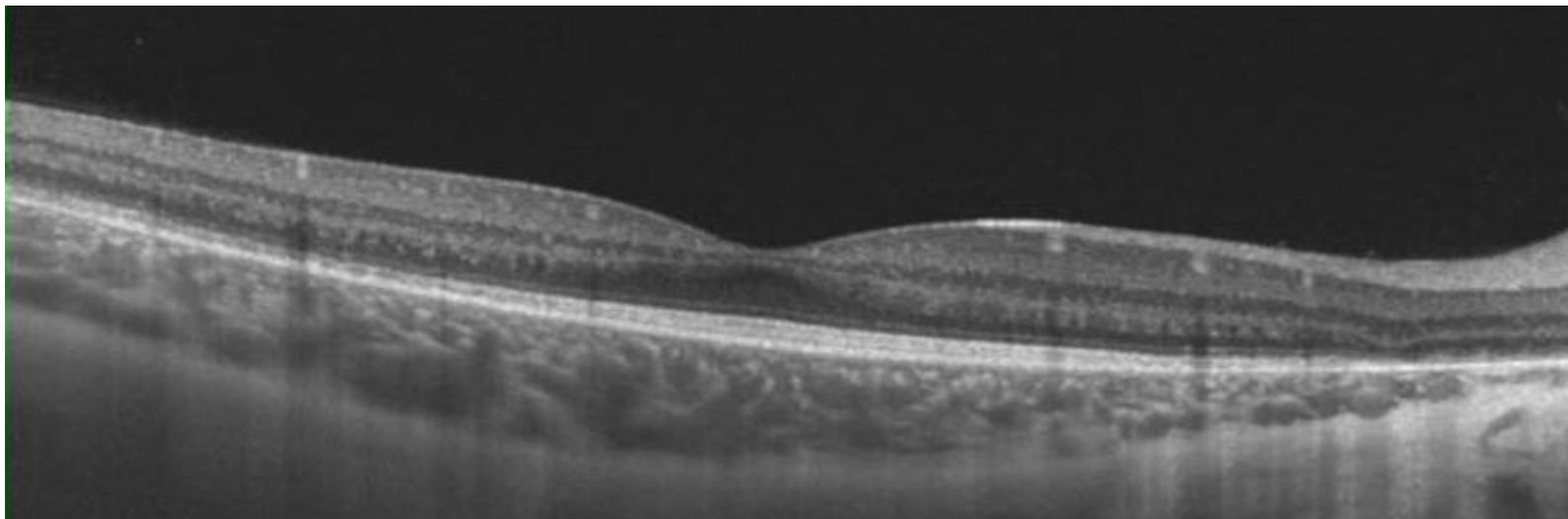
Assessment of OCT measurements as prognostic factors in myopic macular hole surgery without foveoschisis.

Alkabes M, Padilla L, Salinas C, Nucci P, Vitale L, Pichi F, Burès-Jelstrup A, Mateo C.

Graefes Arch Clin Exp Ophthalmol. 2013 Nov;251(11):2521-7. doi: 10.1007/s00417-013-2347-y. Epub 2013 May 22.

PMID: 23695656

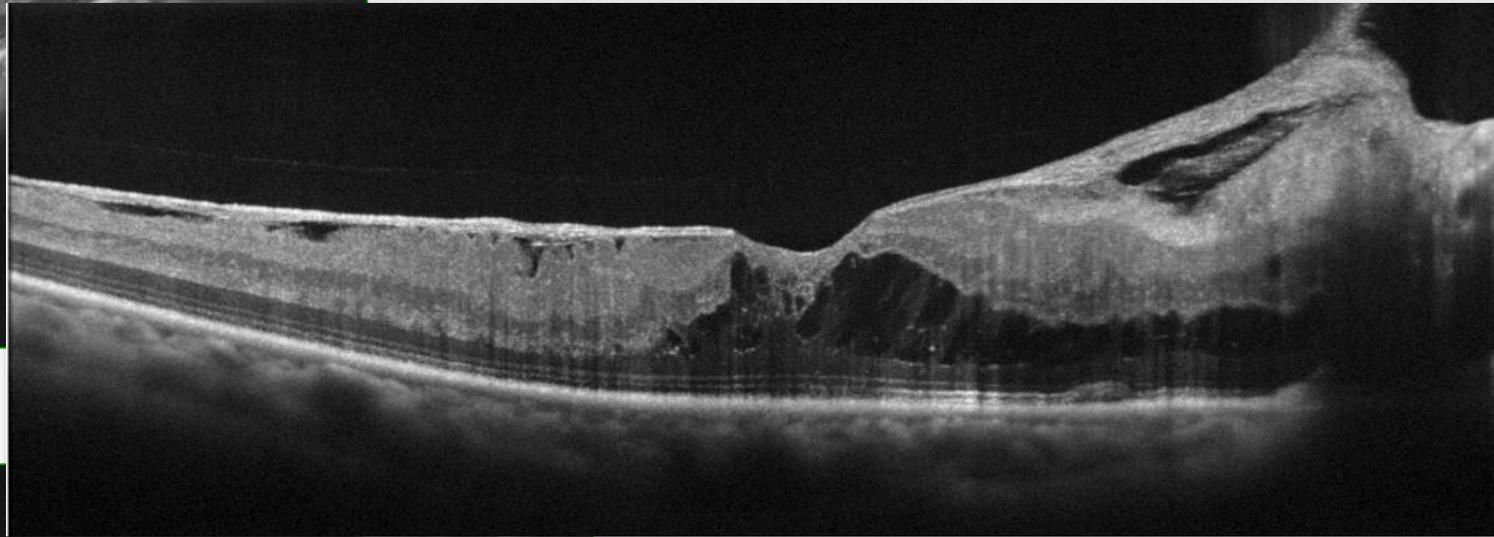
**Normale profilo retinico**



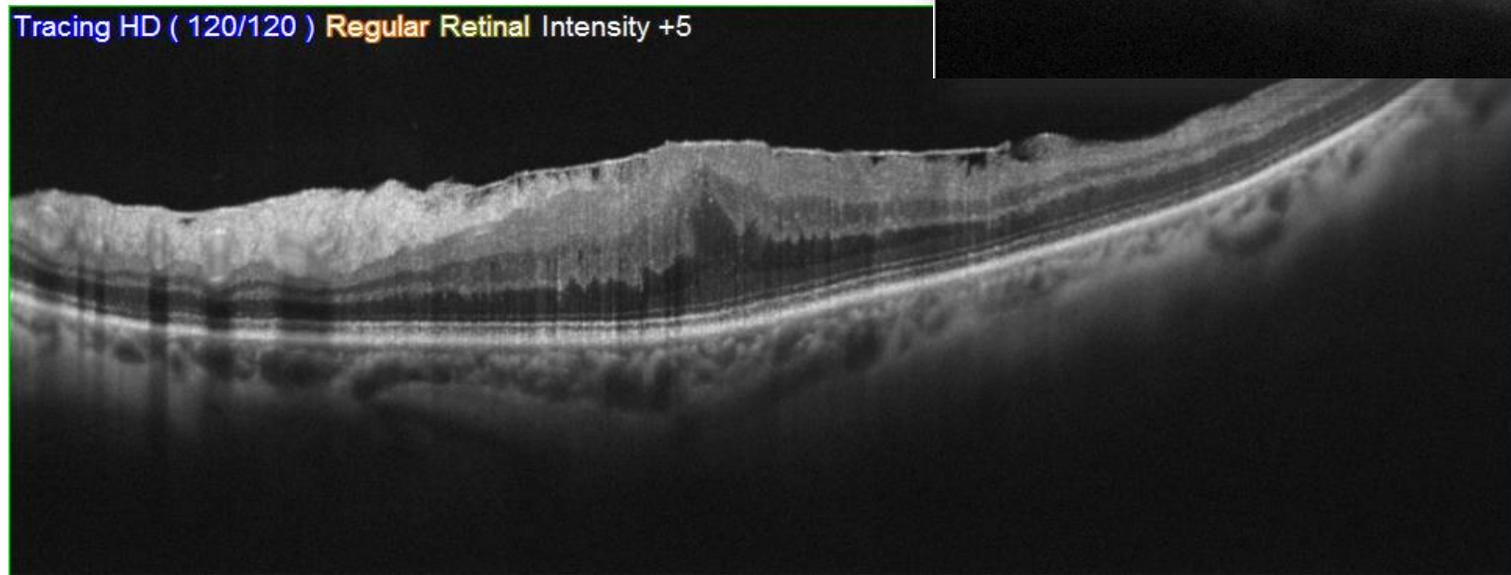
**Membrana epiretinica maculare**



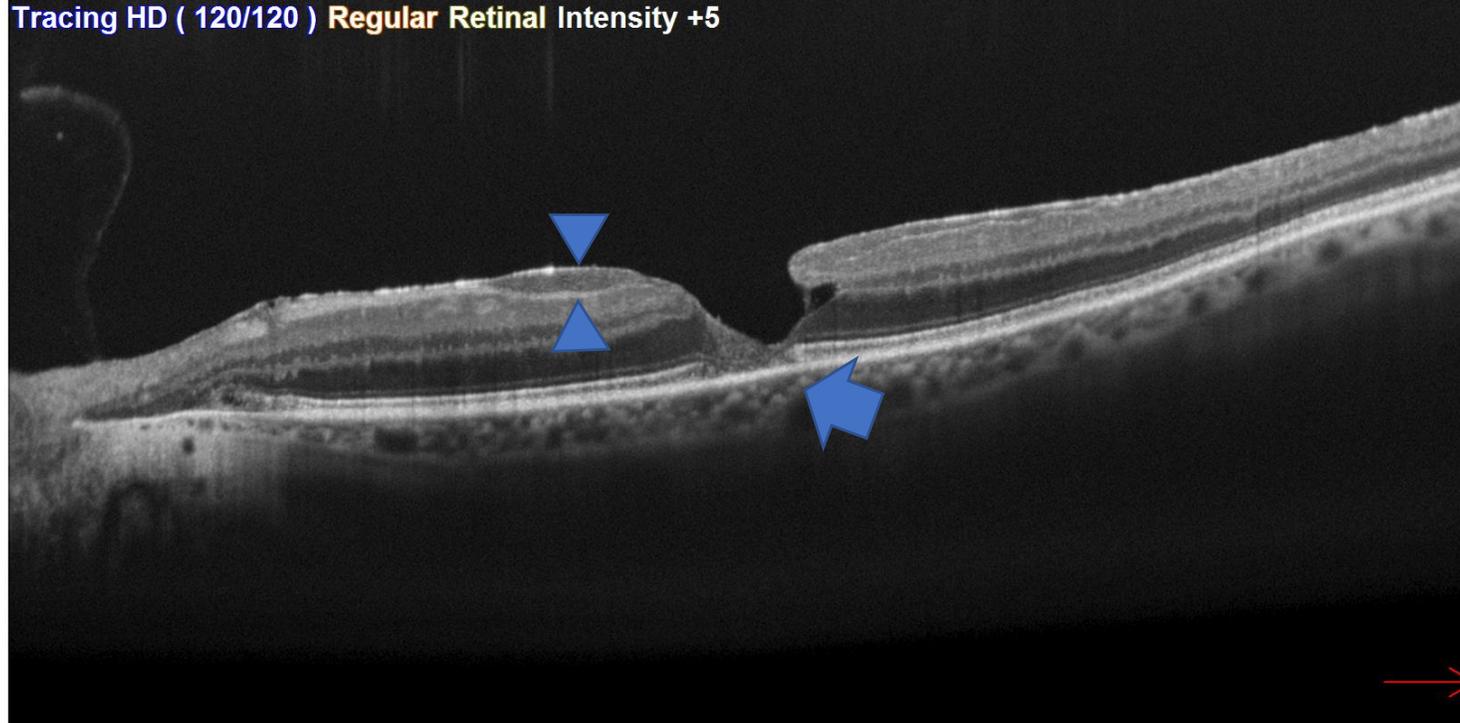
Tracing HD ( 120/120 ) Regular Retinal Intensity +5



Tracing HD ( 120/120 ) Regular Retinal Intensity +5

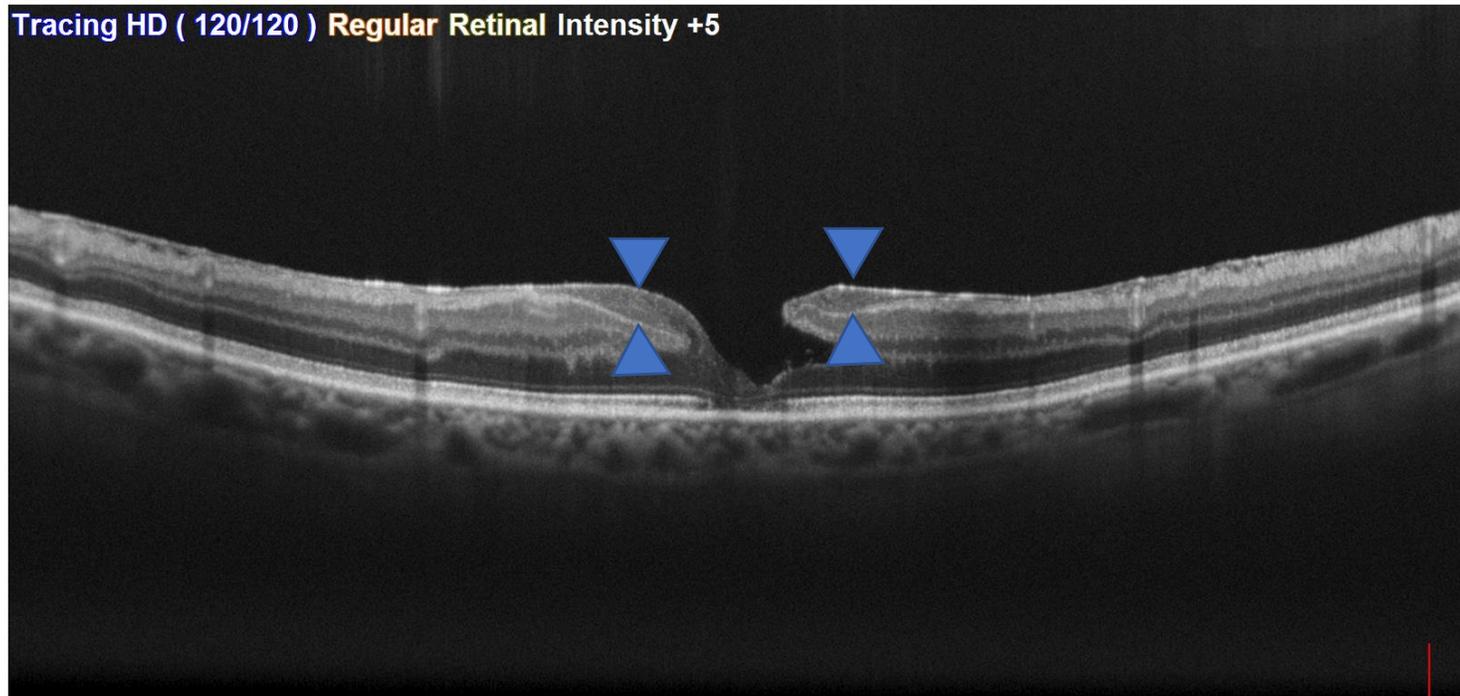


Tracing HD ( 120/120 ) Regular Retinal Intensity +5

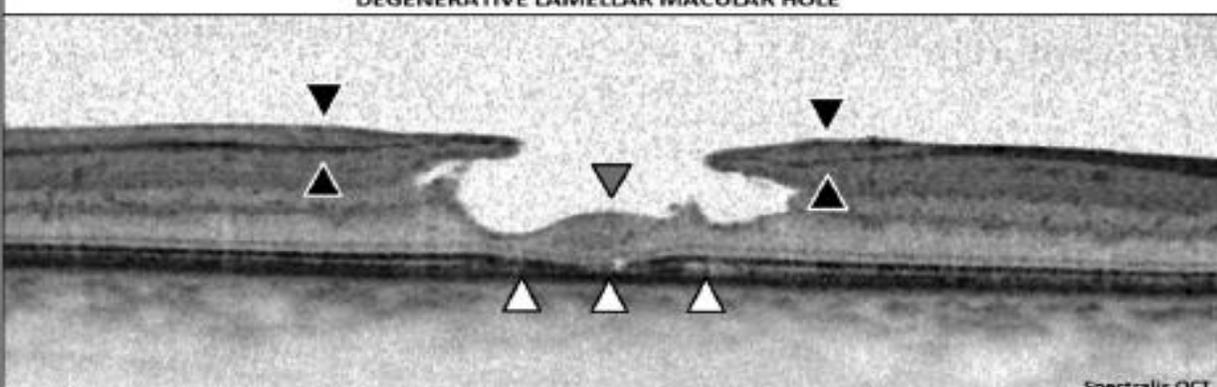


LHEP

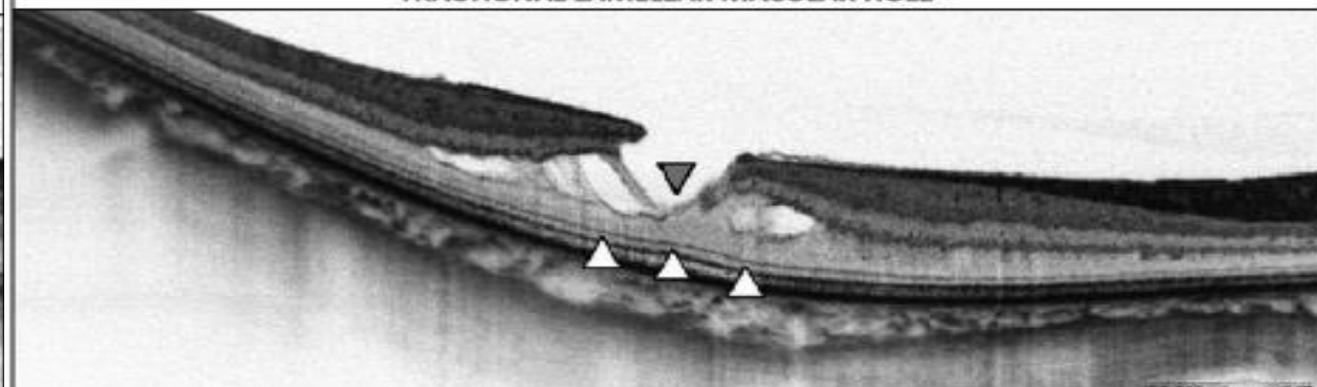
Tracing HD ( 120/120 ) Regular Retinal Intensity +5



DEGENERATIVE LAMELLAR MACULAR HOLE



TRACTIONAL LAMELLAR MACULAR HOLE

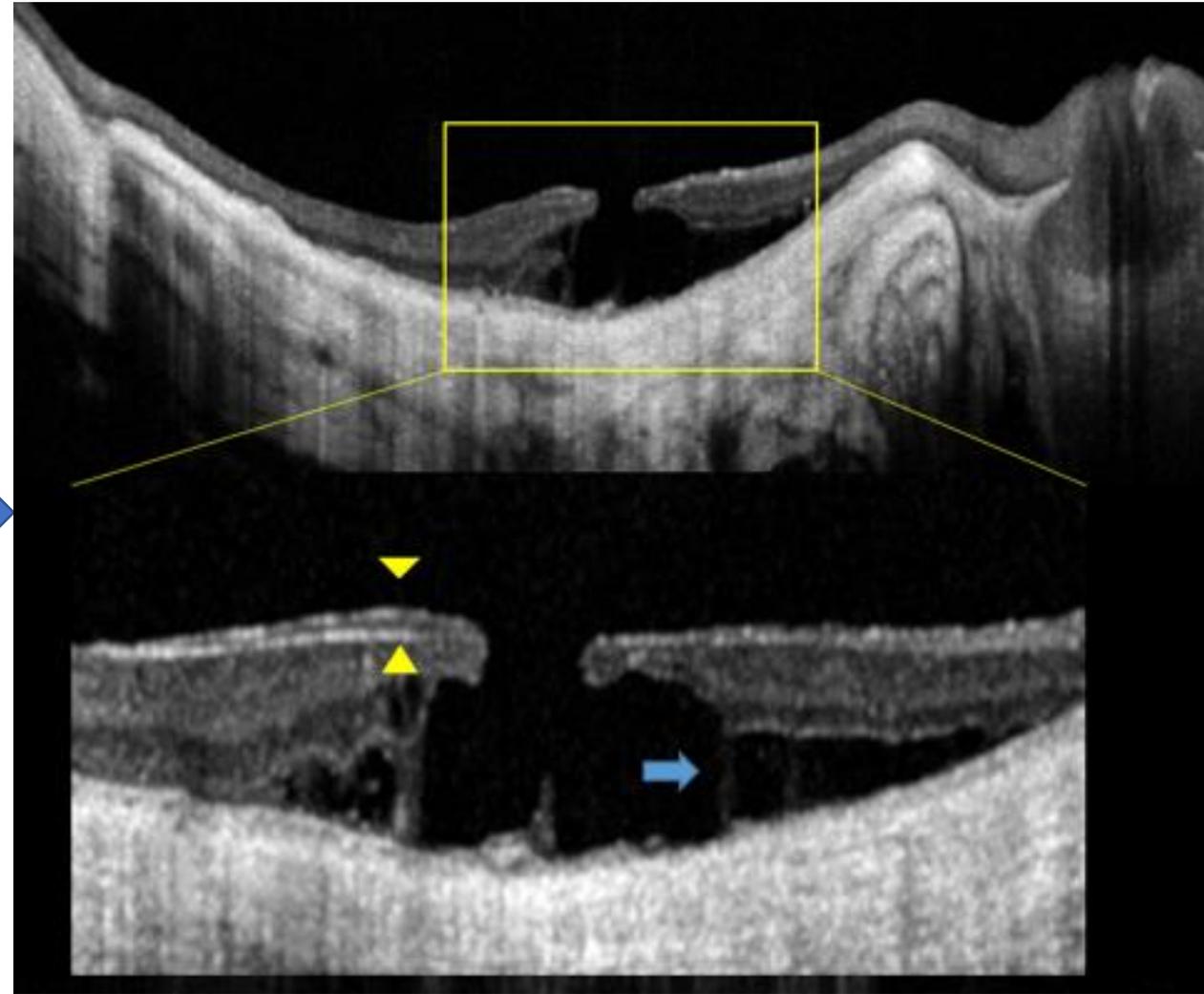
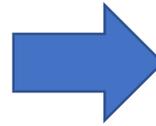
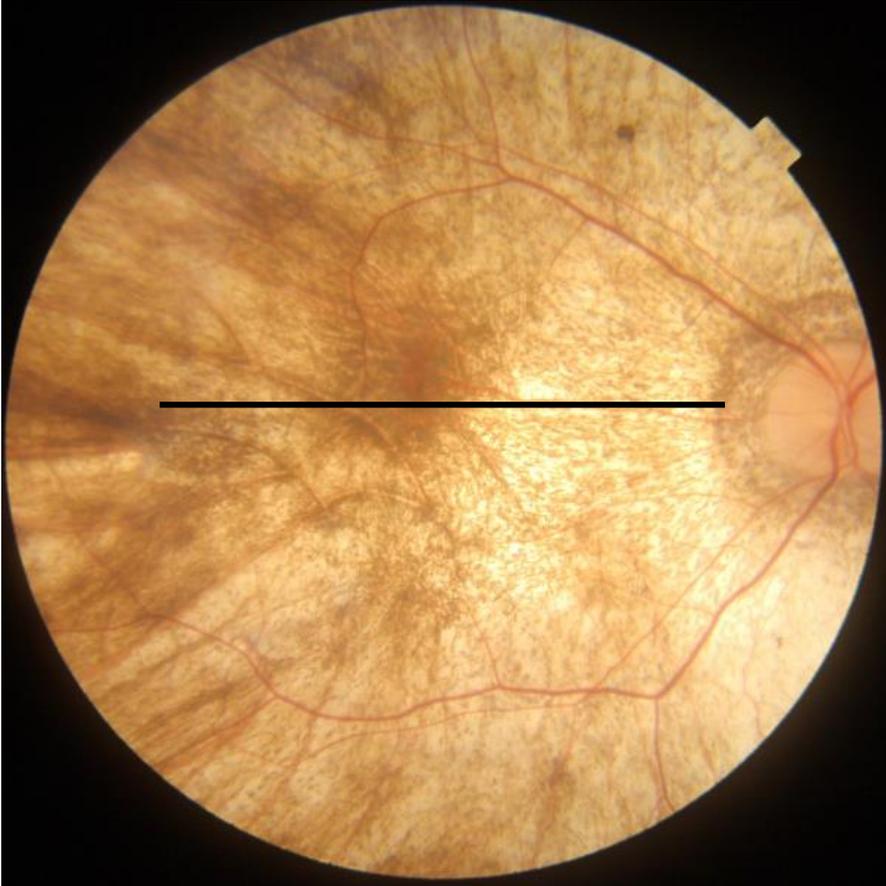


**TABLE 1.** Diagnostic Criteria for Degenerative and Tractional Lamellar Macular Holes

Diagnostic Criteria <sup>a</sup>			
Degenerative n = 48		Tractional n = 43	
Inner/outer diameter ratio > 1:2	n = 44 (91.67%)	Inner/outer diameter ratio < 1:2	n = 37 (86.05%)
Ellipsoid defect	n = 46 (95.83%)	Intact ellipsoid	n = 42 (97.67%)
Round-edged cavitation	n = 47 (97.92%)	Sharp-edged split	n = 43 (100%)
Foveal bump	n = 42 (87.50%)	Intraretinal cystoid spaces	n = 35 (81.40%)
Epiretinal proliferation	n = 46 (95.83%)	Epiretinal membrane	n = 42 (97.67%)

<sup>a</sup>Diagnosis is made with a minimum of 3 out of 5 criteria. If the lesion does not match with both categories, it is classified as "mixed."

D.P età 48 anni,  
pathogenic deletion  
(c.1771-? \_1962+? Del) on the CHM gene

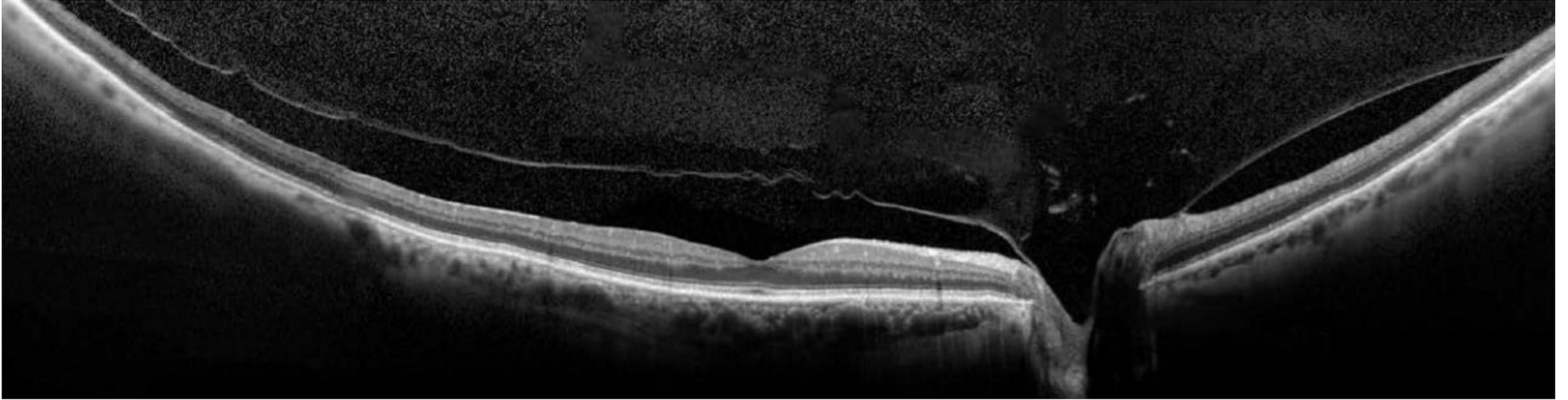


## Lamellar Hole-associated Epiretinal Proliferation in choroideremia: a case report

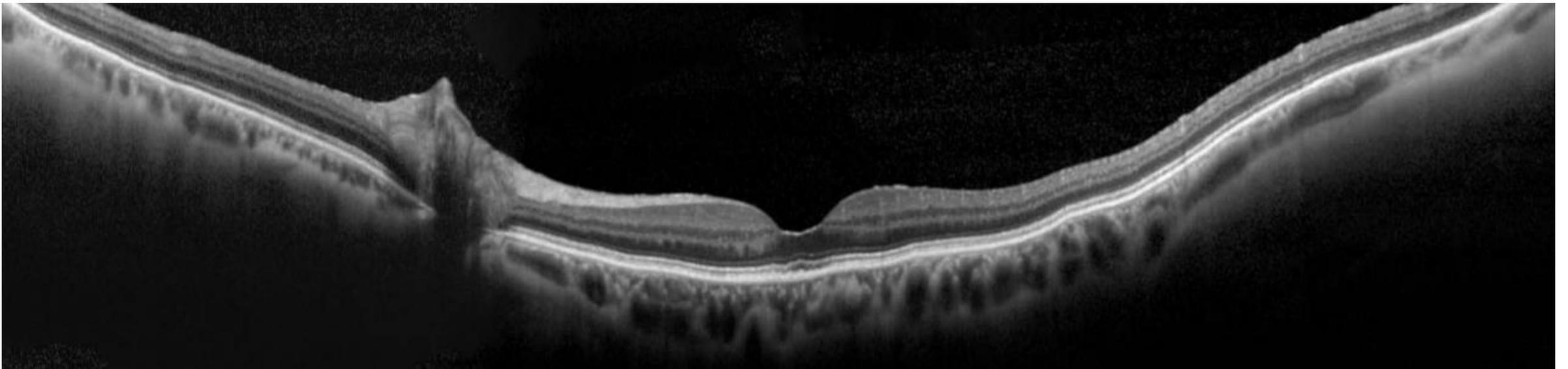
Vittoria Murro<sup>1</sup>, Dario Pasquale Mucciolo<sup>1,2\*</sup>, Dario Giorgio<sup>1</sup>, Tomaso Caporossi<sup>1</sup>, Ilaria Passerini<sup>3</sup>, Daniele Bani<sup>4</sup>, Fabrizio Giansanti<sup>1</sup>, Gianni Virgili<sup>1,5</sup> and Andrea Sodi<sup>1</sup>

# Studiare il CORPO VITREO

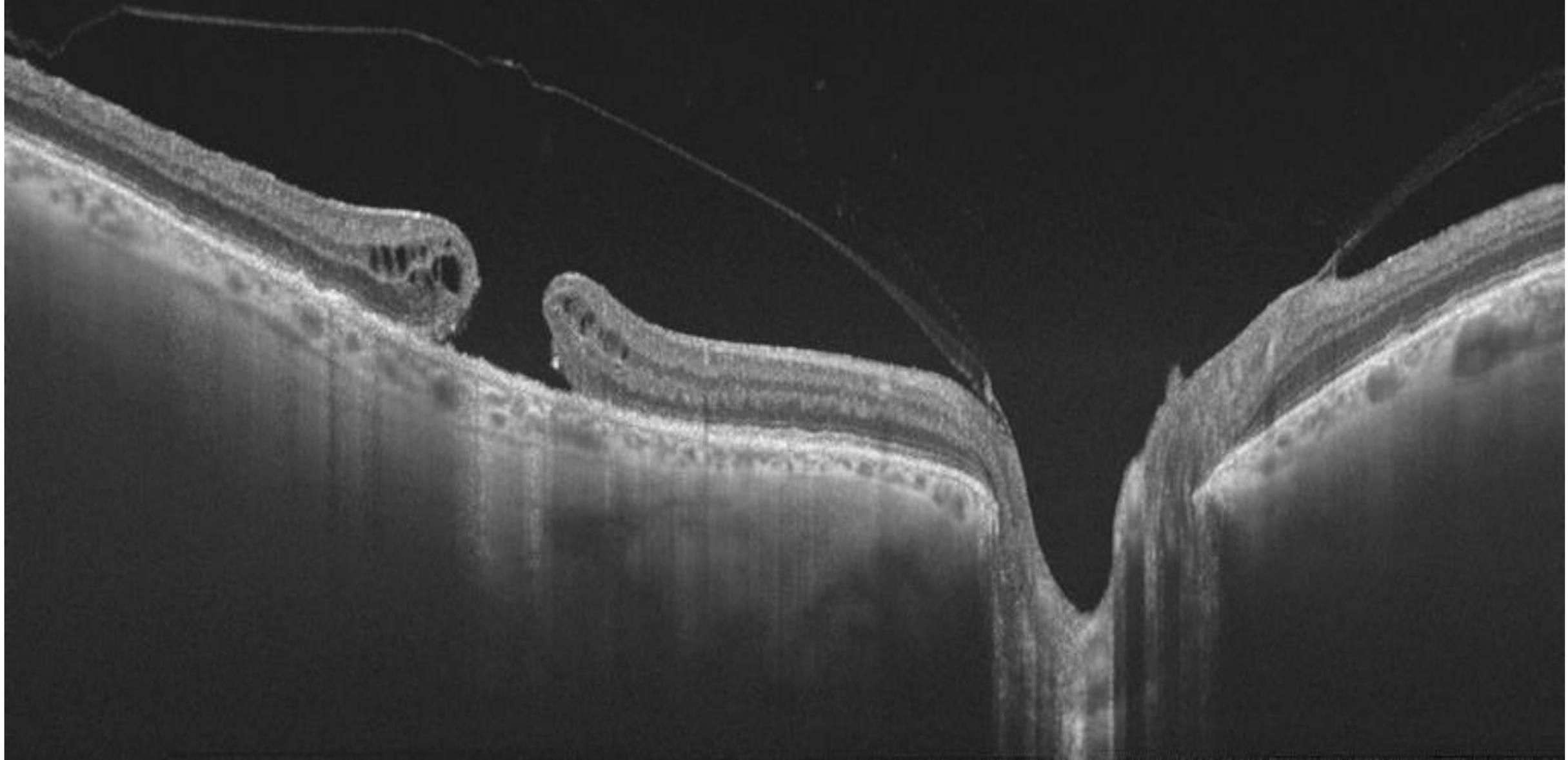
Distacco di vitreo incompleto con adesione vitreopapillare



Distacco posteriore di vitreo completo



12x9 mm SSOCT (high definition line scan)



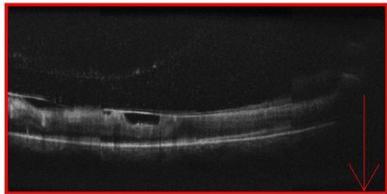
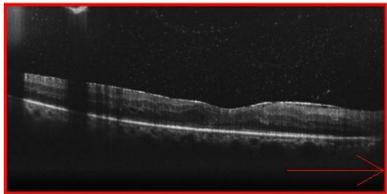
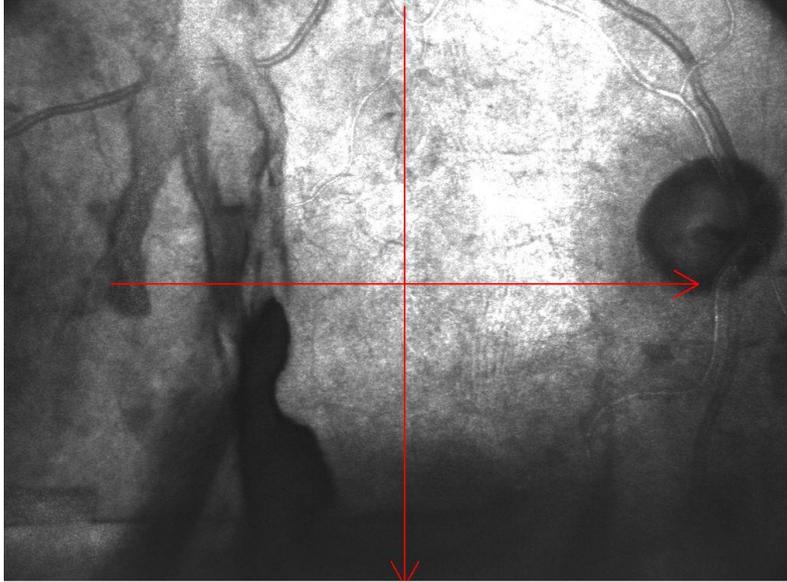
# OCT Setting:MACULA CROSS( 9,0mm[1024] )

Eye:R

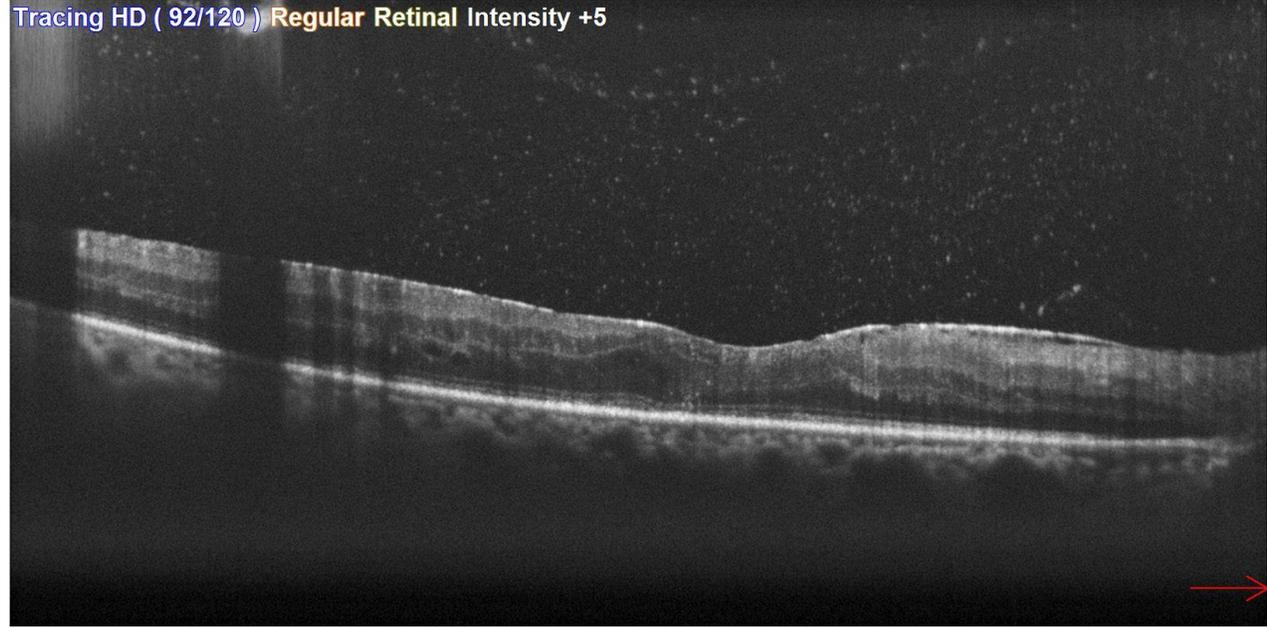


R

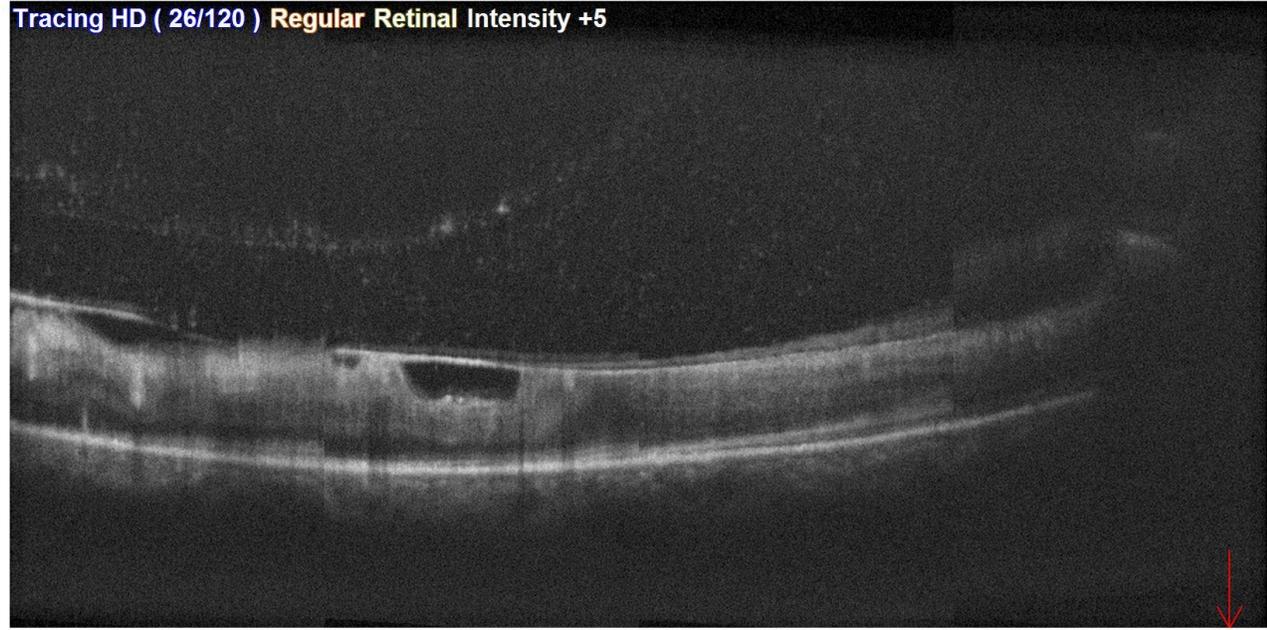
S/N	Version( F/S )	Date	SQI	SSI	SLO	Focus[D]	Axial[mm]
R 650907	22002/2.20.03	03/04/2019 13:35:46	4/5	5/10	Wide	+1,50	Gullstrand



Tracing HD ( 92/120 ) Regular Retinal Intensity +5



Tracing HD ( 26/120 ) Regular Retinal Intensity +5



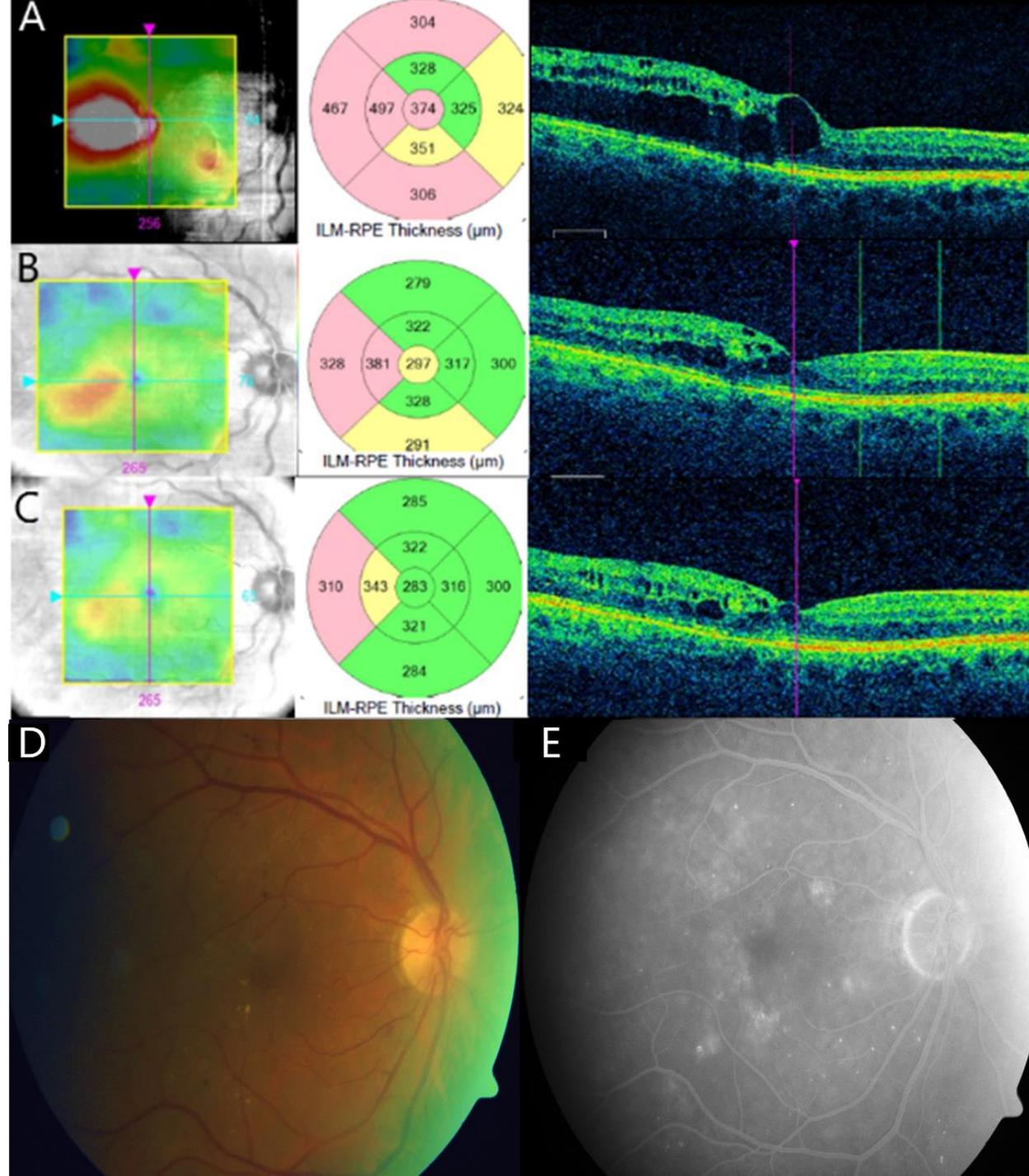
# Follow-up dell'edema maculare

baseline

6 months FU

12 months FU

## OCT COME STRUMENTO DI MONITORAGGIO DI TERAIA



**Subthreshold yellow micropulse laser for treatment of diabetic macular edema  
Comparison between fixed and variable treatment regimen**

Maria Carla Donati, Vittoria Murro, Dario Pasquale Mucciolo , more...

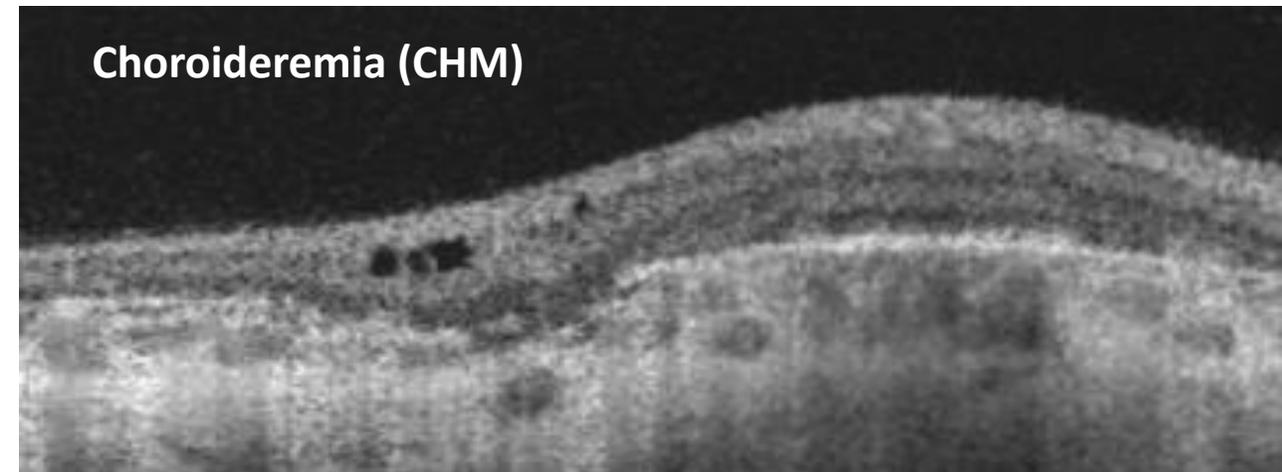
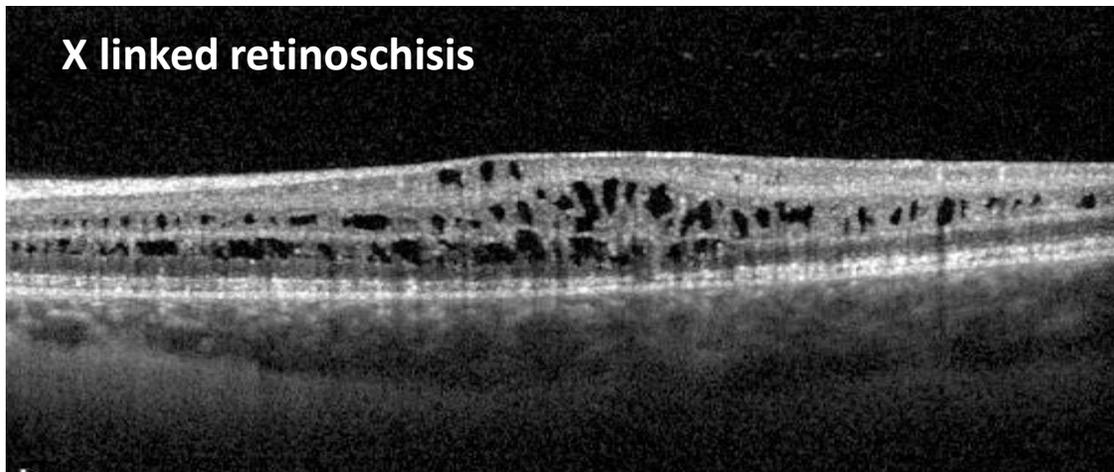
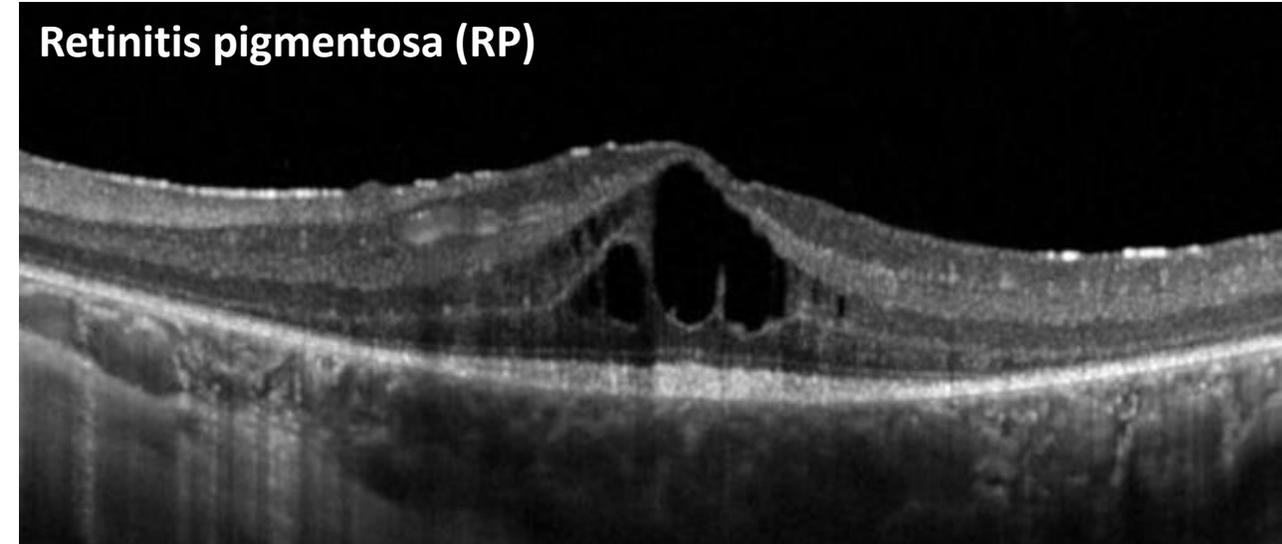
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First Published April 14, 2020 | Research Article | [Find in PubMed](#) |  Check for updates

<https://doi.org/10.1177/1120672120915169>

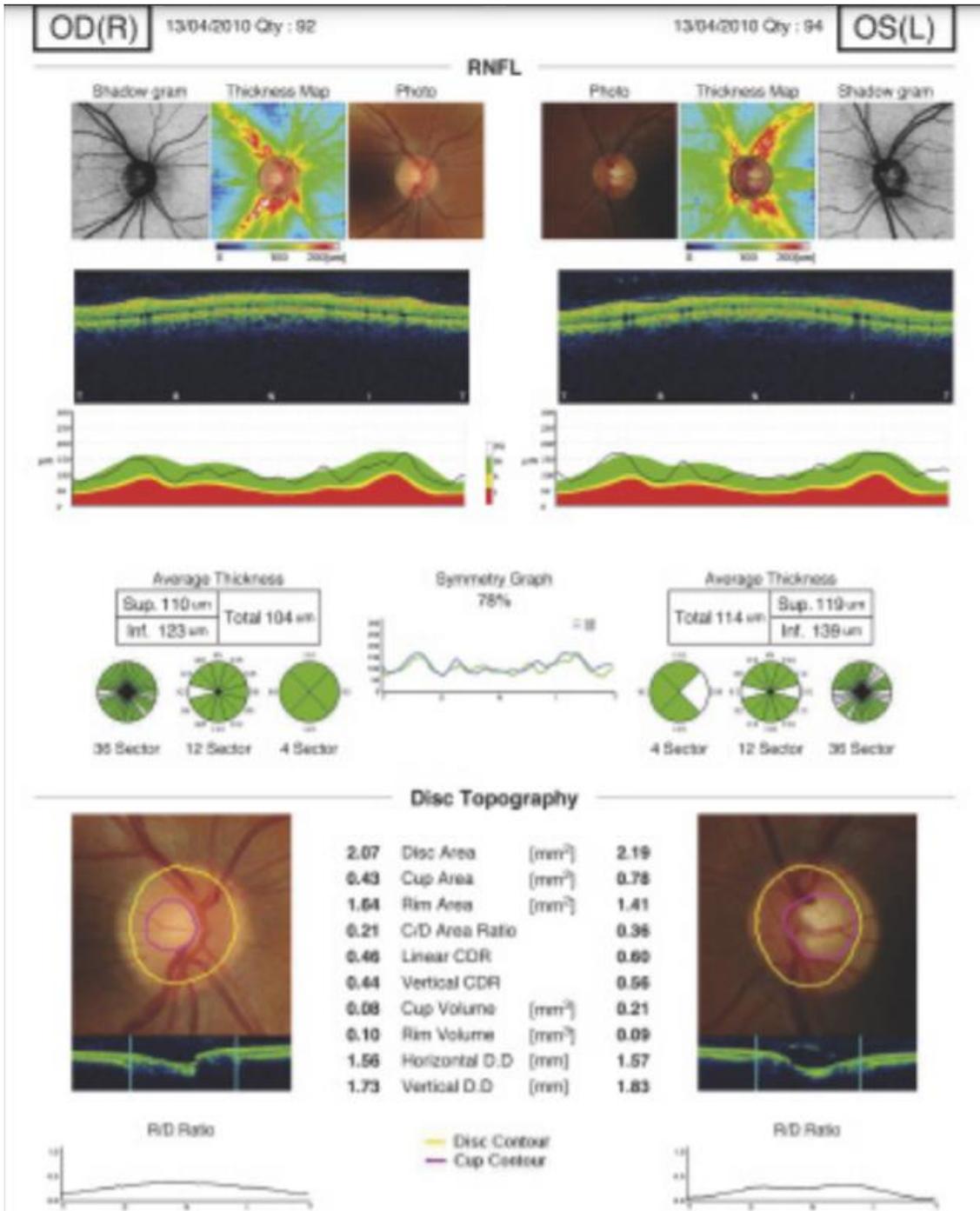
[Article information](#) 

Studiare la morfologia dell'edema maculare nelle distrofie retiniche ereditarie

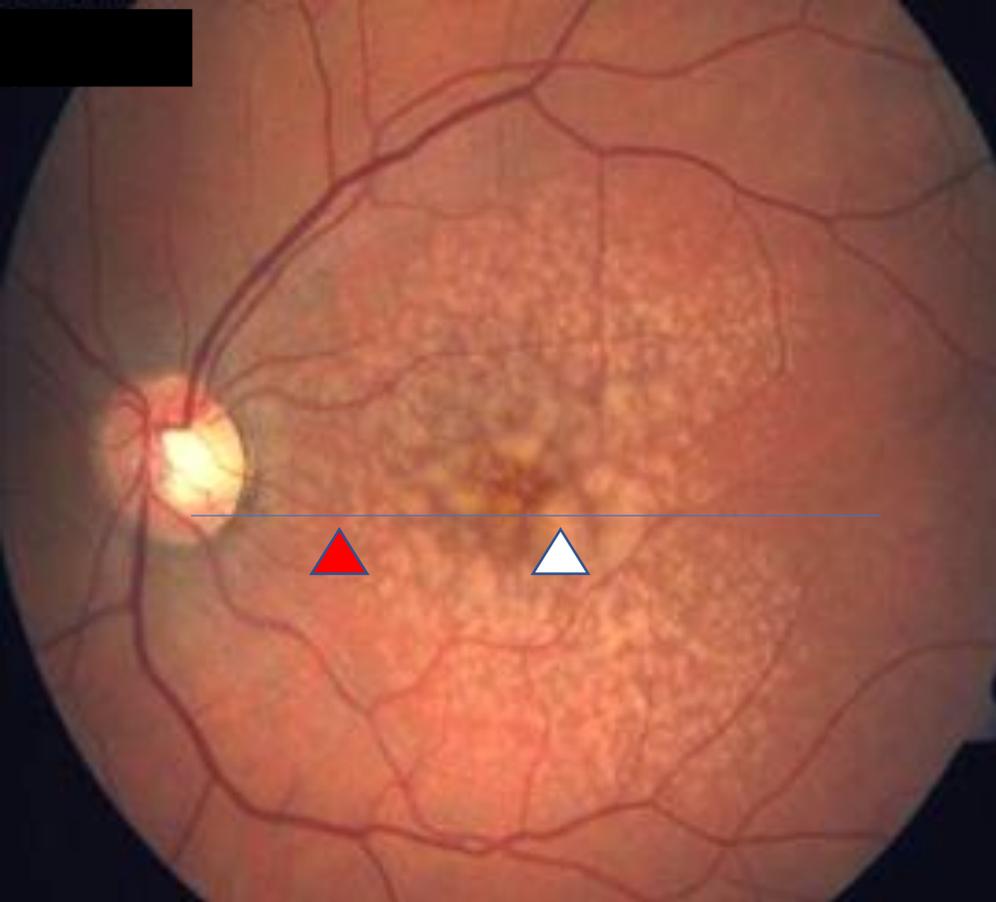


**Cystoid spaces in RP, x-linked retinoschisis, enhanced S-cone syndrome, and gyrate atrophy are detected when RPE and outer retinal layers are preserved**

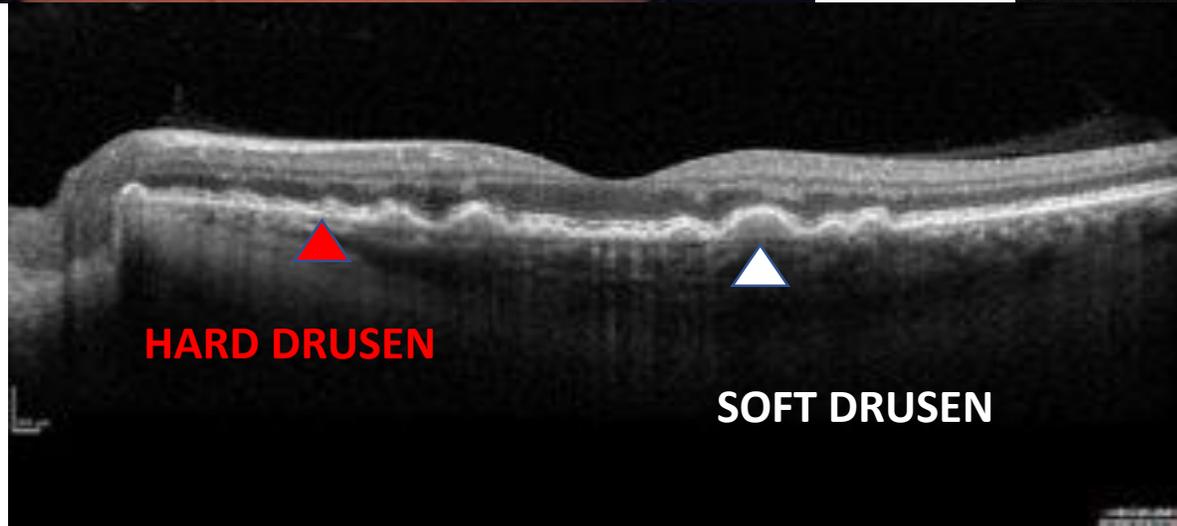
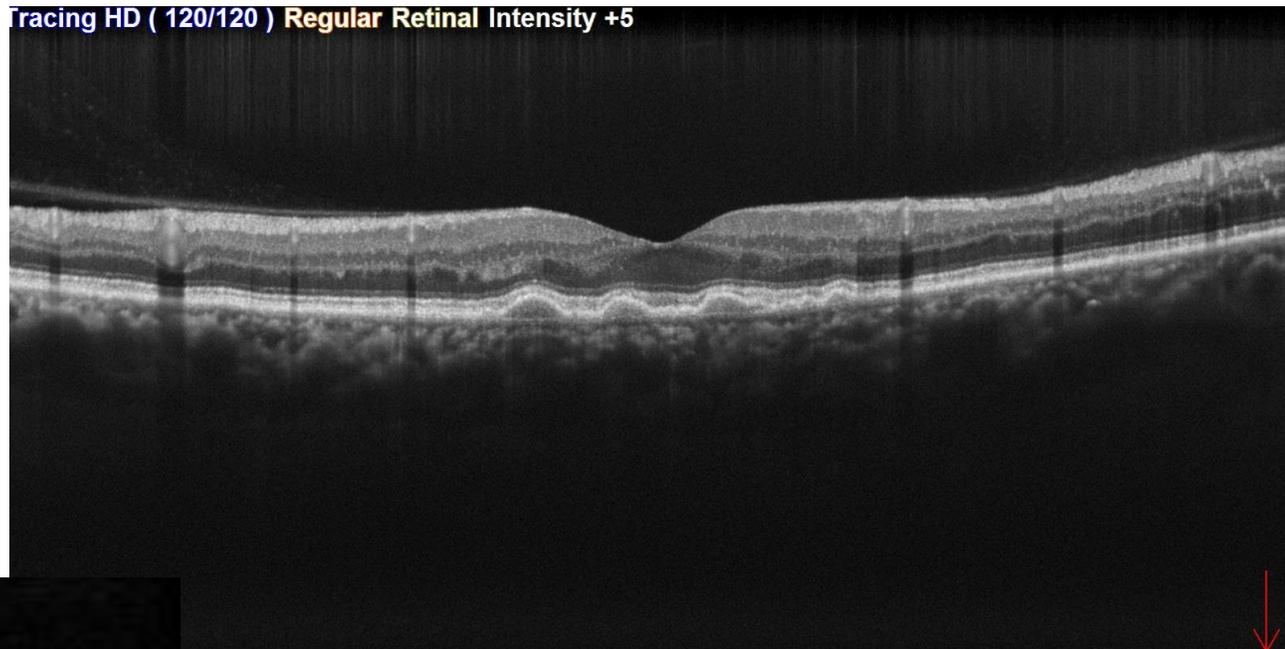
RNFL: spessore fibre nervo ottico



**Drusen maculari: hallmark della  
degenerazione maculare senile**

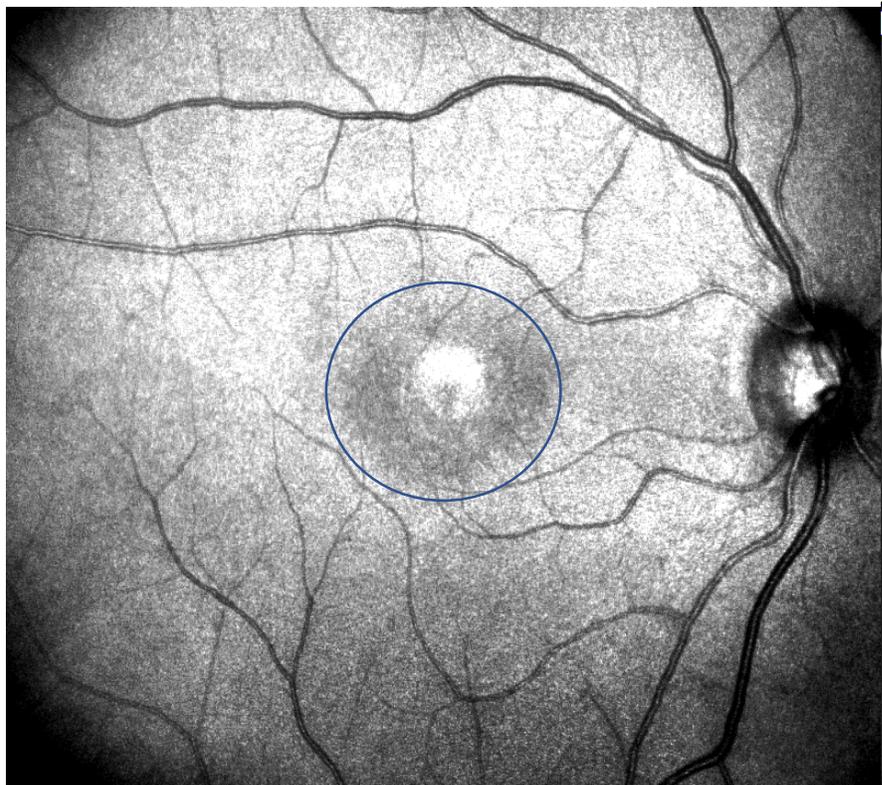


Tracing HD ( 120/120 ) Regular Retinal Intensity +5



**HARD DRUSEN**

**SOFT DRUSEN**



Tracing HD ( 120/120 ) Regular Retinal Intensity +5

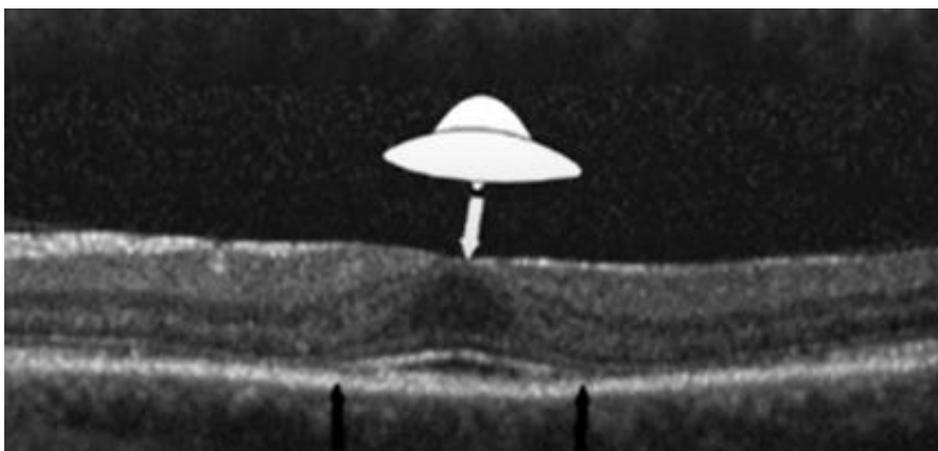
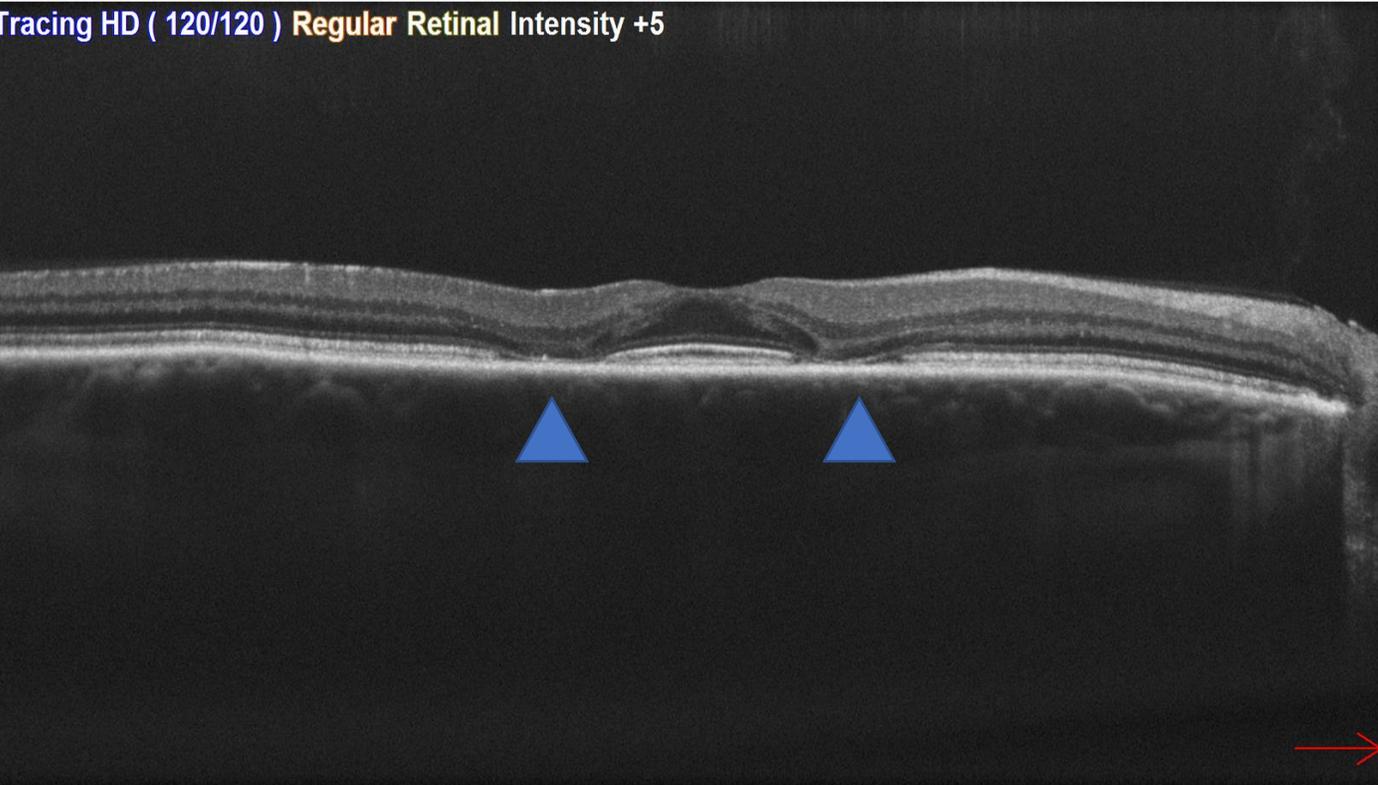


Table 3. Clinical Examination Techniques

Recommended Screening Tests

Primary tests: ideally do both

Automated visual fields (appropriate to race)

**SD-OCT**

Other objective tests (as needed or available):

mfERG

FAF

**Recommendations on Screening for Chloroquine and Hydroxychloroquine Retinopathy (2016 Revision)**

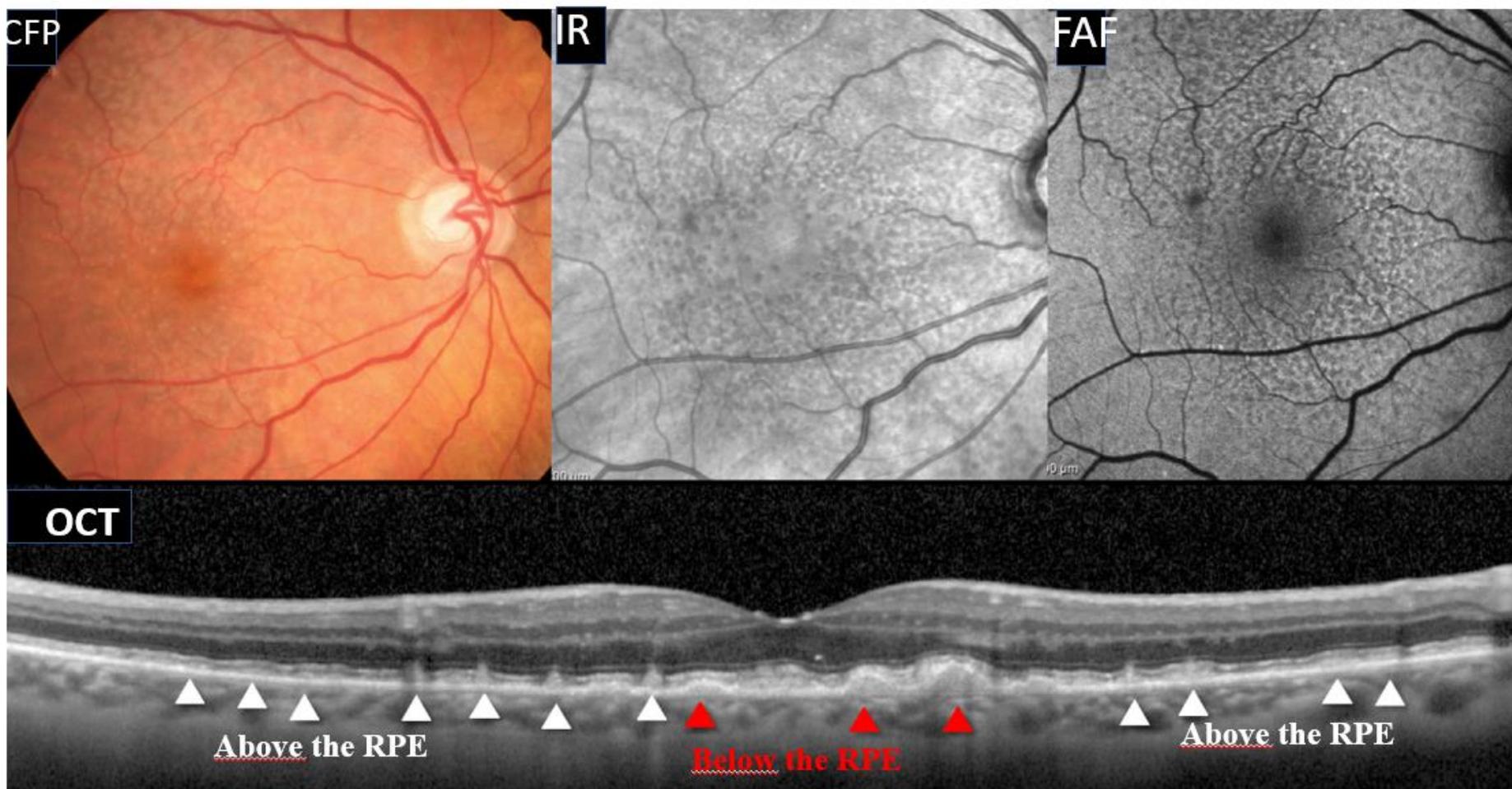
# Caratterizzare la localizzazione delle drusen maculari. DRUSEN RETICOLARI



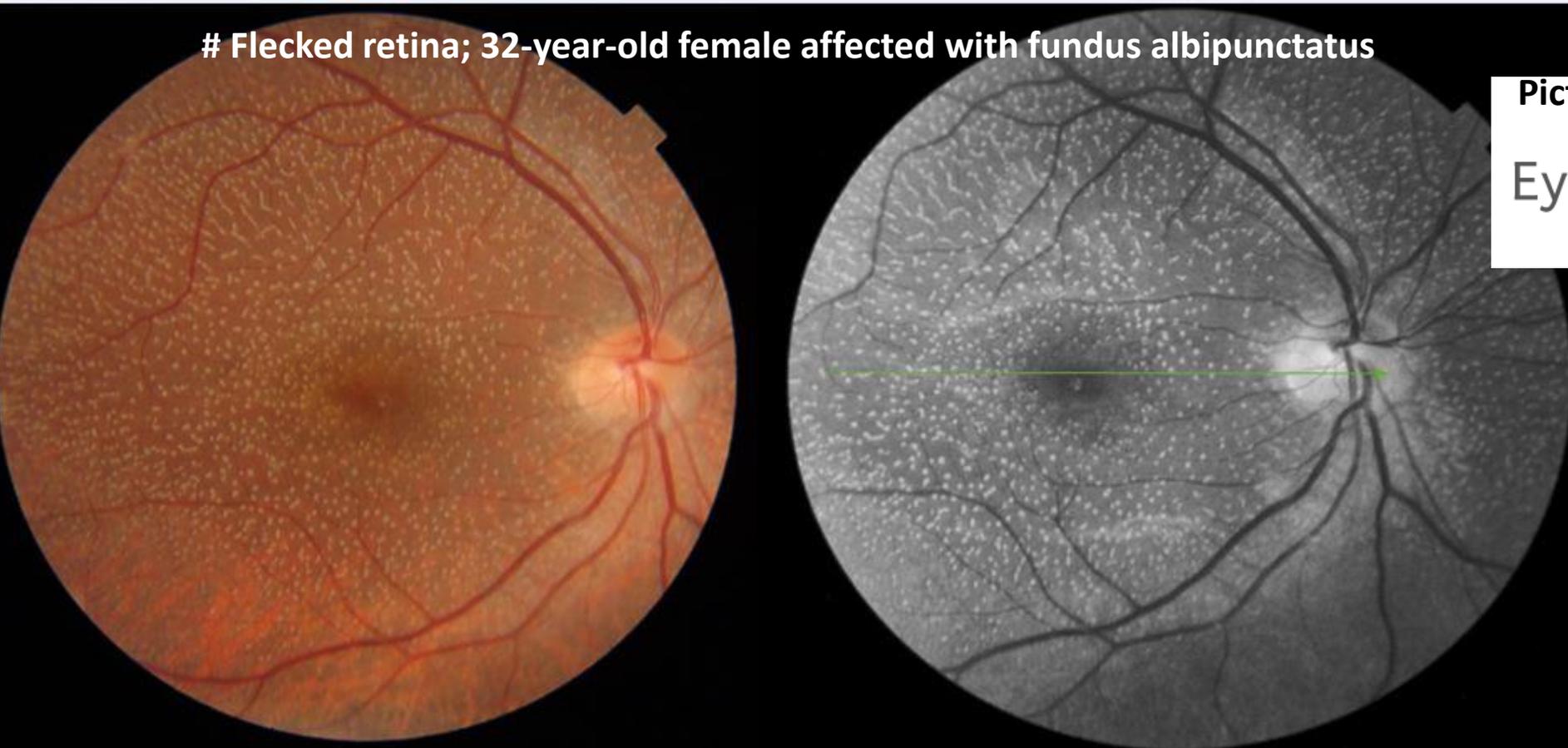
SOFT DRUSEN



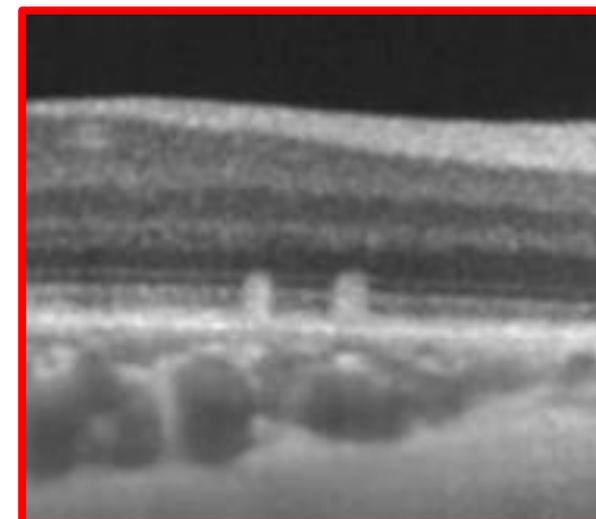
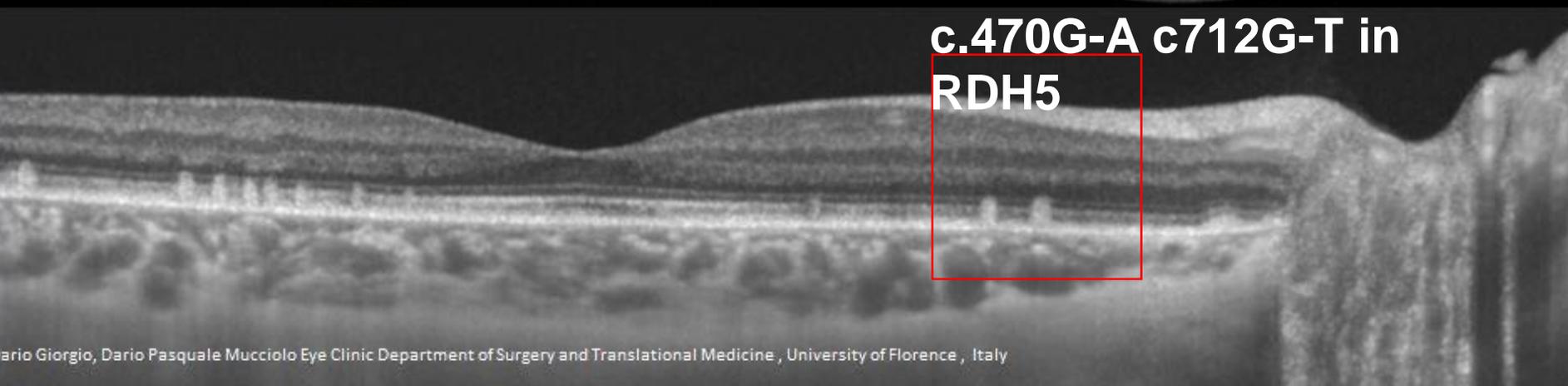
SDD



# Flecked retina; 32-year-old female affected with fundus albipunctatus



Picture of the month OCT 2019 (ERN  
Eye Diseases (ERN-EYE))



## ***NUOVE TECNOLOGIE IN COMMERCIO.....***

SD OCT montage using HRA spectralis OCT



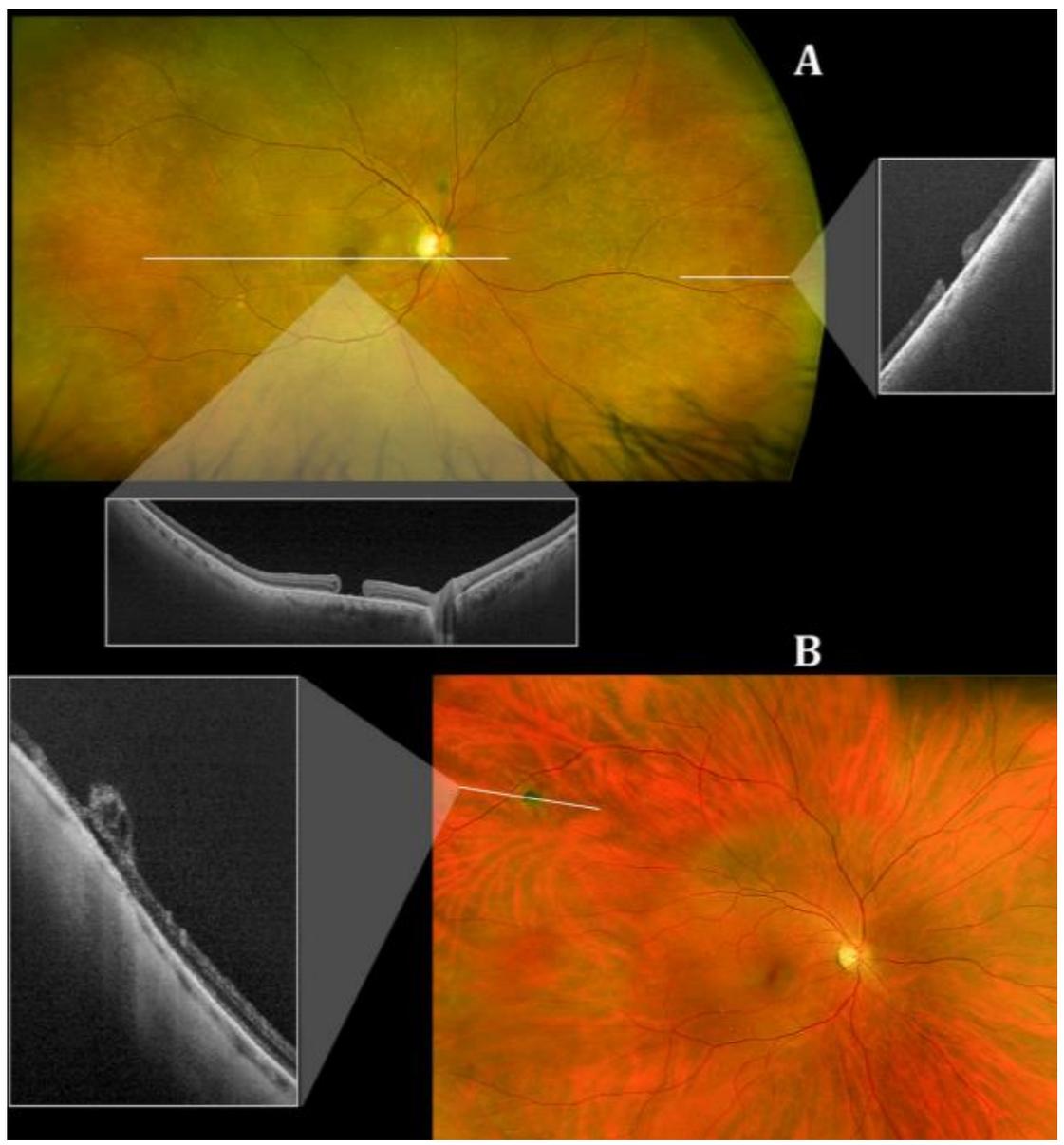
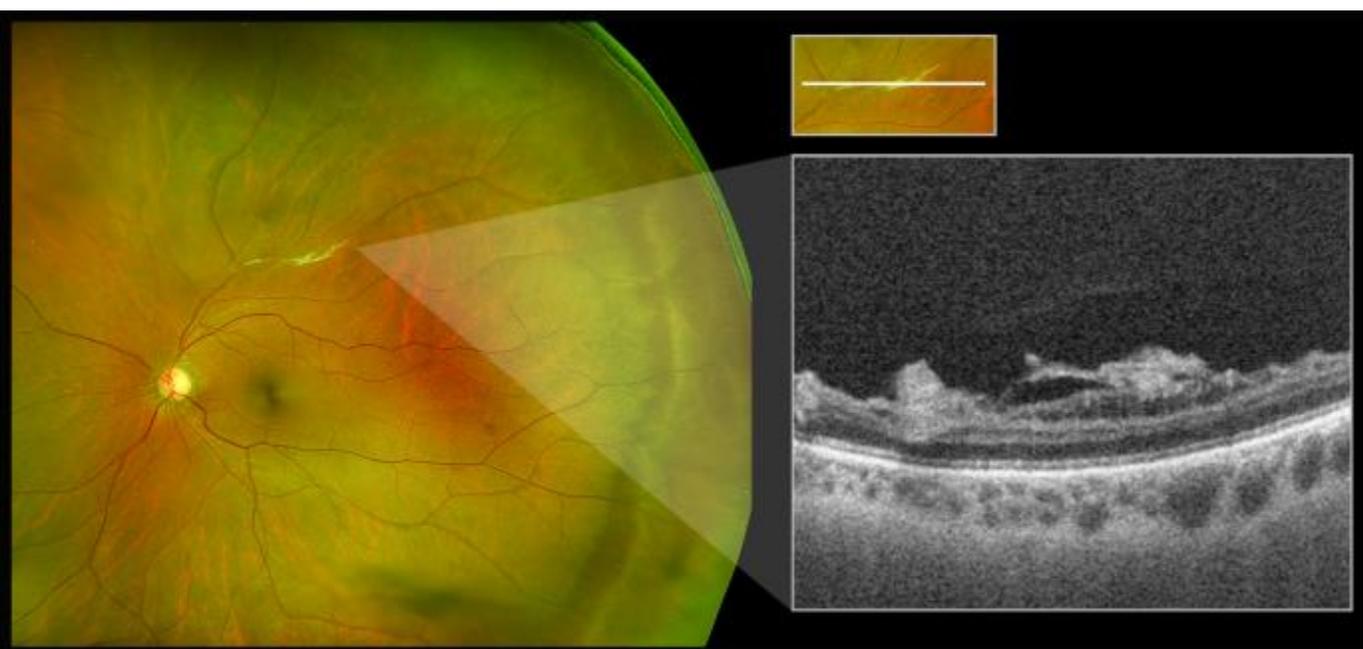
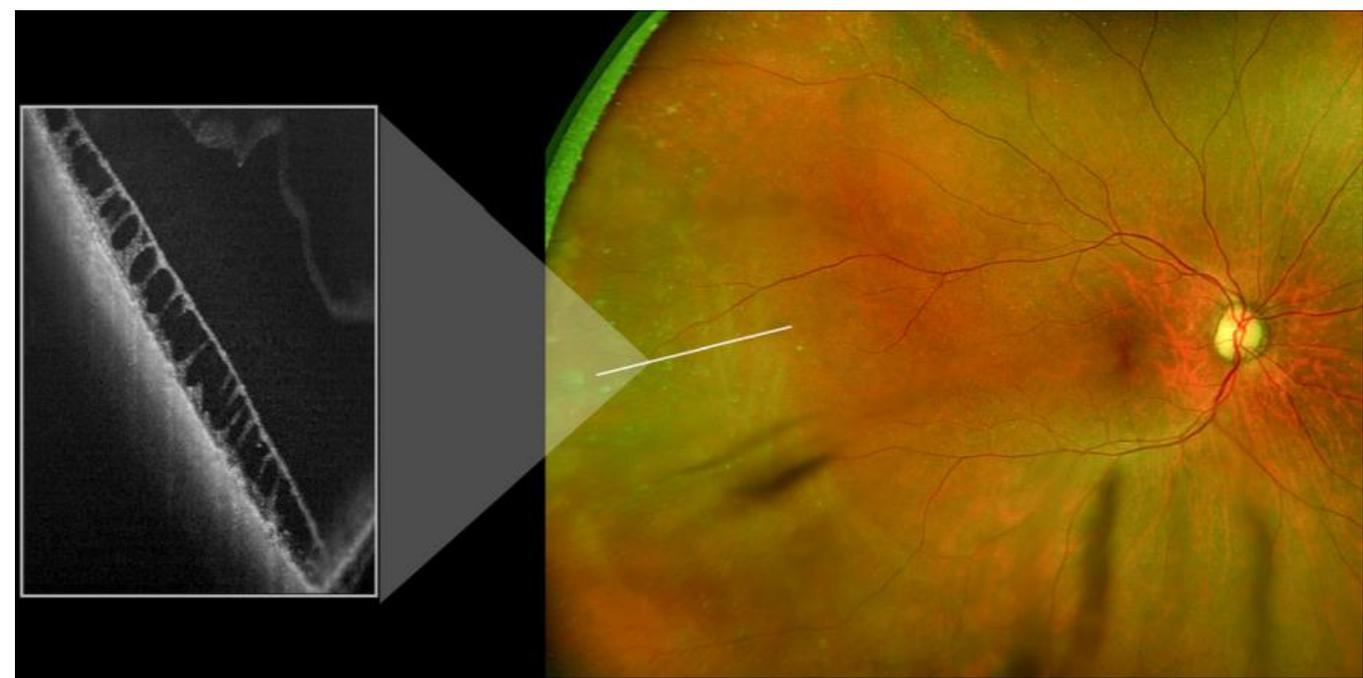
### **Imaging device**

Optical coherence tomography  
system  
Heidelberg Spectralis OCT  
system

### **Description**

This is an SD-OCT montage  
image of a 55 year old  
male representing a wide-  
field OCT spanning 130  
degrees

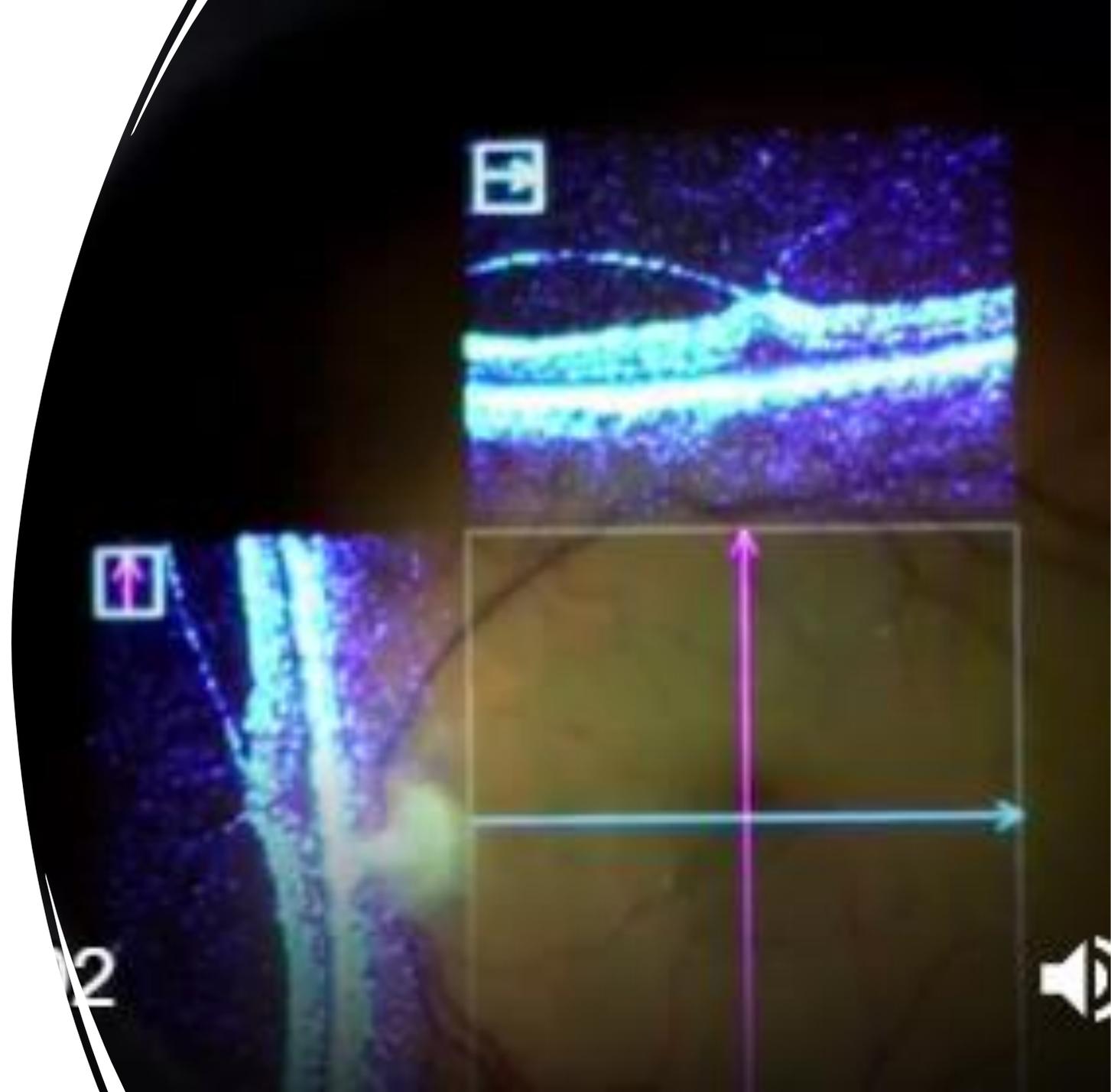
# Ultrawidefield OCT (UWF) OCT



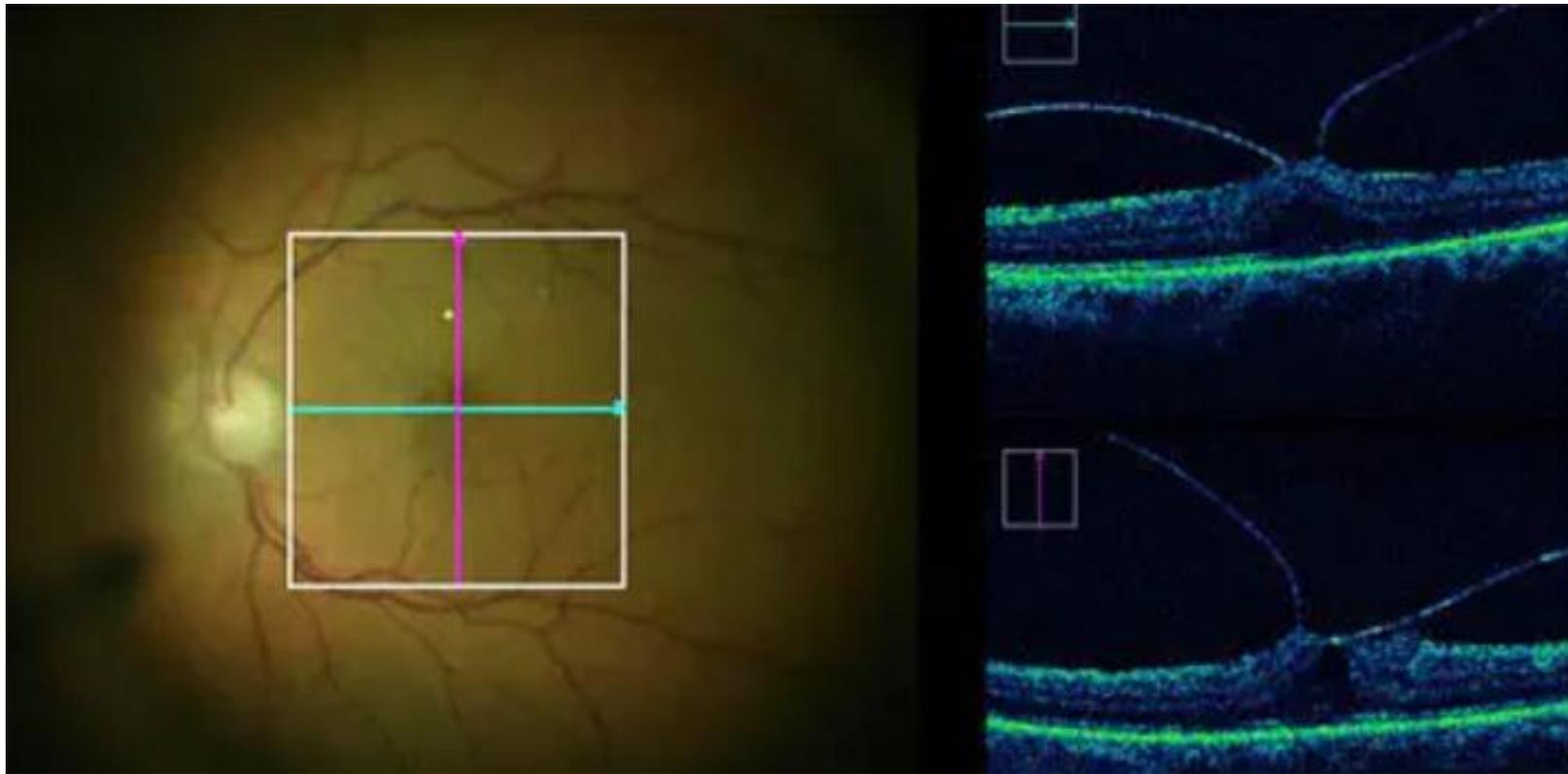
# OCT retinico intraoperatorio(iOCT)

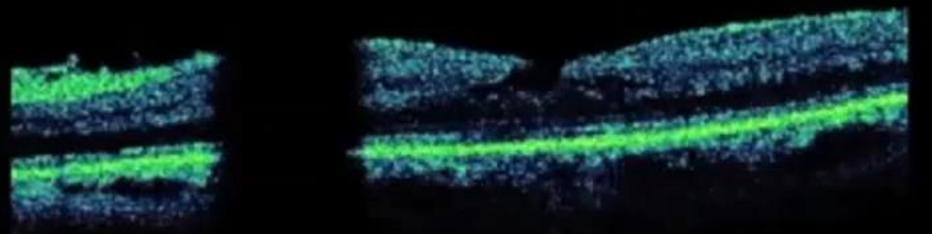
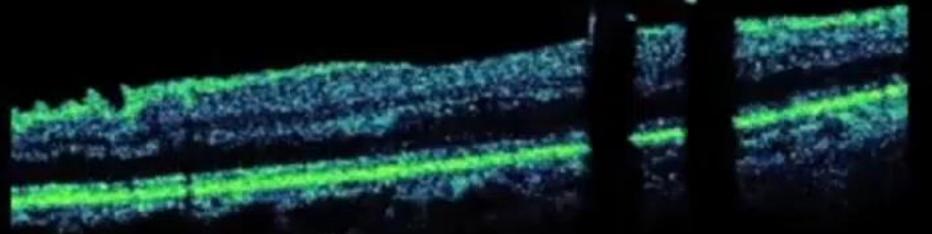
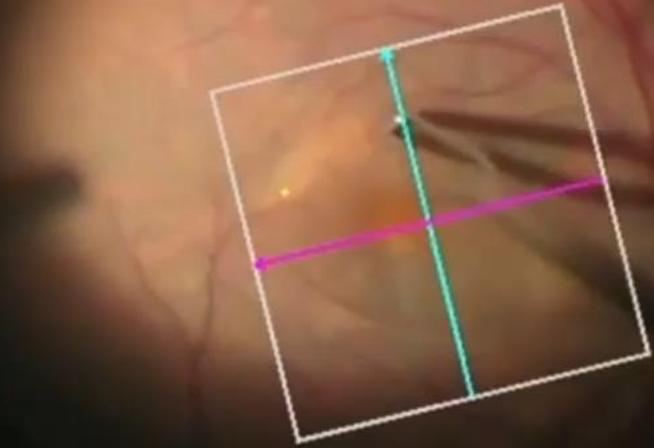
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- Utile supporto nella chirurgia maculare ( foro maculare, peeling ILM e pucker maculare)



- ❑ Monitorare il decorso operatorio durante la chirurgia
- ❑ Valutare outcome chirurgico post op ( foro chiuso?)
- ❑ Studiare le possibili complicanze intraoperatorie ( sanguinamento, rotture retiniche..)





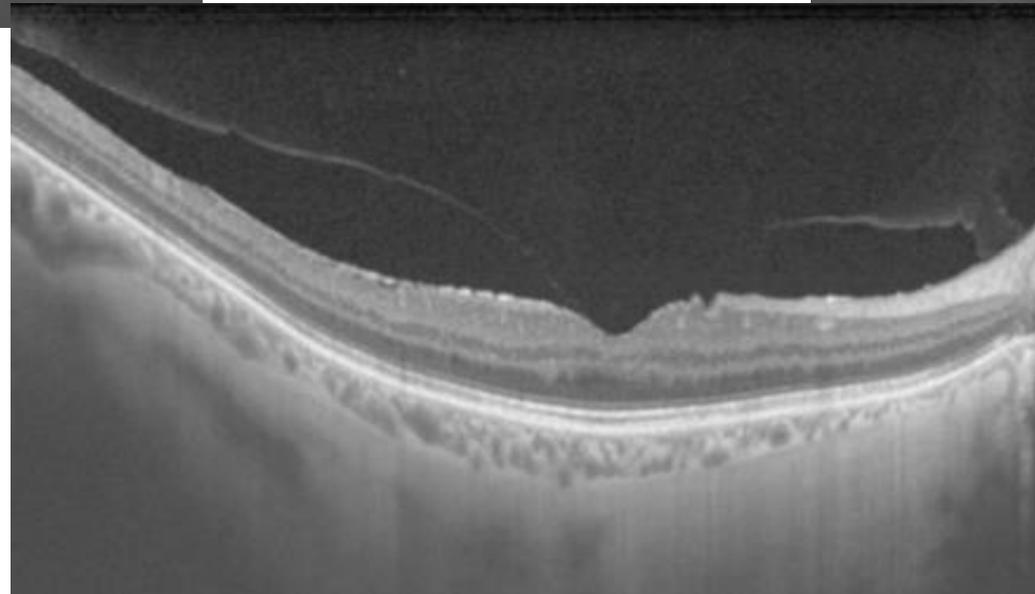
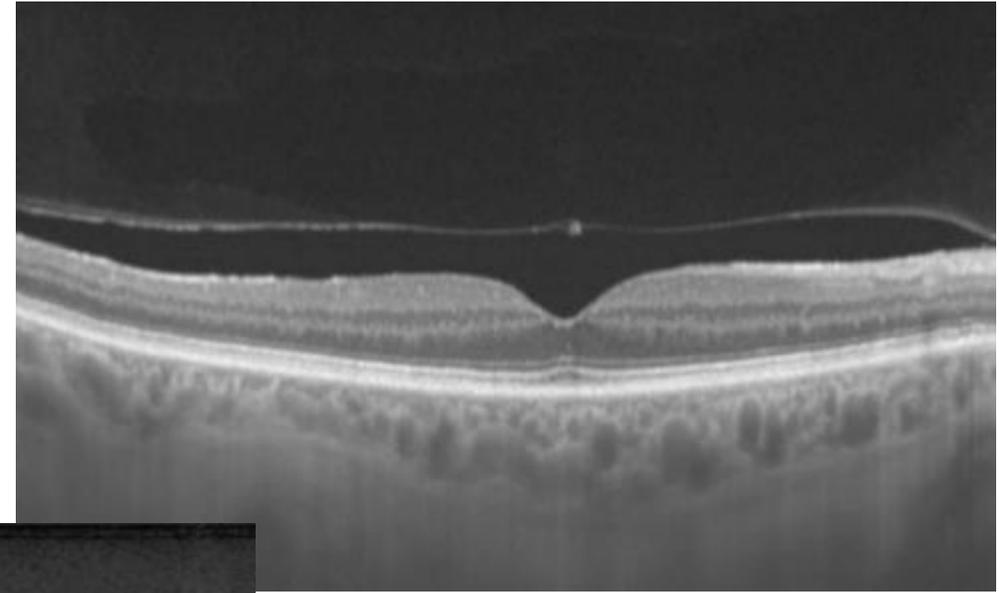
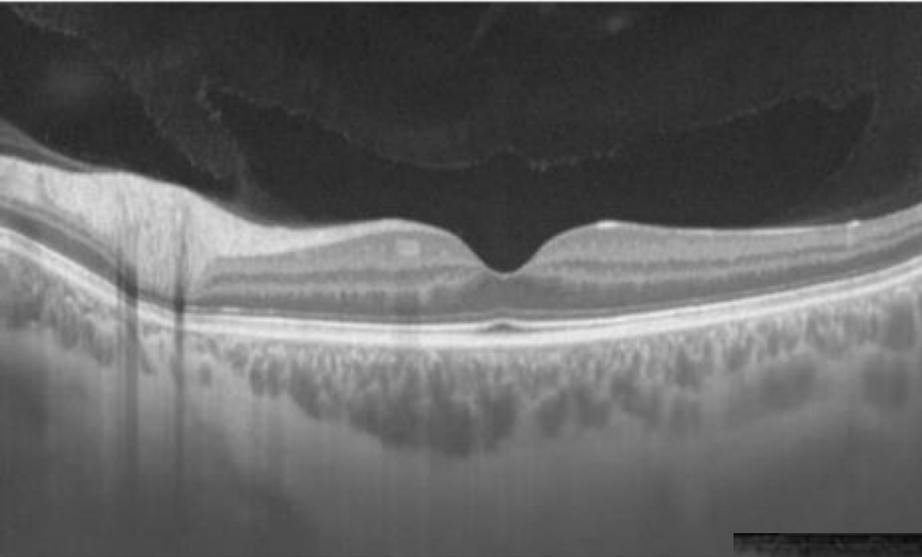
Il futuro degli OCT va verso un ulteriore miglioramento della definizione dei particolari strutturali...

...con possibilità di scansioni coroideali e vitreali AD ALTA RISOLUZIONE

...con la possibilità di un'indagine vascolare non invasiva mediante OCT angiografia (OCTA)

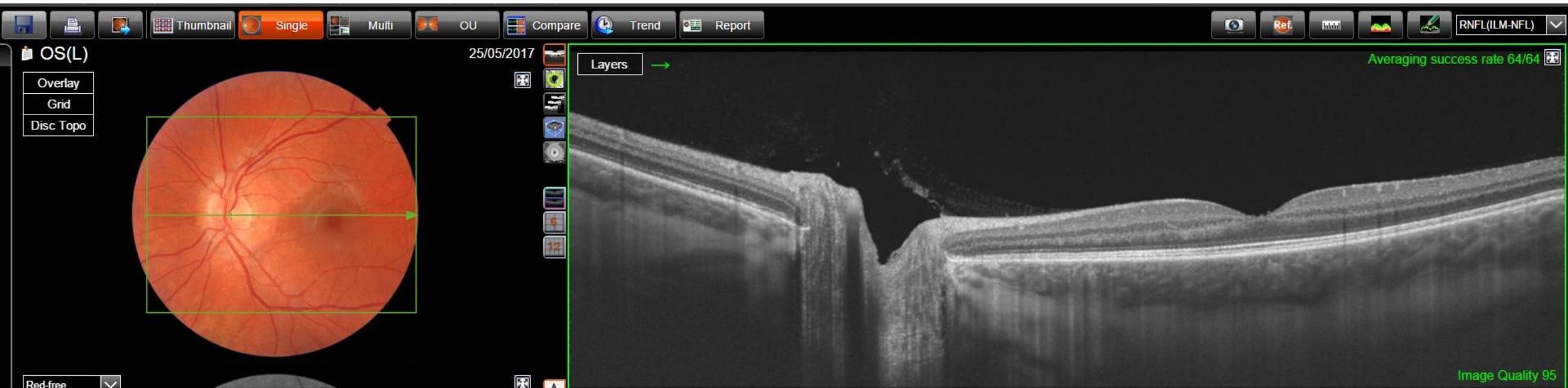
# Vantaggi tecnologia swept source (SS-OCT)

Sensibilità ottimizzata per la visualizzazione di vitreo e coroide ad alta definizione

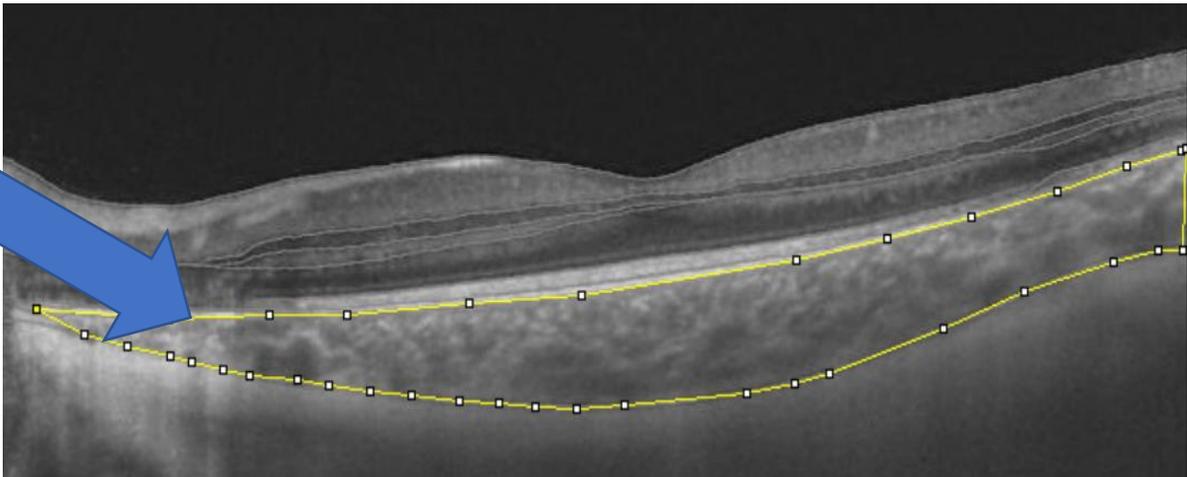


# High definition OCT line 12x9 mm SS-OCT

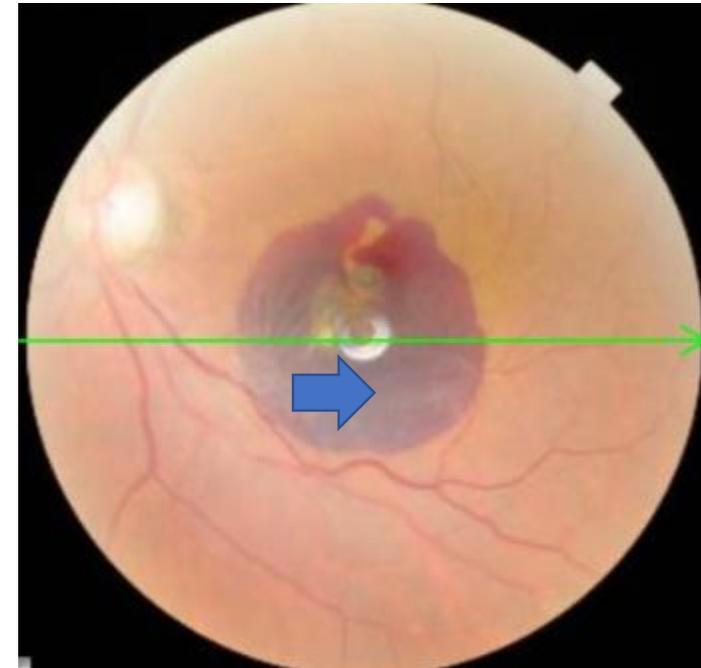
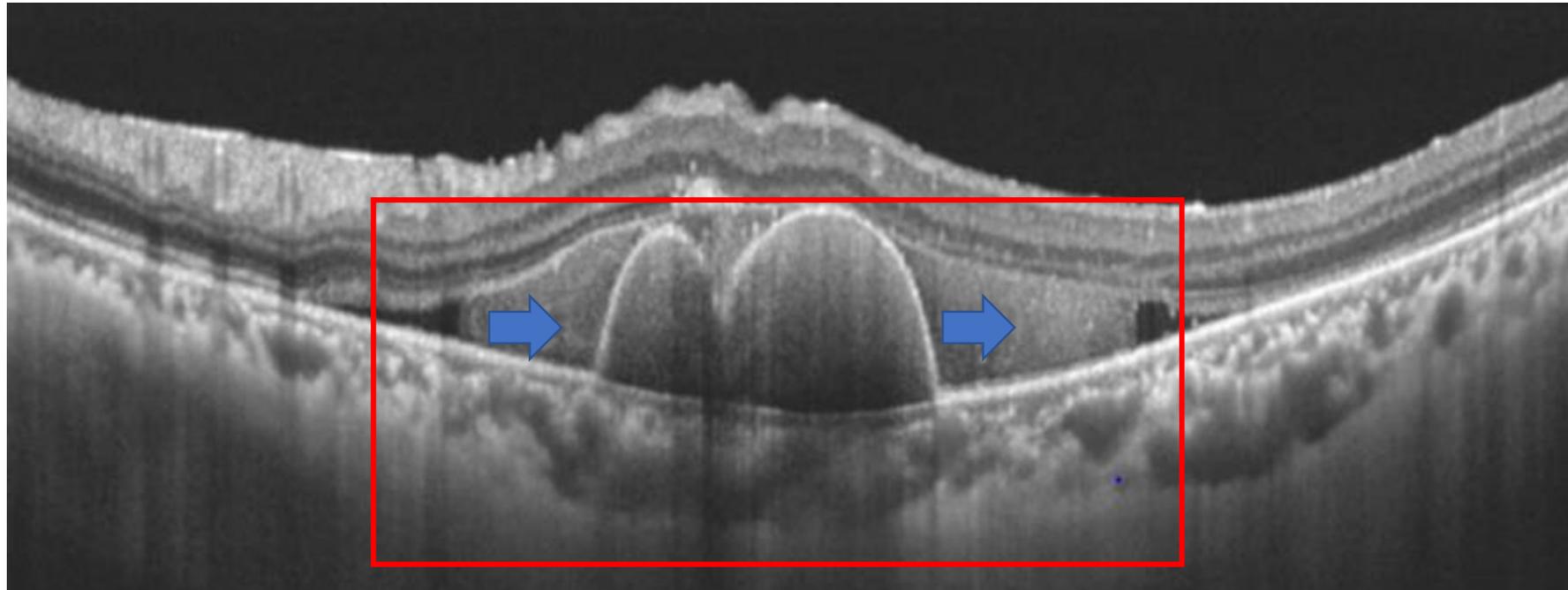
[DRI OCT Triton, OCT swept source](#)



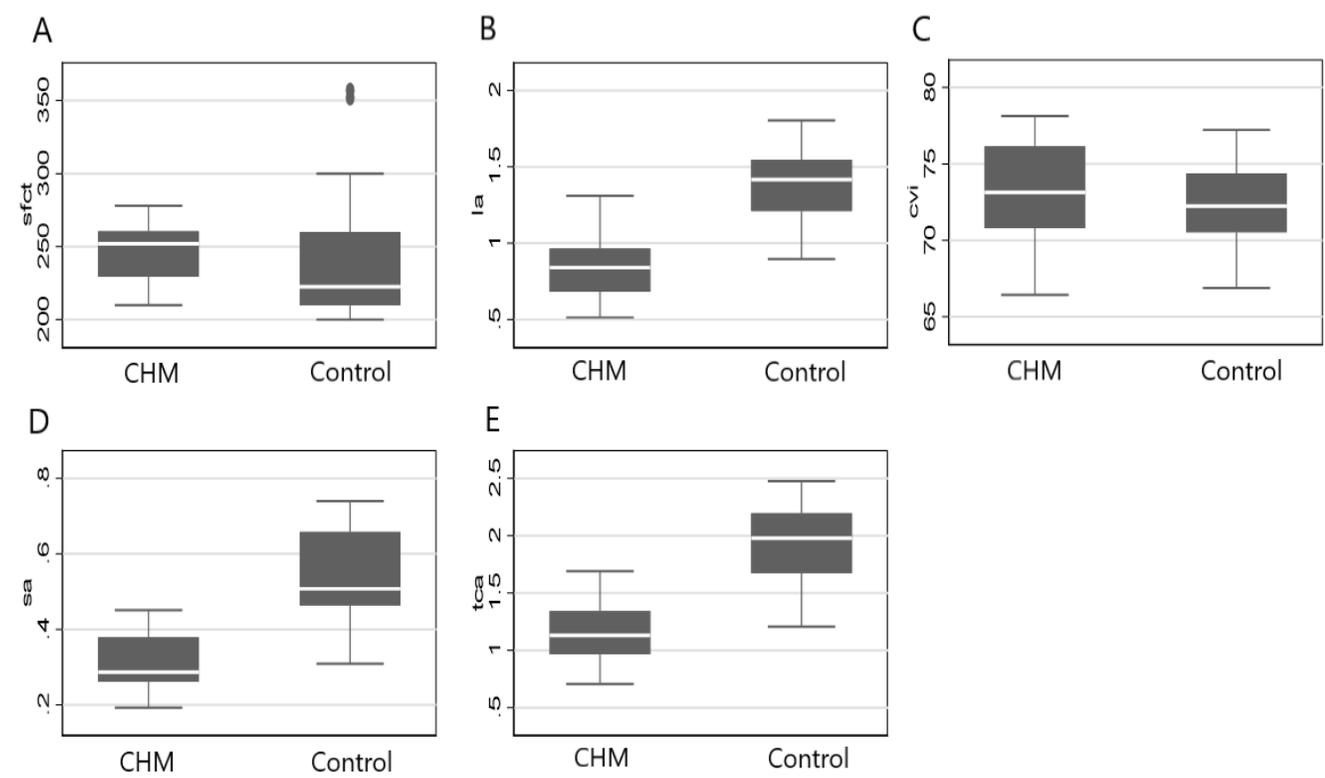
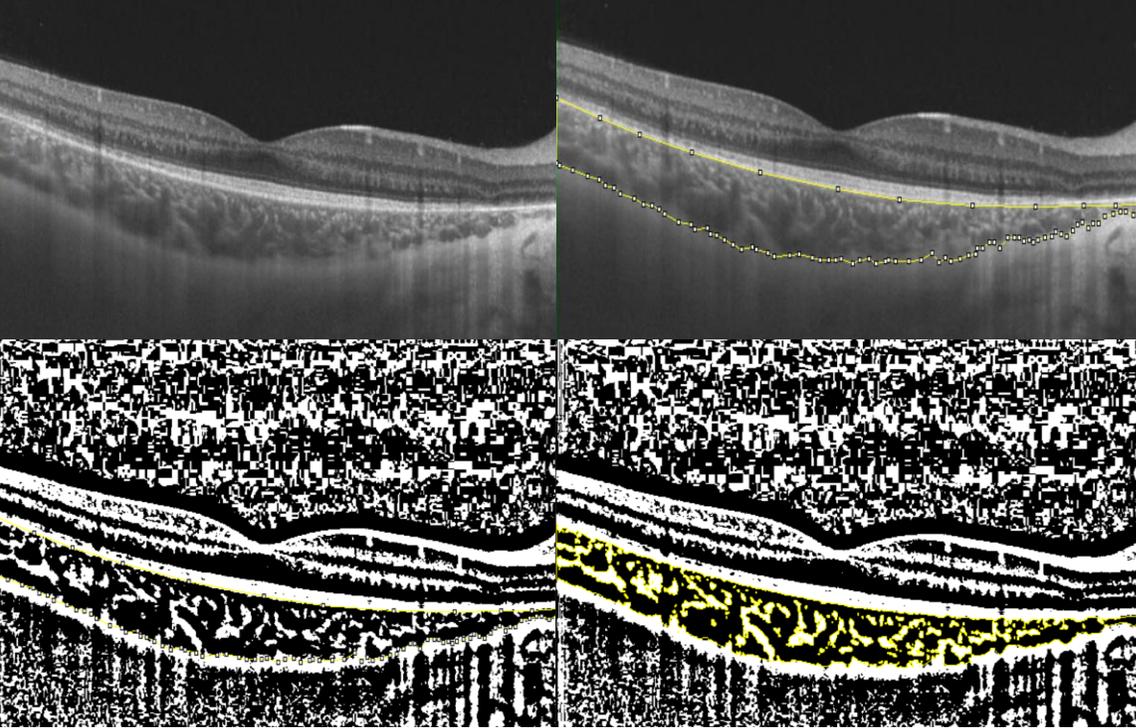
Choroidal mode- Per visualizzare la coroide



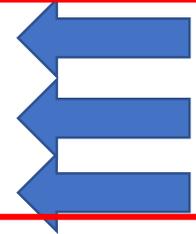
Migliore penetrazione attraverso opacità, cataratta, emorragie maculari

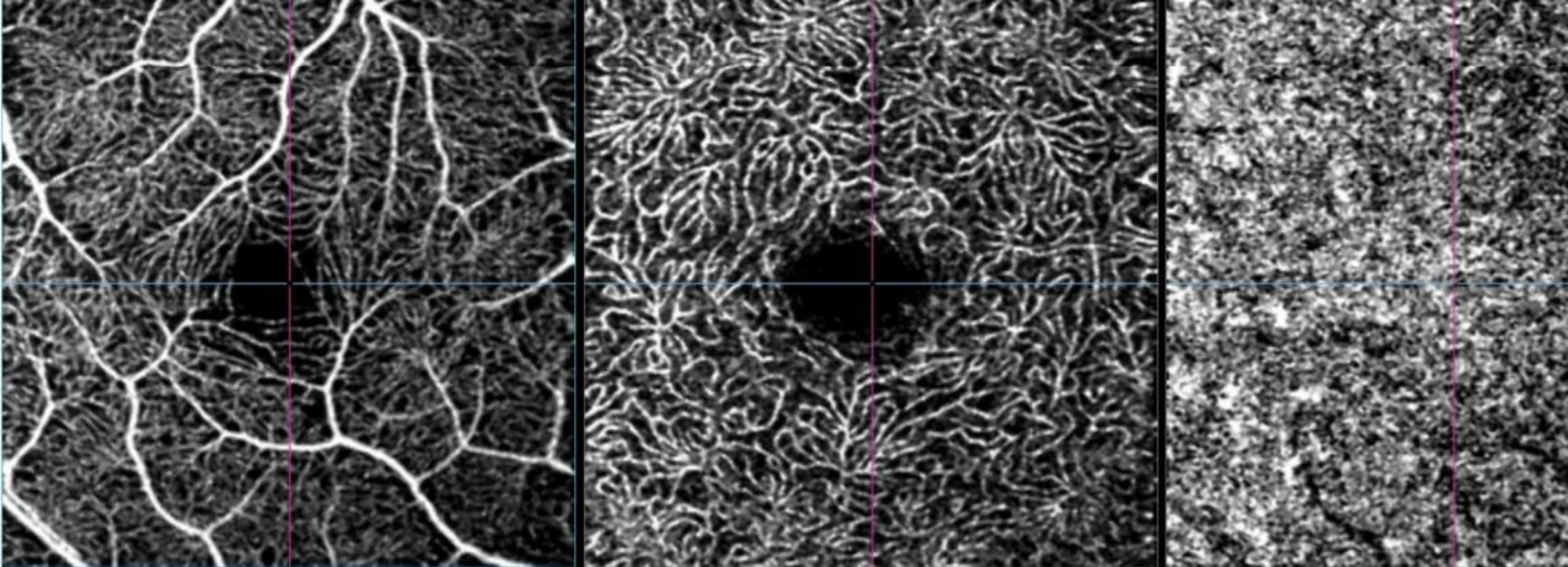


# High-definition SS-OCT 9 mm scan



choroidal parameters (9 mm scan)	CHM patients	Control group	P
SFCT (micron)	247 ± 20,3 (210-278)	246 ± 53,5 (200-357)	0,959
LA (mm <sup>2</sup> )	0,842 ± 0,20 (0,514-1,311)	1,400 ± 0,23 (0,897-1,803)	<0,01
SA (mm <sup>2</sup> )	0,305 ± 0,07 (0,193-0,451)	0,539 ± 0,12 (0,309- 0,740)	<0,01
TCA (mm <sup>2</sup> )	1,148 ± 0,27 (0,707- 1,690)	1,939 ± 0,34 (1,707-2,476)	<0,01
CVI (LA/TCA)	73,21 ± 3,64 (69,56-77,74)	72,35 ± 2,71 (66,87-75,89)	0,535

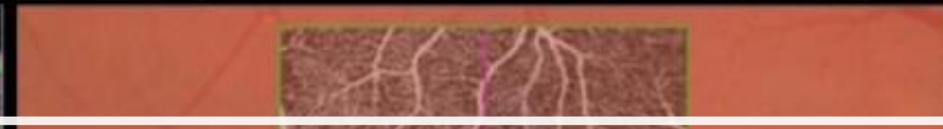




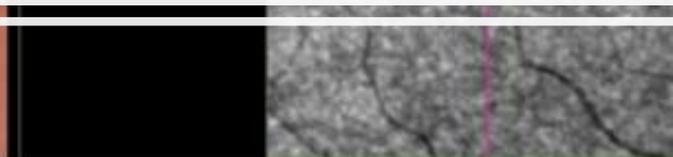
Superficial

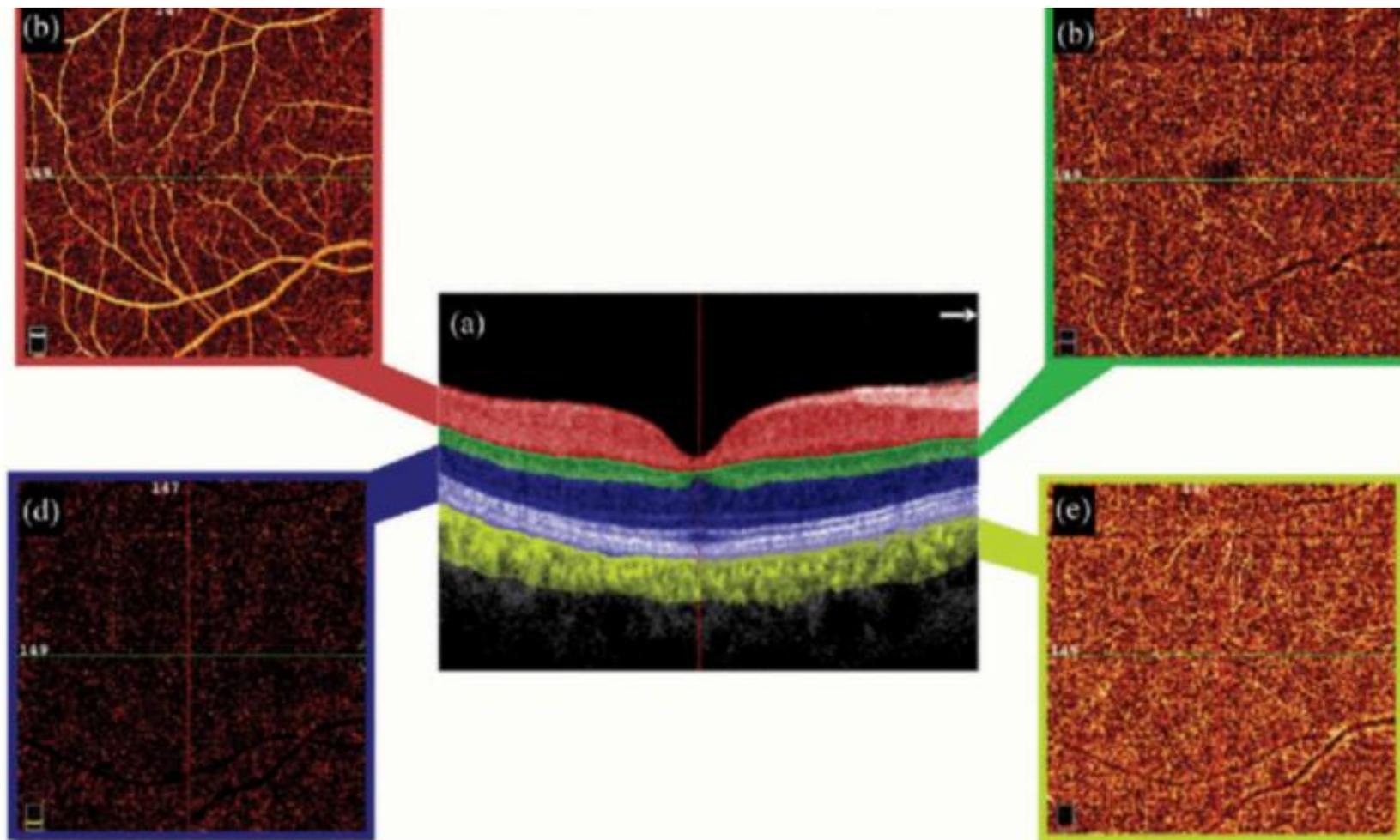
Deep

Choriocapillaris



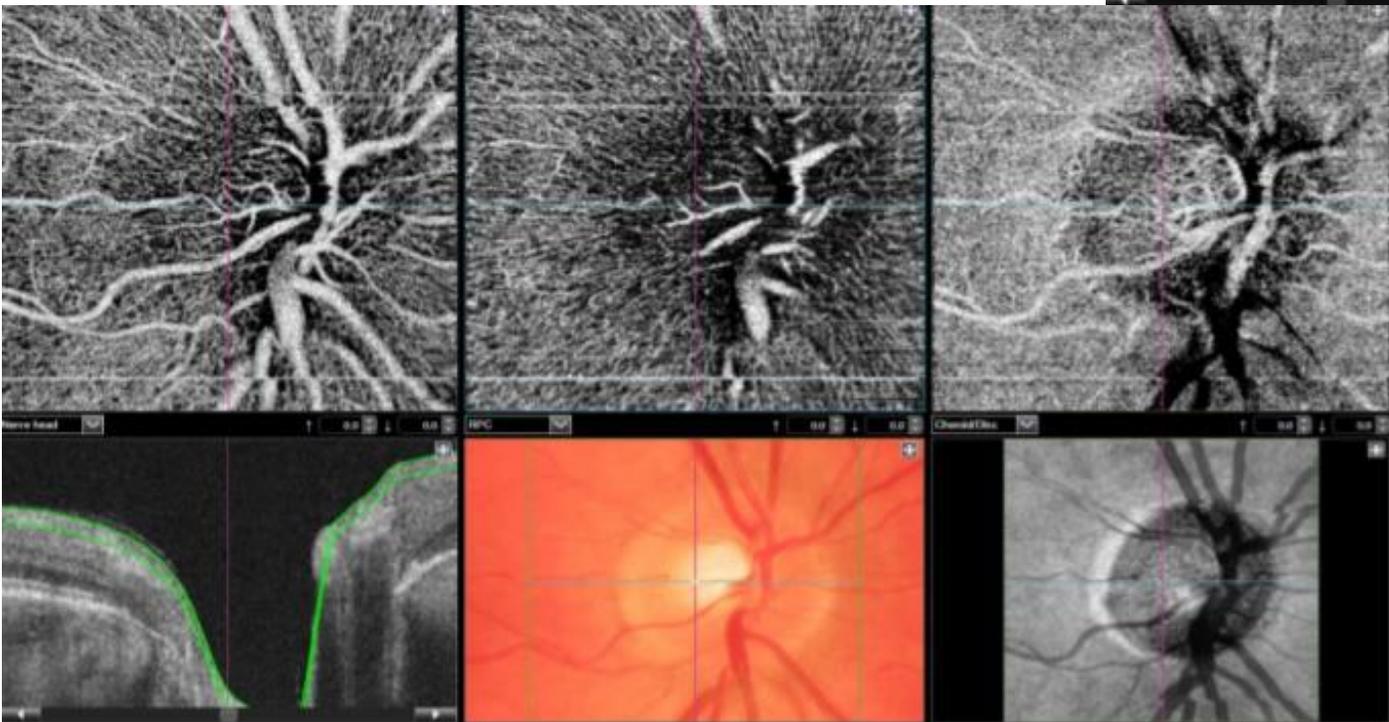
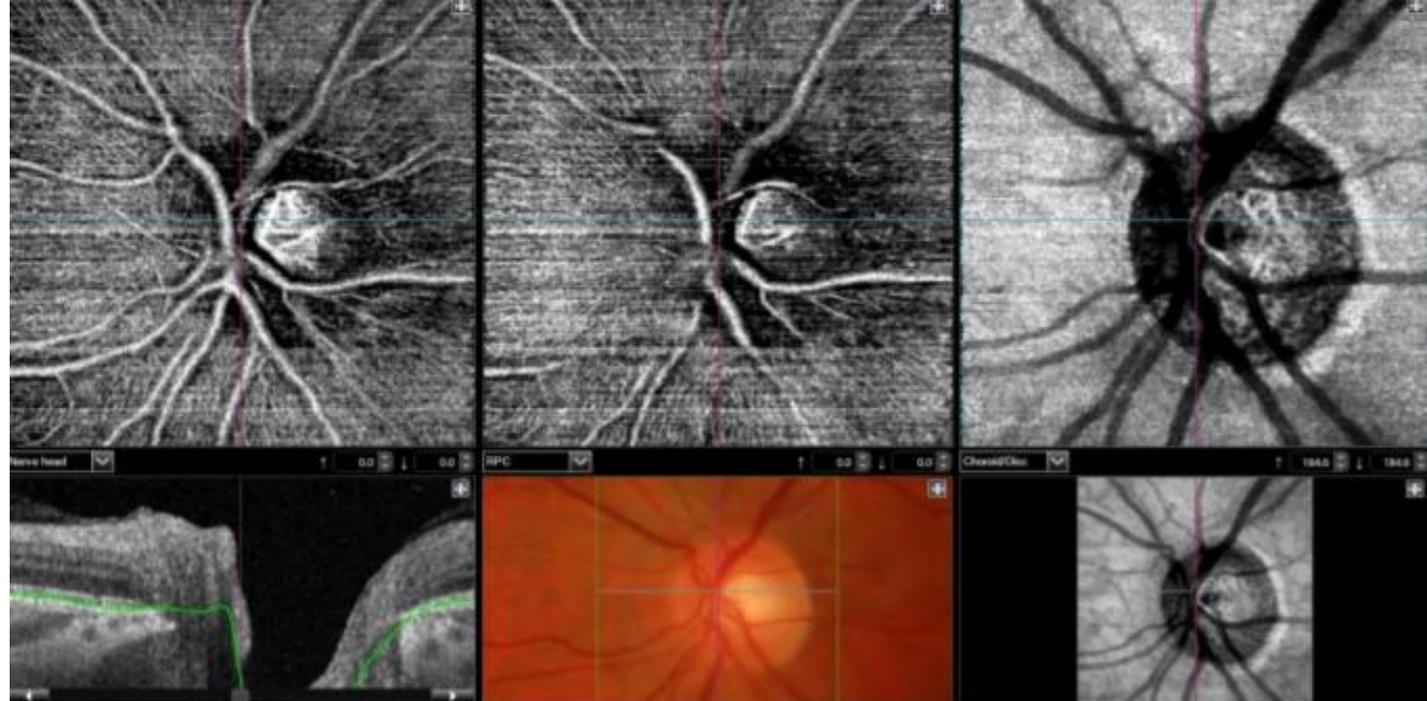
OCT angiografia



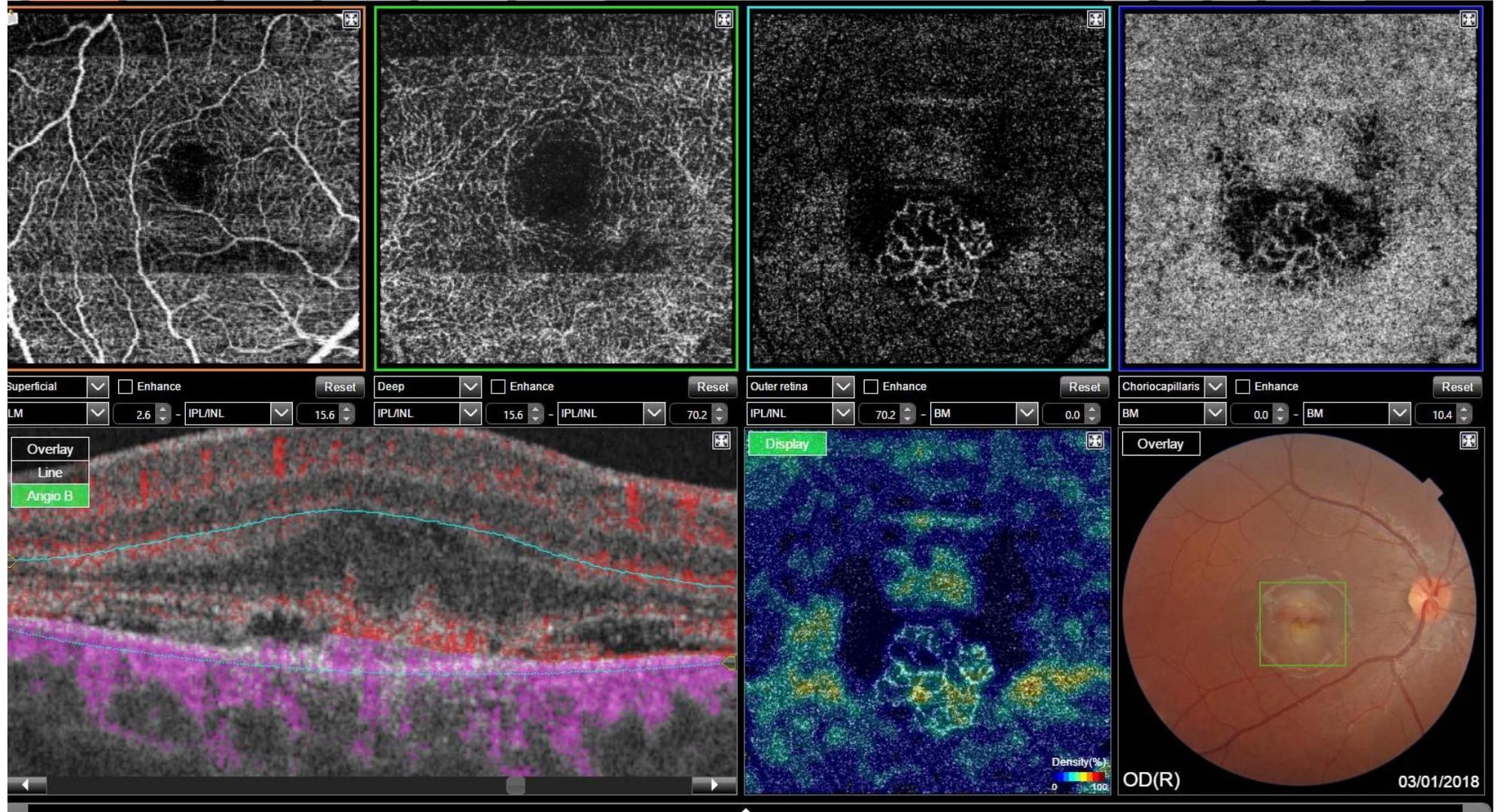


Depth localization of different OCTA segmentation slabs on B-Scan (a). Superficial Vascular plexus (b) correspond to area from internal limiting membrane to outer boundary of the inner plexiform layer. Deep capillary plexus (c) corresponds to an area between outer boundaries of the inner plexiform layer to outer boundary of the outer plexiform layer. Outer Retinal slab (d) is avascular area from outer nuclear layer to RPE, and Choriocapillaris segmentation (e) include Bruch's membrane and up to 20  $\mu\text{m}$  below). Shadowing of larger vessels from superficial vascular plexus is evident on all three outer segmentations (c, d and e)

# PAPILLA

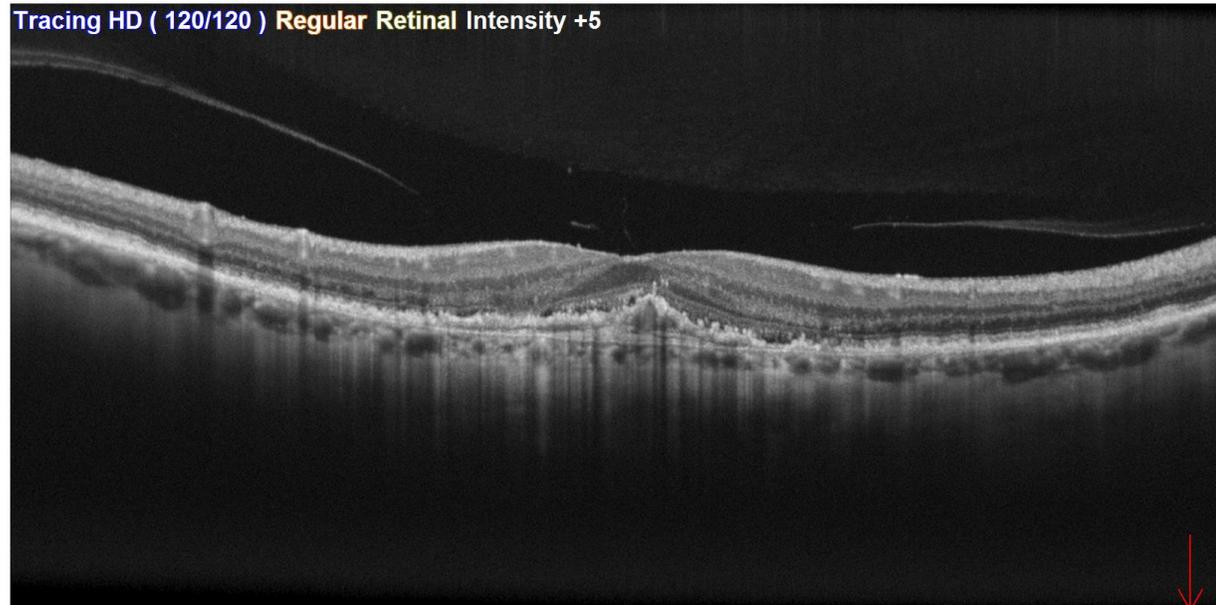
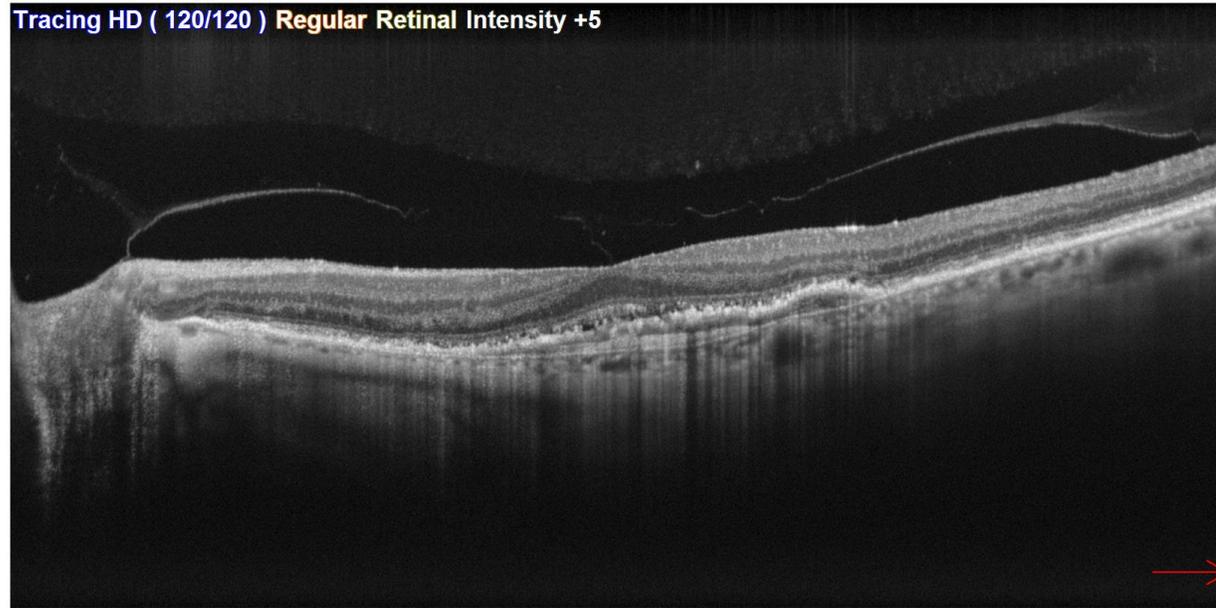


# MACULA

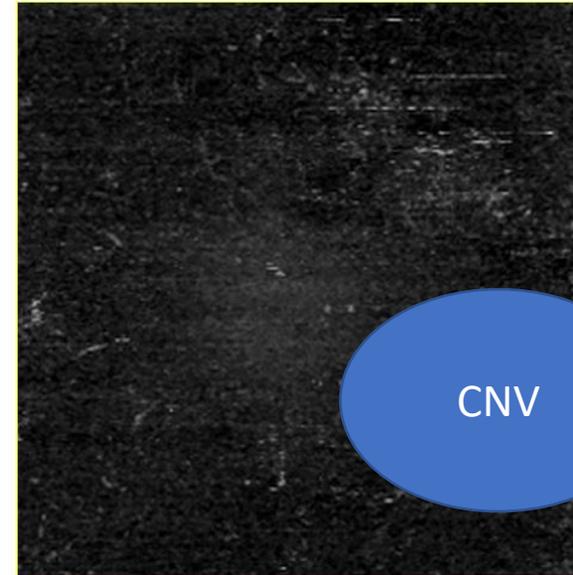


Utilizzata per caratterizzare e studiare in maniera non invasiva la vascolarizzazione retinica e coroideale di alcune malattie della retina

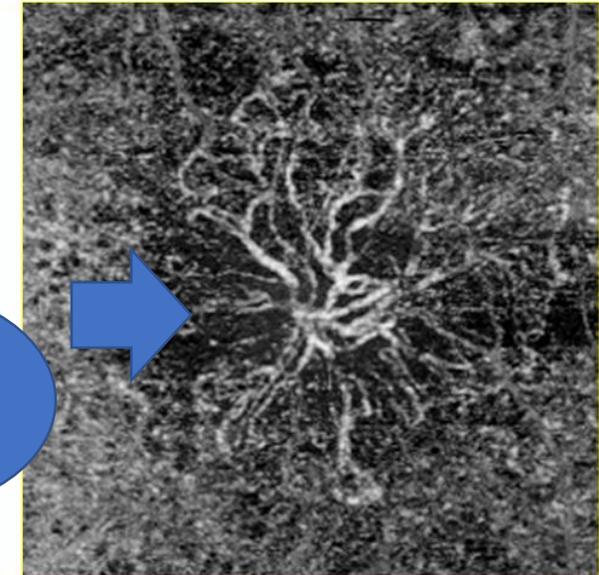
# Degenerazione maculare senile



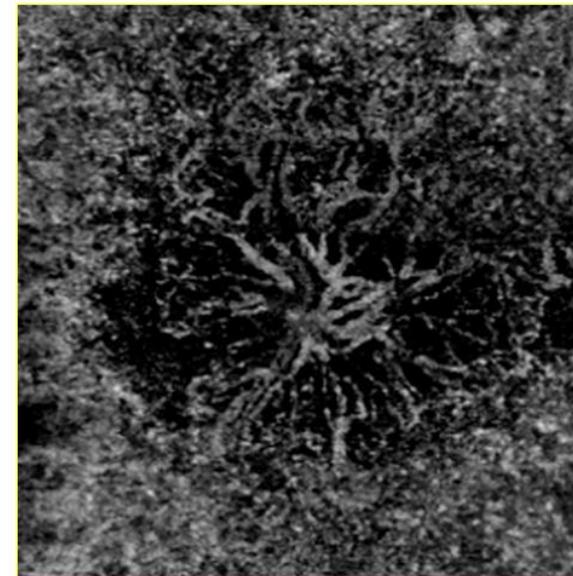
Outer retina



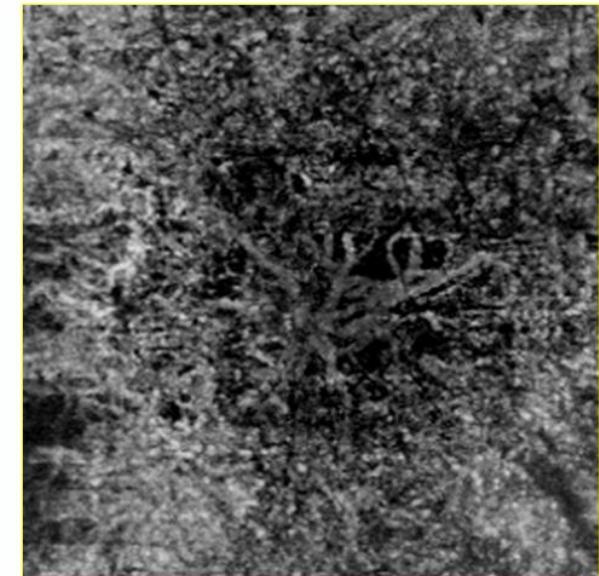
ORCC



Choriocapillaris

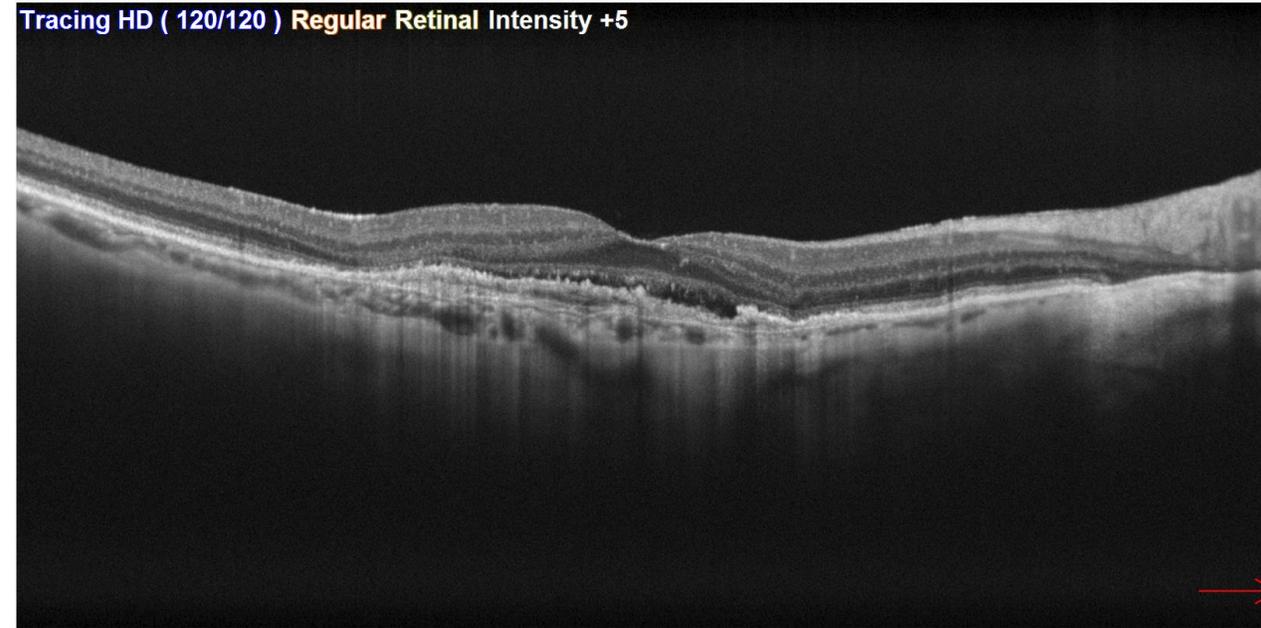


Choroid



h[1024] ) Eye:R

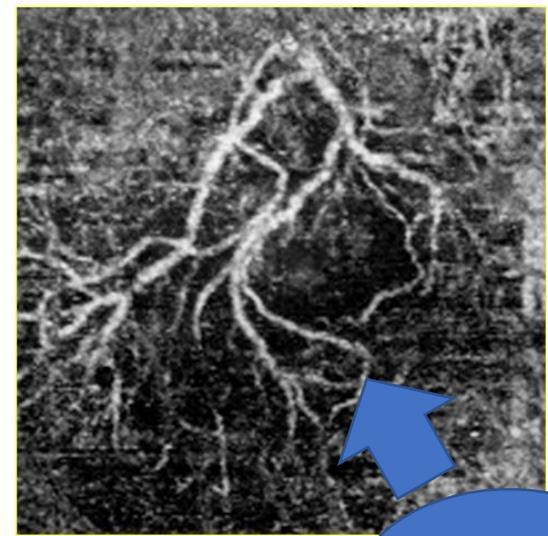
SLO Focus [D] Axial [mm]  
Wide -0.25 Gullstrand



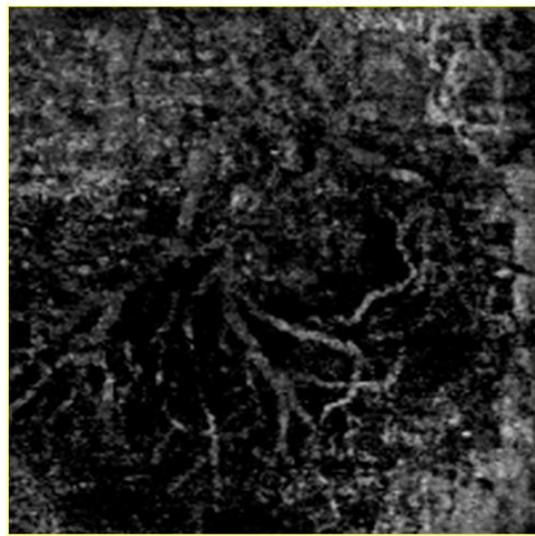
Outer retina



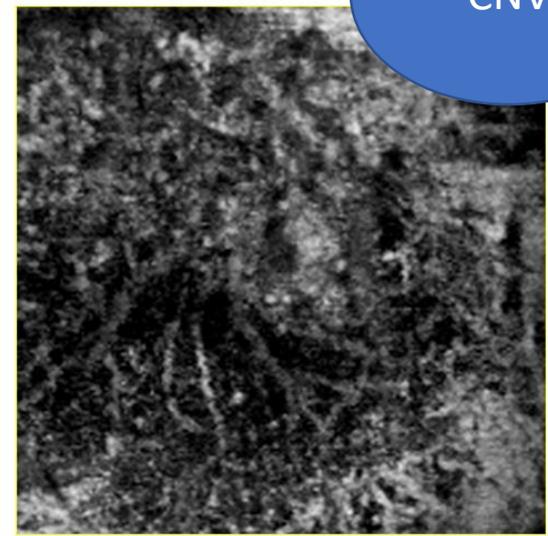
ORCC



Choriocapillaris



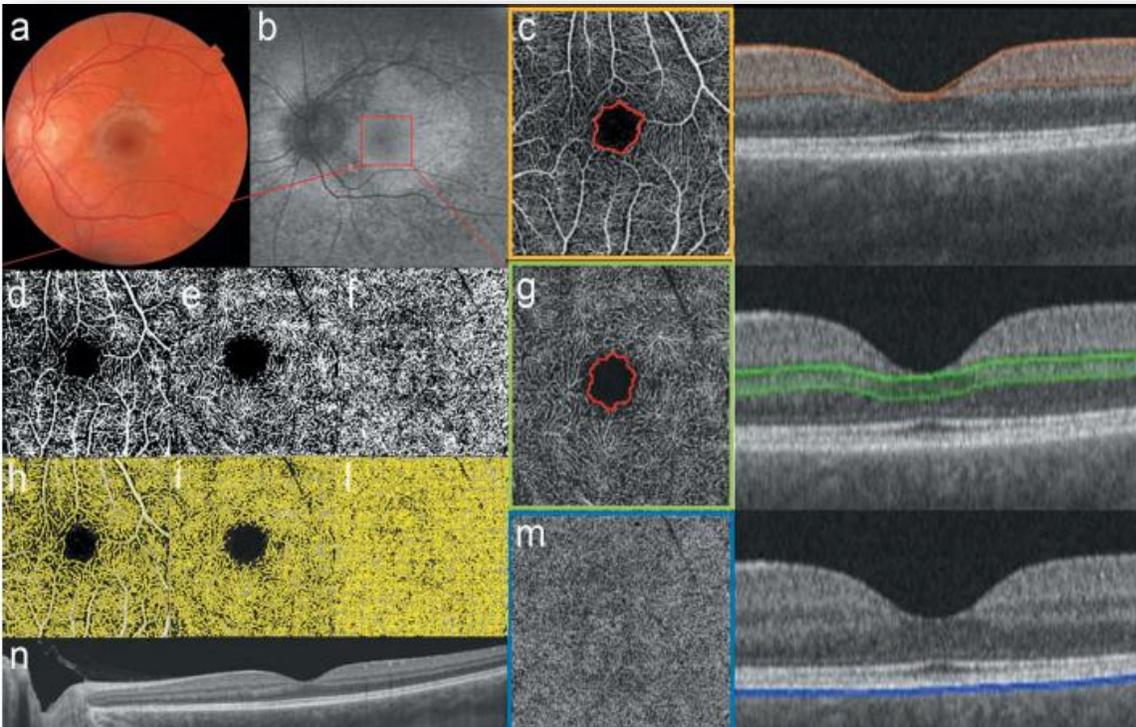
Choroid



CNV

# Coroideremia

- BCVA 20/20 all
- 5/7 CHM genetically characterized
- All phakic ,
- All CHM patients were characterized by a preserved 3x3 central macular area



## QUANTITATIVE ANALYSIS OF THE MACULAR VASCULAR DENSITY,FAZ AND STRUCTURAL PARAMETERS BETWEEN CHM PATIENTS AND CONTROLS

	PATIENTS	CONTROLS	P VALUE
<b>SCP</b>			
FAZ( $\mu\text{m}^2$ )	198,99 $\pm$ 83,68	288,708 $\pm$ 45,05	<b>P&lt;0,001</b>
VD (%)	76.239 $\pm$ 4,56	105.322 $\pm$ 4,10	<b>P&lt;0,001</b>
<b>DCP</b>			
FAZ( $\mu\text{m}^2$ )	243,98 $\pm$ 86,11	320,16 $\pm$ 48,21	<b>P&lt;0,001</b>
VD(%)	73.059 $\pm$ 3,30	104.740 $\pm$ 4,26	<b>P&lt;0,001</b>
<b>CC (VD) (%)</b>	51.622 $\pm$ 11.85	74.530 $\pm$ 2.565	<b>P&lt;0,01</b>
<b>CRT(<math>\mu\text{m}</math>)</b>	245 $\pm$ 21,2	212 $\pm$ 8,01	<b>P&lt;0,01</b>
<b>CCT (<math>\mu\text{m}</math>)</b>	234 $\pm$ 53,7	259 $\pm$ 52,5	P=0,342

- ***OCT-A examinations revealed early vascular abnormalities in both inner retinal layers and choriocapillaris.***
- ***A reduced vascular flow was also detectable in the presence of a preserved macular RPE at the color fundus, FA, and OCT examinations.***

Optical Coherence Tomography Angiography (OCT-A) in young choroideremia (CHM) patients.

Murro V, Mucciolo DP, Giorgio D, Sodi A, Passerini I, Virgili G, Rizzo S.

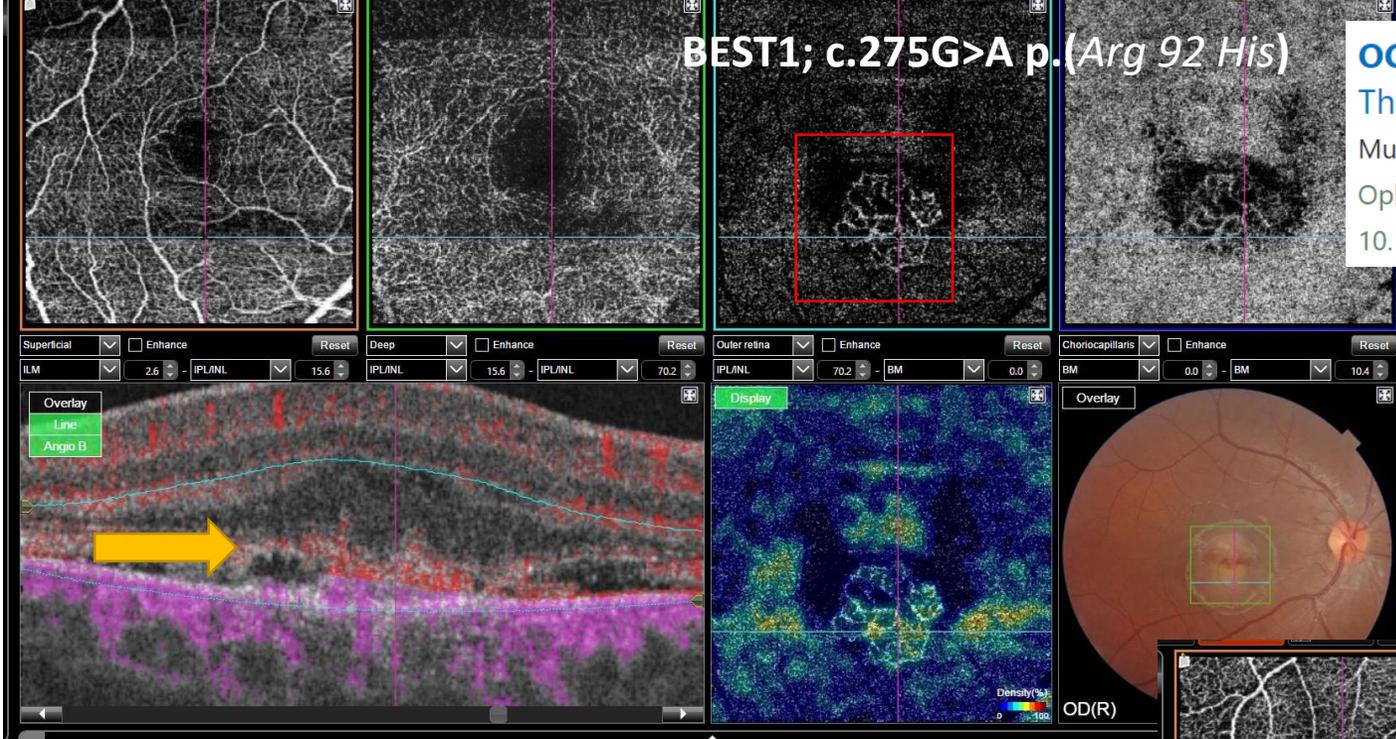
Ophthalmic Genet. 2019 Jun;40(3):201-206. doi: 10.1080/13816810.2019.1611880. Epub 2019 May 28.

**BEST1; c.275G>A p.(Arg 92 His)**

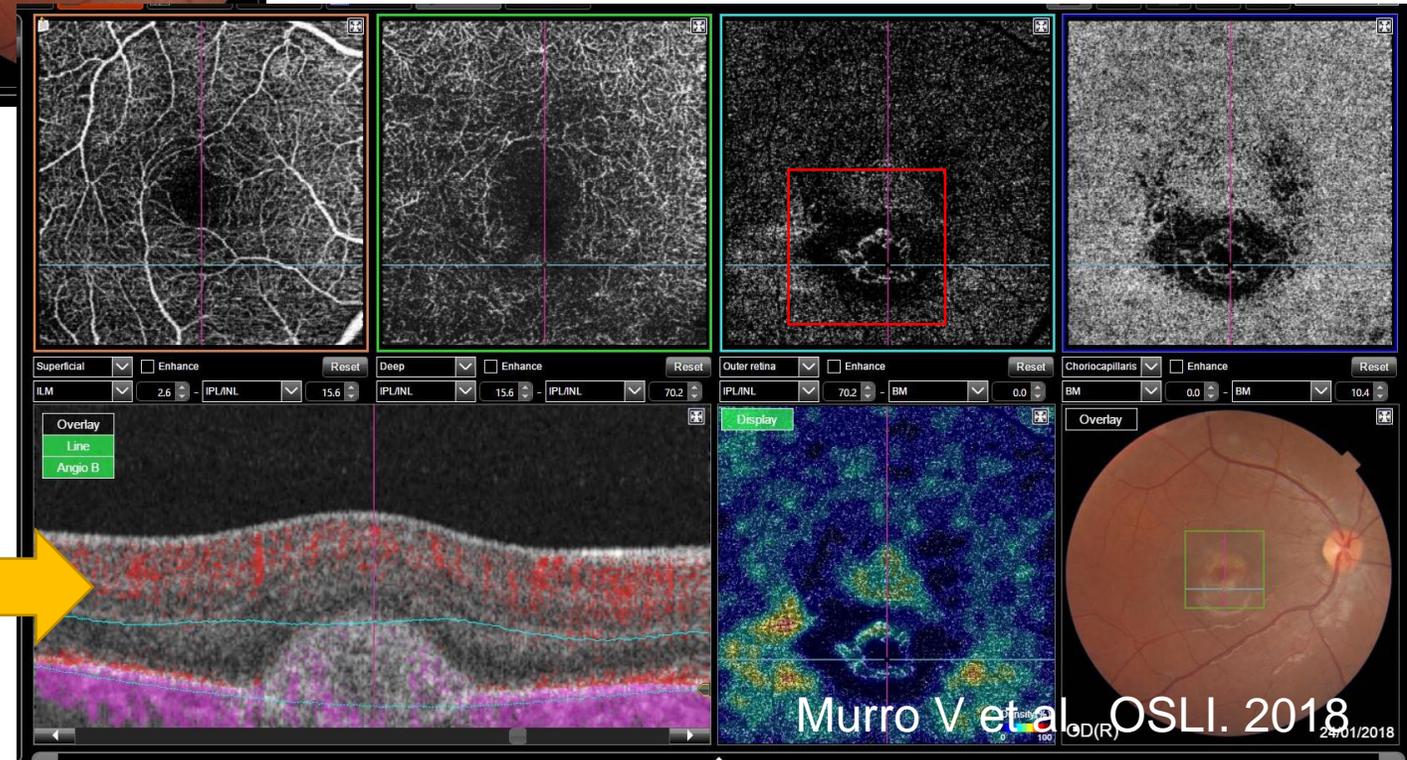
**OCTA Imaging of Choroidal Neovascularization Treated Using Photodynamic Therapy in a Young Patient With Best Macular Dystrophy.**

Murro V, Mucciolo DP, Giorgio D, Sodi A, Passerini I, Virgili G, Rizzo S.

Ophthalmic Surg Lasers Imaging Retina. 2018 Dec 1;49(12):969-973. doi: 10.3928/23258160-20181201-10.

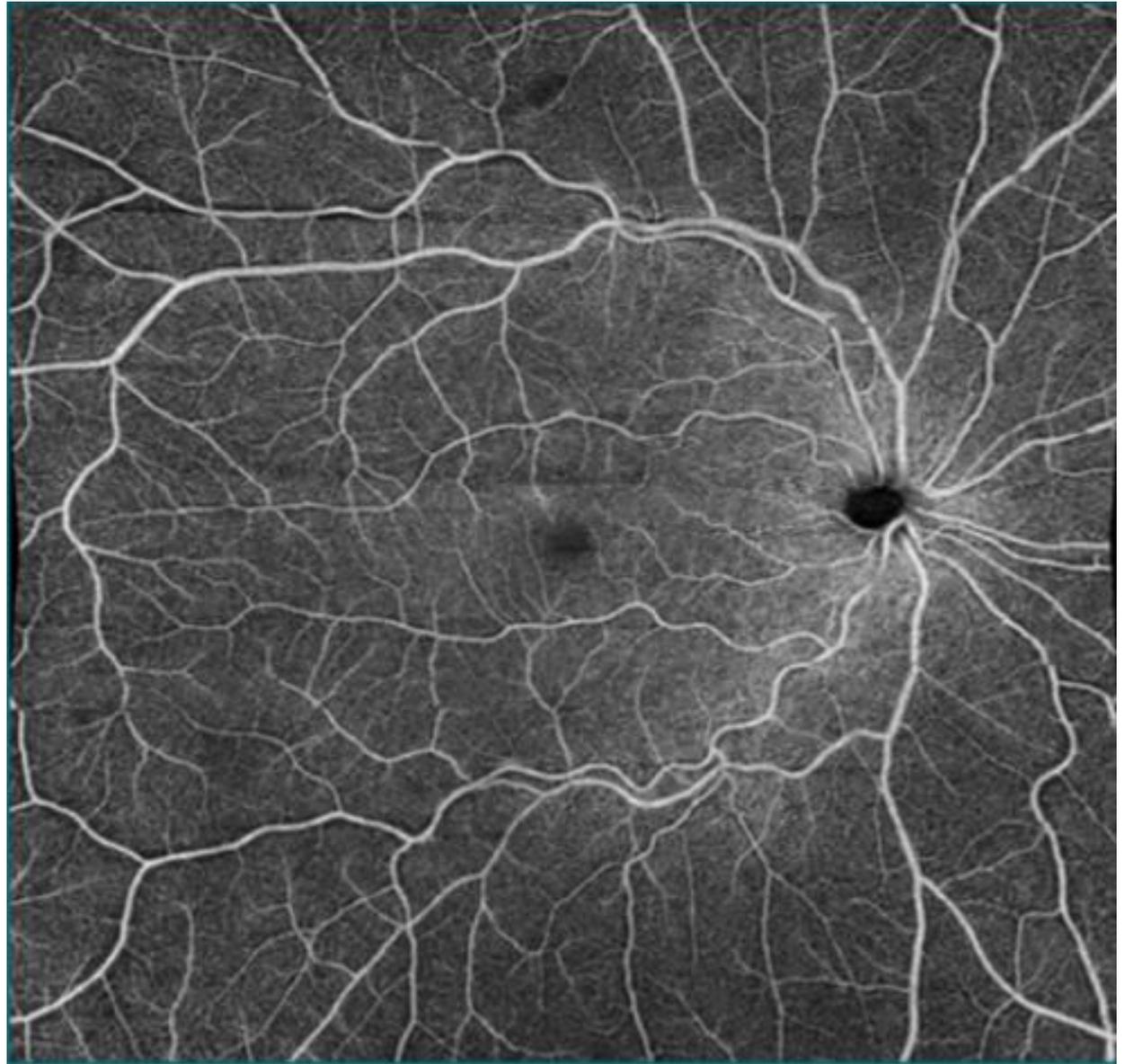


**3 month post PDT**



Evoluzione....

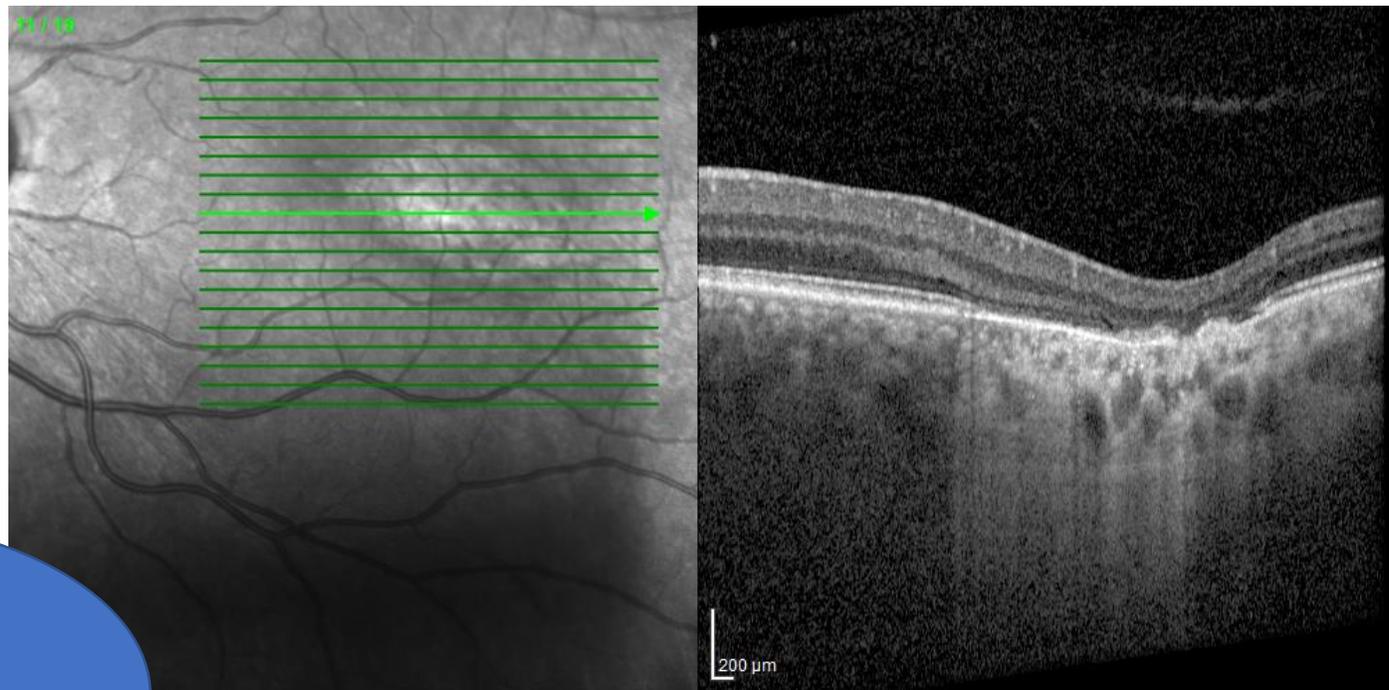
Studiare l'intera  
vascolarizzazione  
retinica



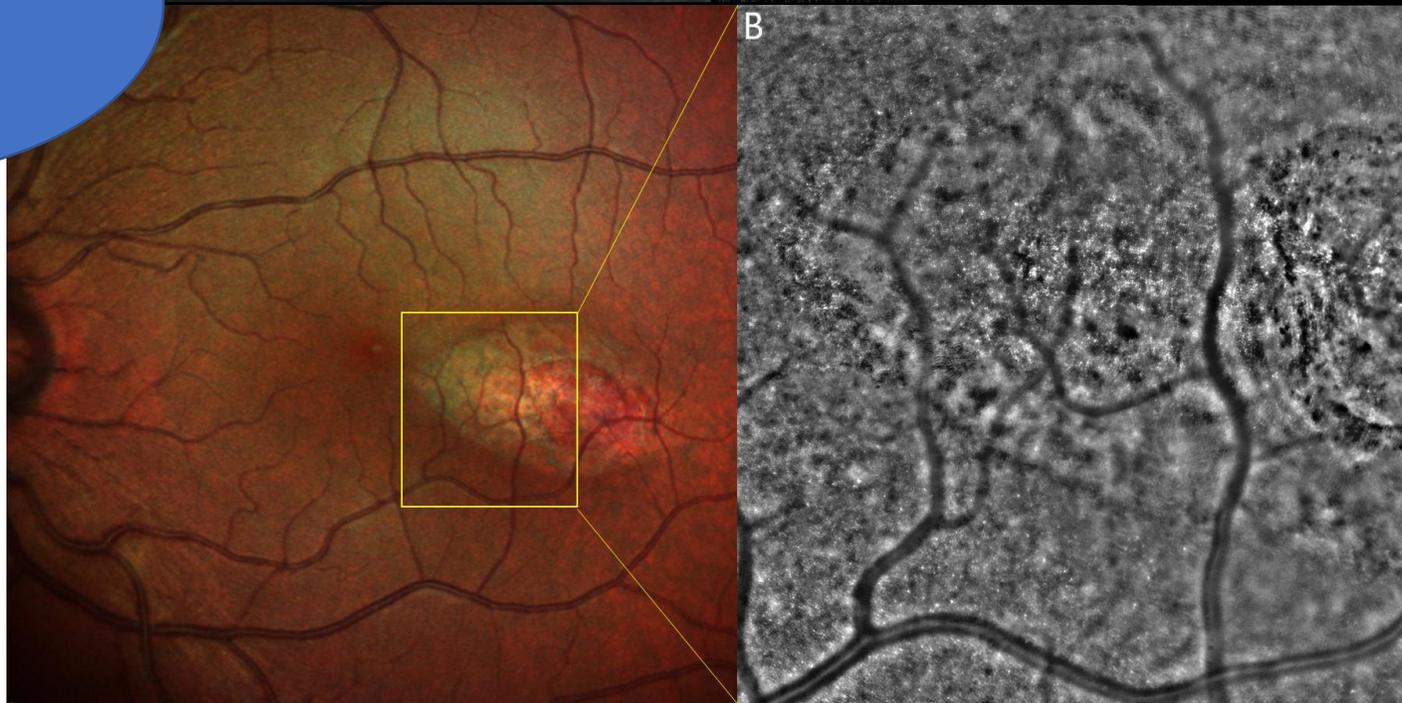
Montage 5 images 8x8mm con AngioPlex Cirrus Zeiss 5000

Per concludere

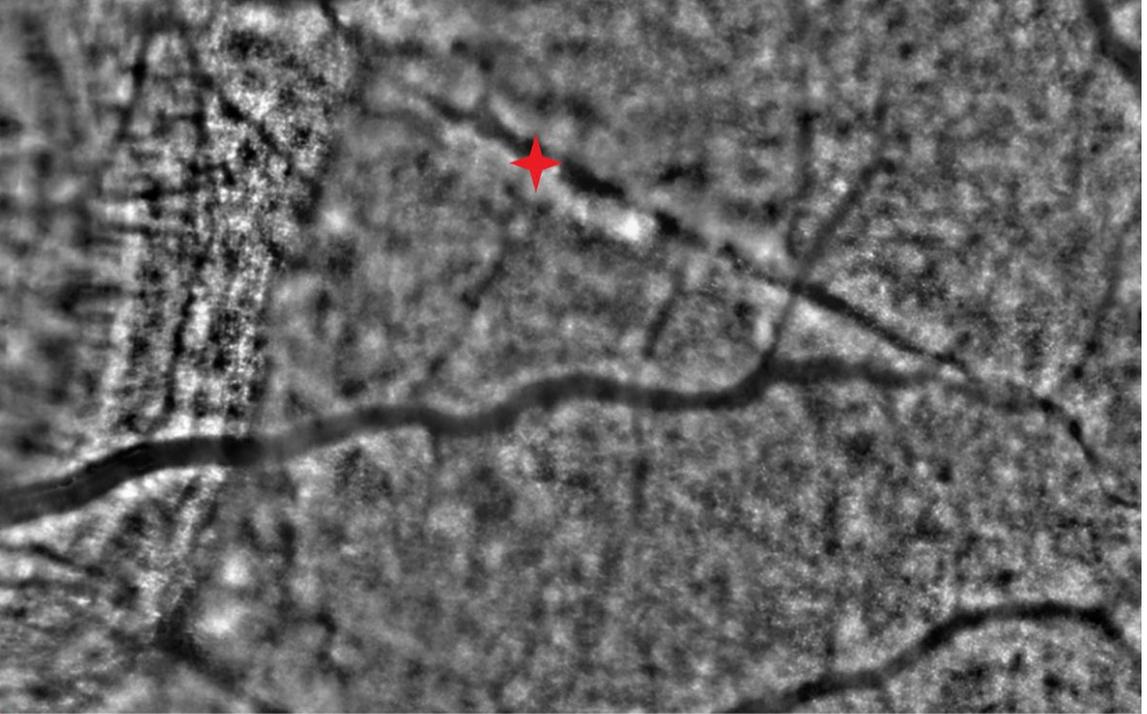
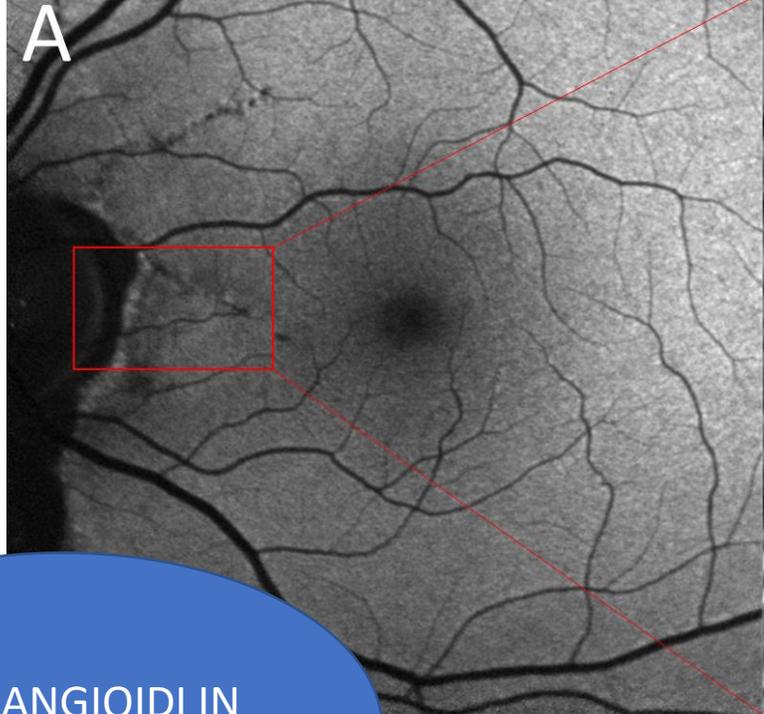
TORPEDO  
MACULOPATHY



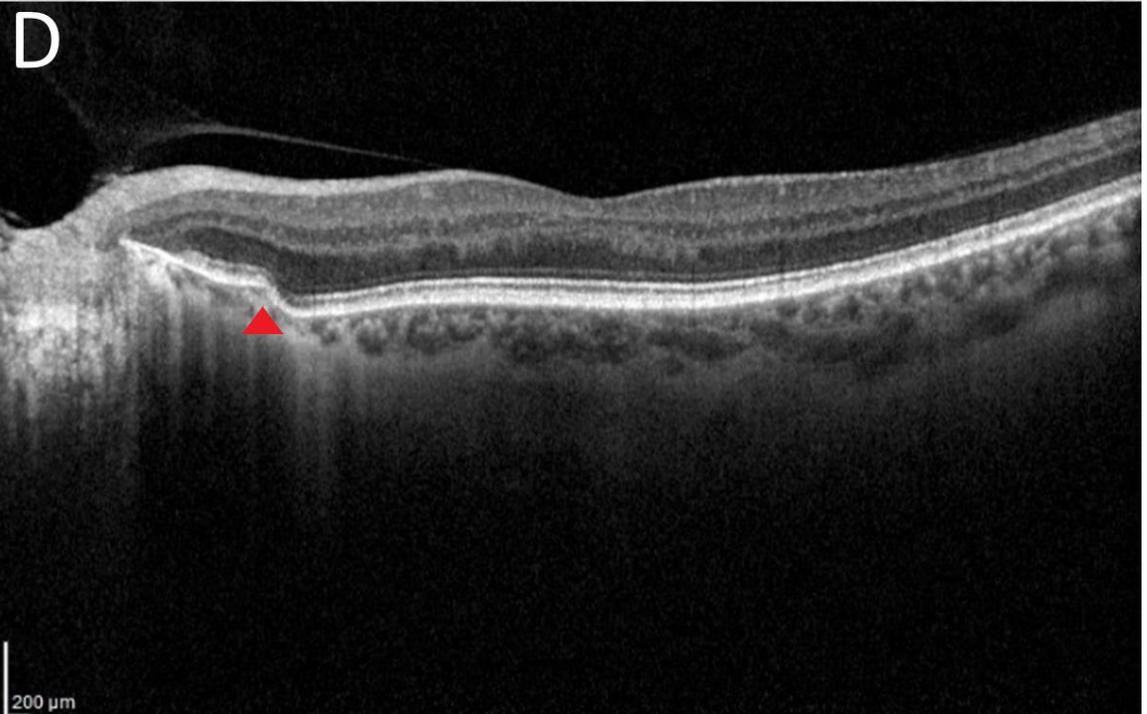
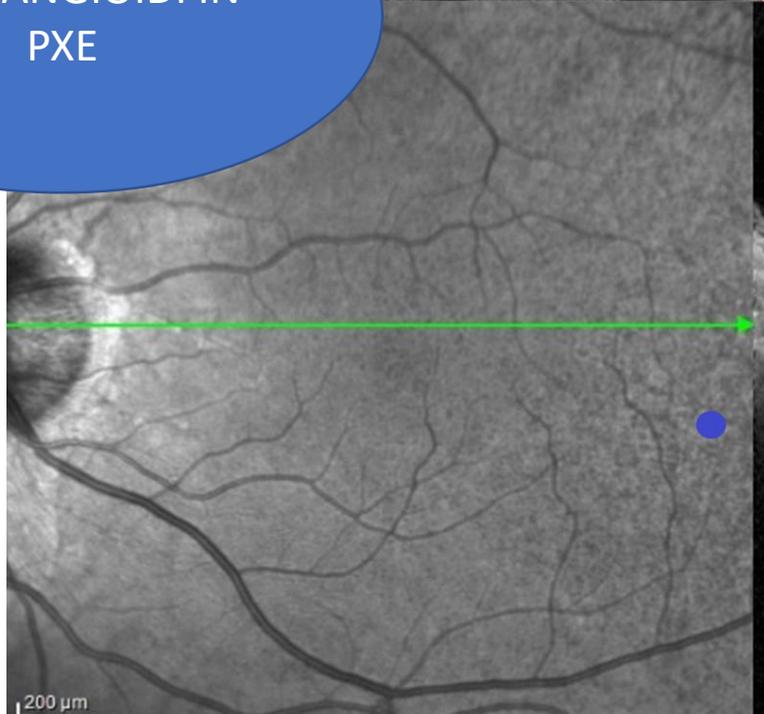
Tecnologia  
OCT associata  
a esame in  
OTTICA  
ADATTIVA



OTTICA  
ADATTIVA



STRIE ANGIOIDI IN  
PXE



*Grazie per l'attenzione!*

*Vittoria.murro@unifi.it*

