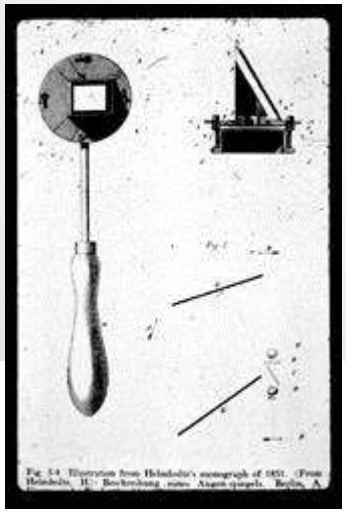
Optical Coherence Tomogrpahy

Nicholas Lee
Consultant The Hillingdon Hospital
& The Western Eye Hospital

- 1851 Hermann von Helmholtz
- 1871 Marc-Antoine Giraud-Teulon

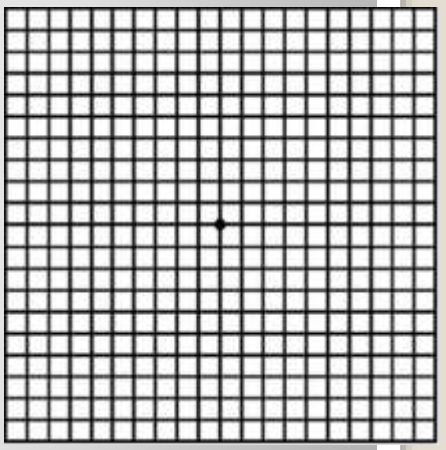
Early Ophthalmoscope
Edouard Meyer 1873
(From NLM History of Medicine Collection)



How we Examine the eye

Diagnosis of AMD

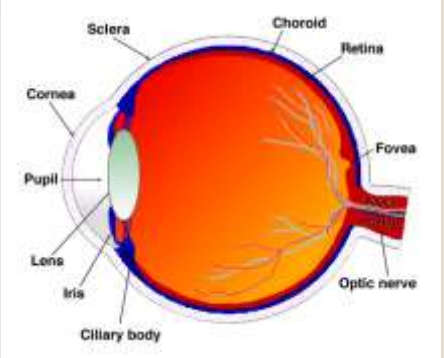
- Symptoms
- Examination
  - Visual Acuity
  - Dilated Fundal examination
    - Ophthalmoscope
    - Slit Lamp Bio-microscopy 78/60D
- Investigations
  - Optical Coherence Tomography
  - Fundus fluorescein angiography
  - Indocyanine Green Video Angiography (ICG)
  - Auto fluorescence



Fundal Examination

Pupil dilation – why Not?

- Conundrum in GP & Optometrist practice
  - Time
  - Driving
  - Fear of Closed angle Glaucoma
  - Equipment
  - Training
  - Expertise
- If symptoms present
  - Going to refer any way
  - Prefer expert to make diagnosis
- Dual Pathology
  - Do not assume its just a Cataract

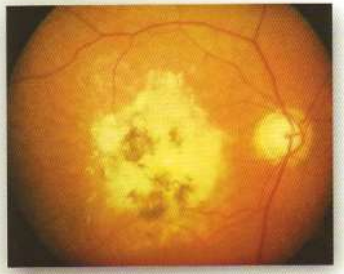


Fundal examination

- Ophthalmoscope
- Slit lamp Biomicroscopic
- Non-Mydriatic Photography – 3mm pupil
- Fundus fluorescein angiography
- Optical Coherence Tomography
- ICG

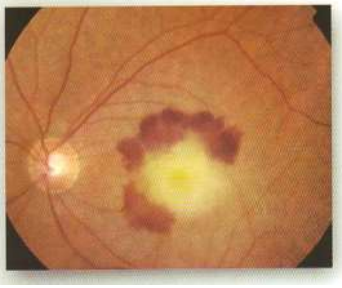
Untreatable AMD

Routine referral for LVA assessment



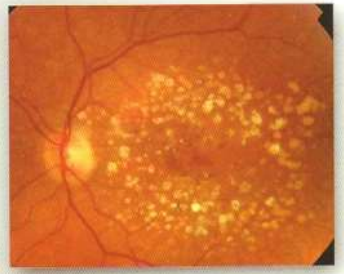
Disciform Scar: Extensive sub retinal fibrosis and pigment change at the macula. This shows advanced disease which is not appropriate for treatment.

Geographic atrophy: Another form of advanced AMD (Dry) showing extensive retinal atrophy / thinning at the macula. This patient is not suitable for treatment.

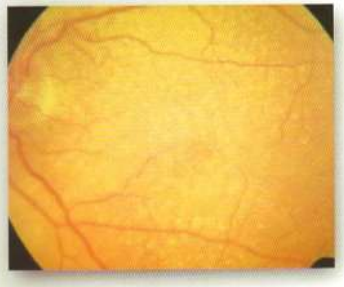


Drusen

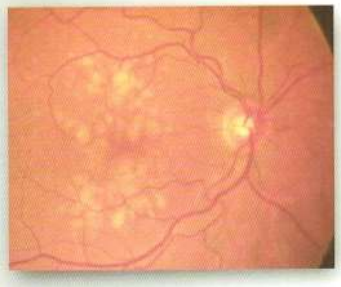
Refer only if fulfills guidelines on form



Multiple drusen and pigment change.

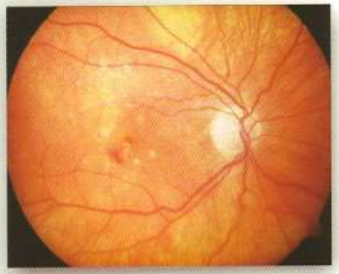


Multiple fine hard drusen.

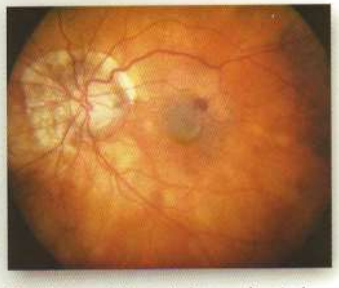


AMD

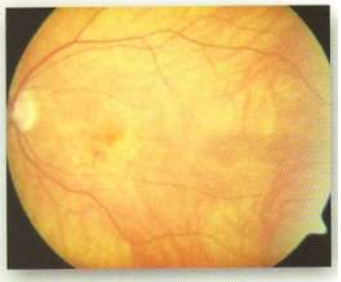
Refer if fulfills guidelines on form



Features of wet macular degeneration: Intra retinal haemorrhage centrally and exudates deposition superiorly. There maybe associated subtle sub retinal fluid / retinal thickening. Refer urgently if VA in this eye is 6 / 60 or better.



Myopic eye with central grey elevated area representing sub foveal choroidal neovascular membrane with associated haemorrhage. Refer urgently if VA in this eye is 6 / 60 or better.



The Macula

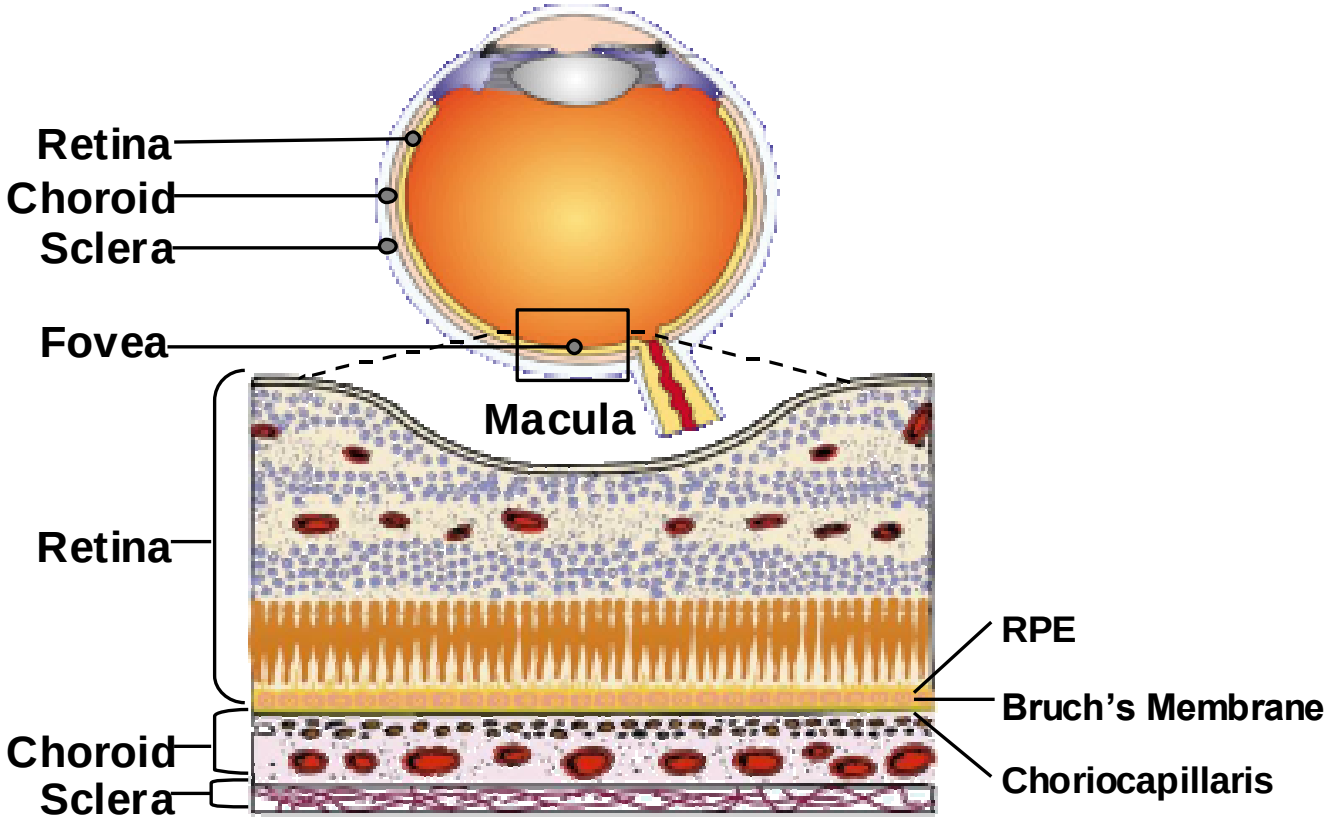
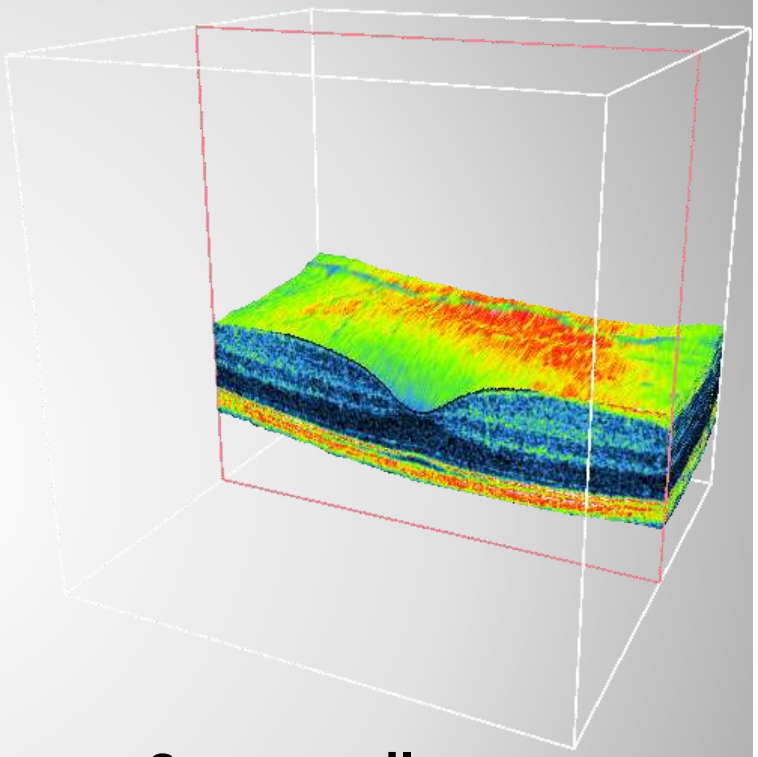


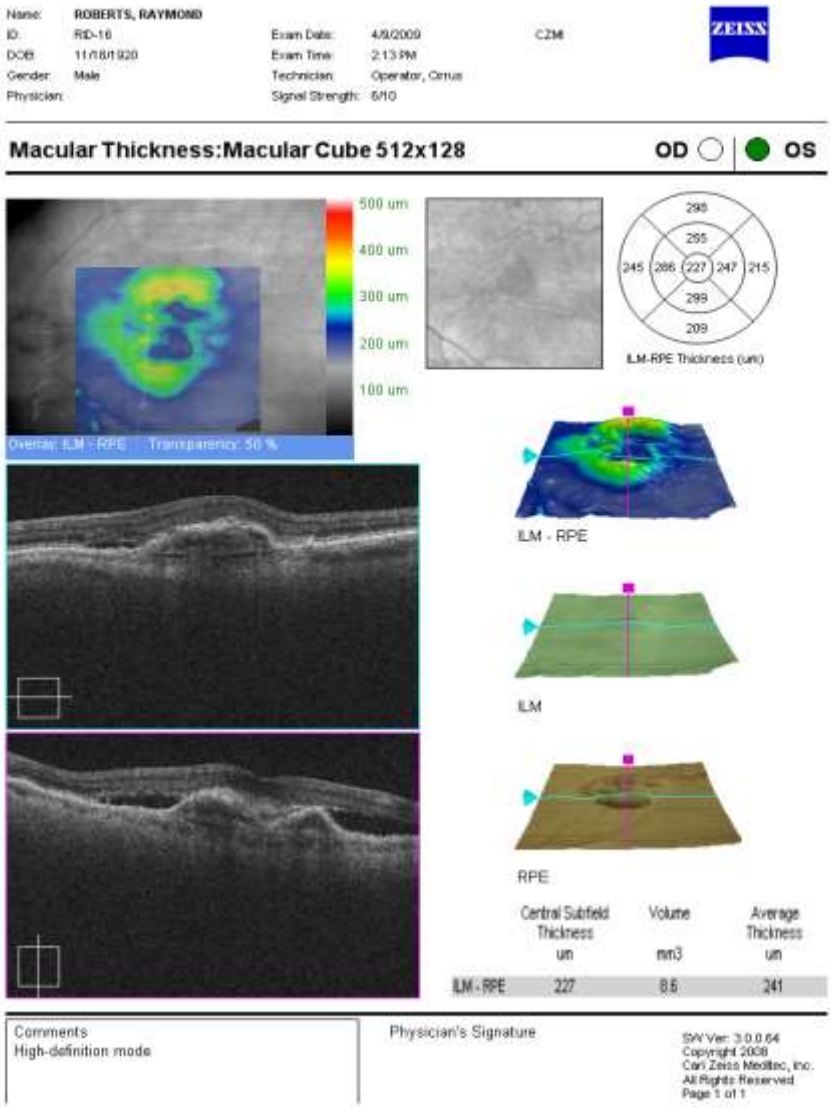
Figure courtesy of Novartis.

Optical Coherence Tomography (OCT)

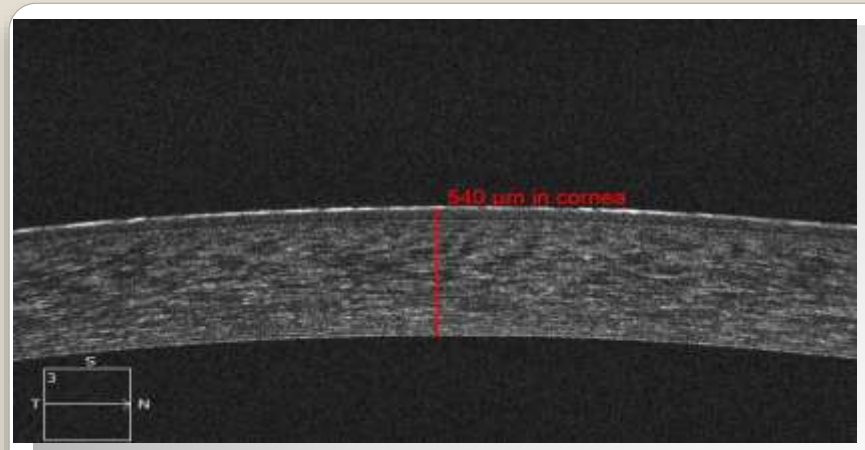


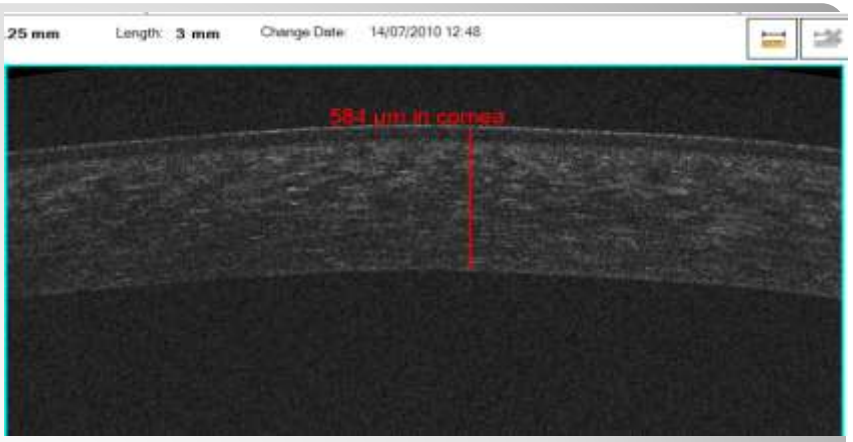
- Very versatile Scanner akin to MRI scans – 3mm pupil
- Pachymetry, Corneal
- Iris Angles for Closed or Narrow Angles
- Retina
- Optic nerve for glaucoma GDx

Zeiss Cirrus HR OCT

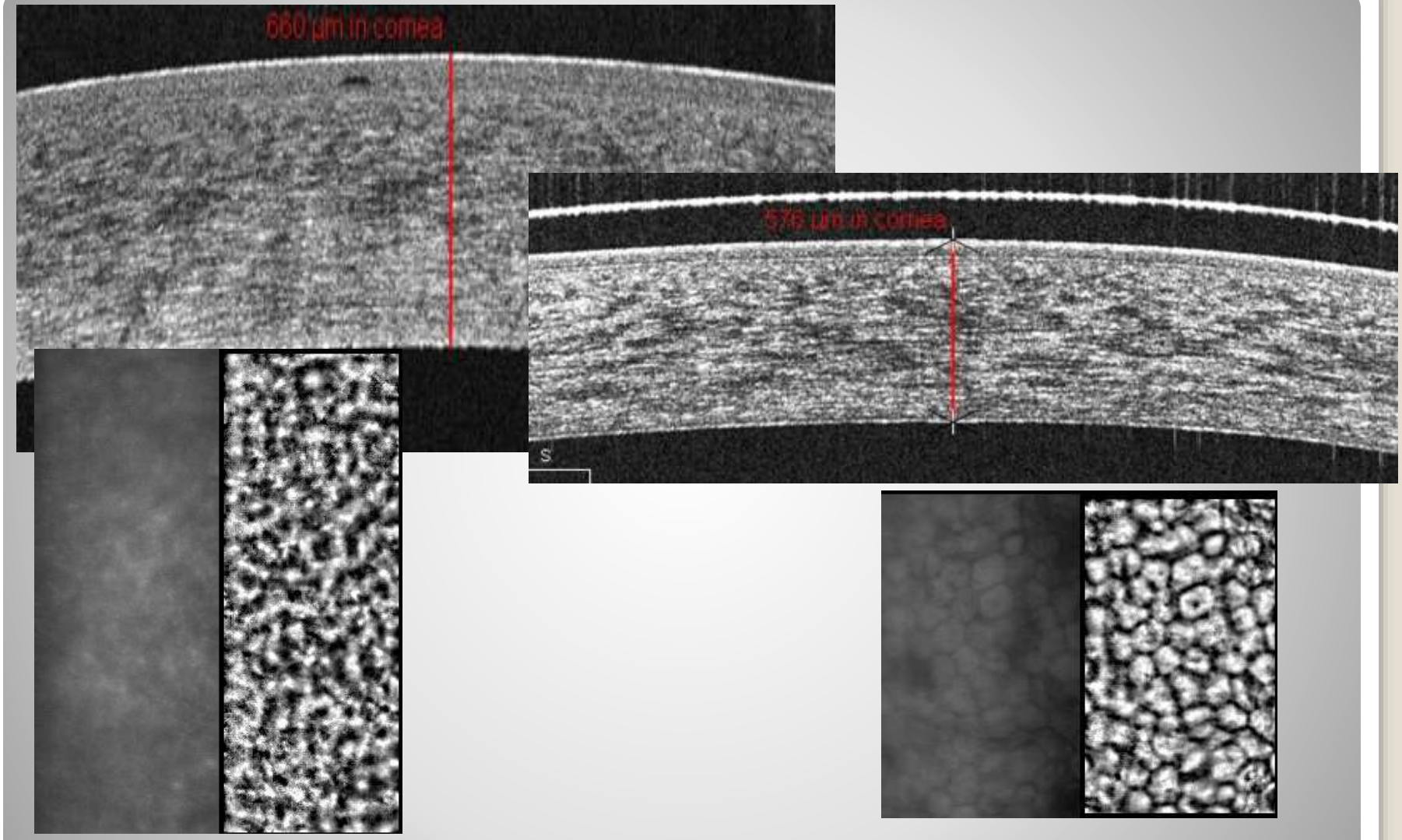


- **Fast Acquisition**
- **Fast processing**
- **Networkable**
- **Portable**



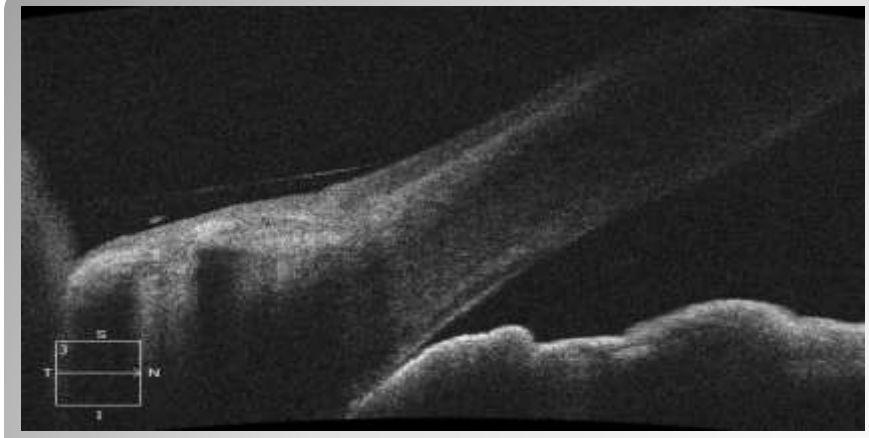


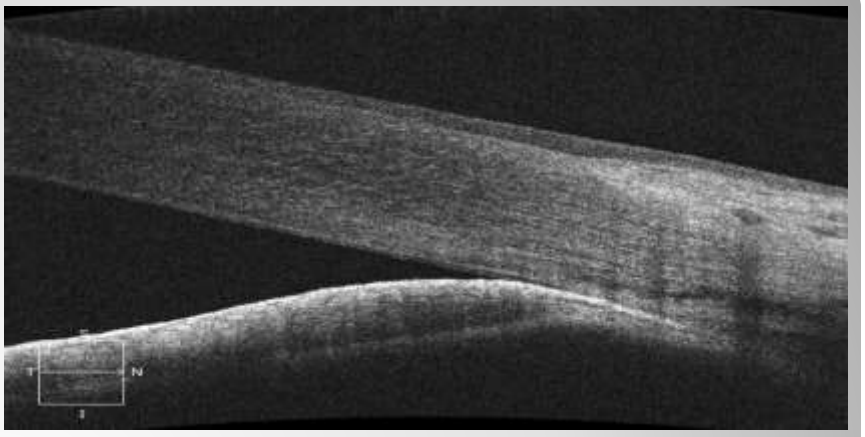
Pachymetry
Easy to measure corneal thickness
Corneal Pathology

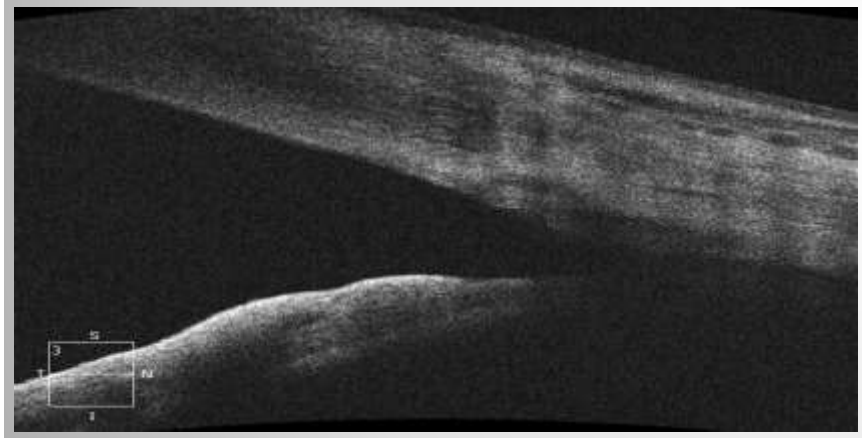


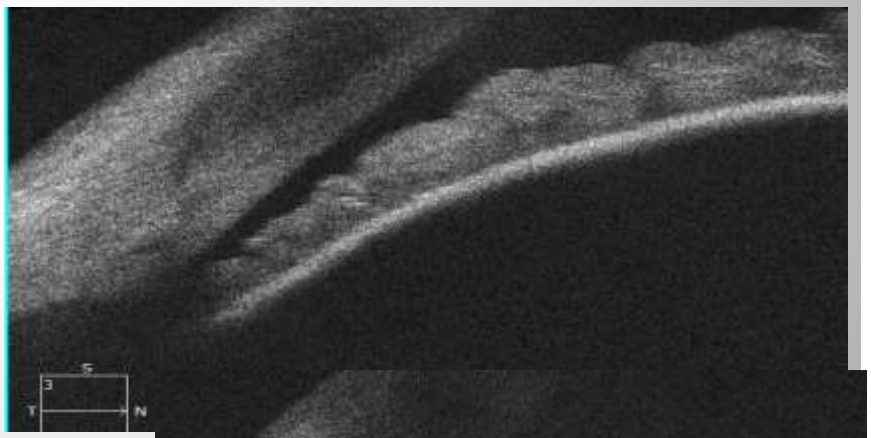
Corneal odema from contact lens wear

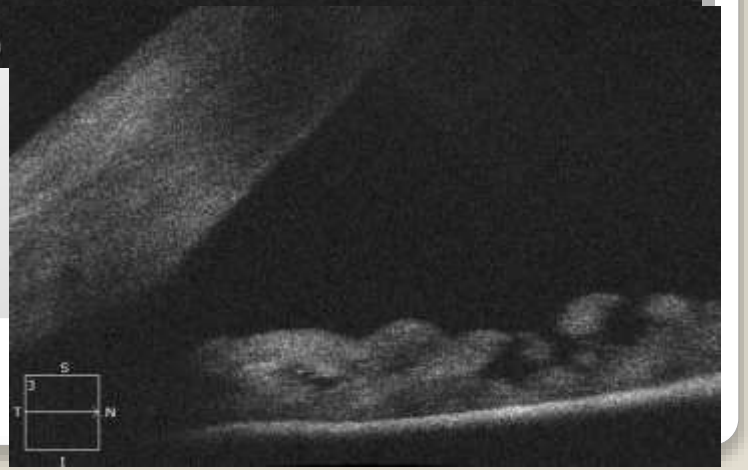
660 Vs 567 um



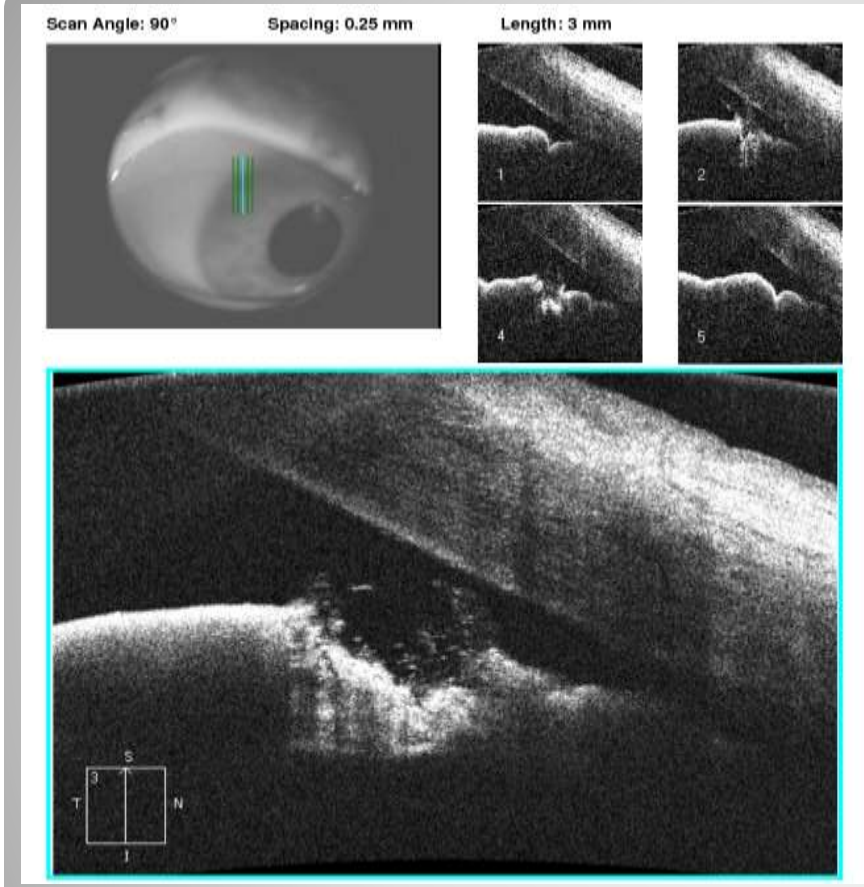




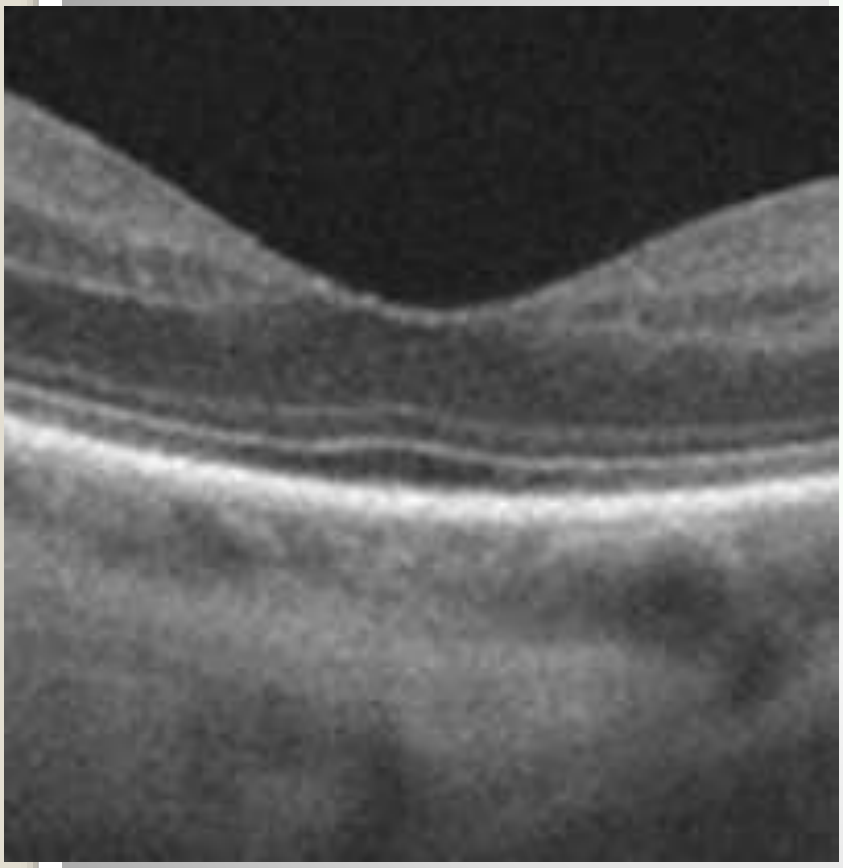


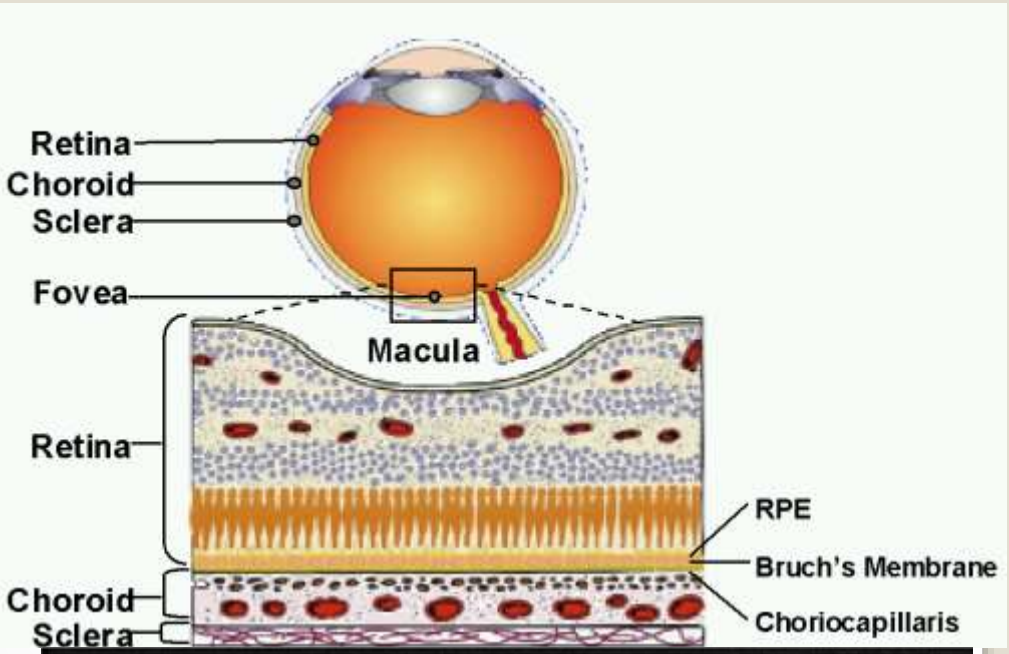


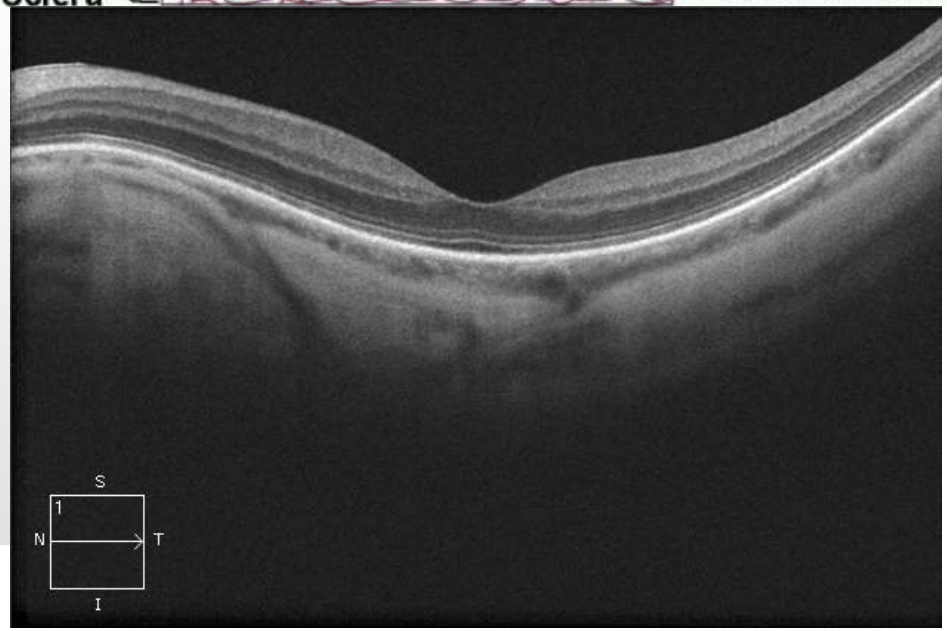
Iris Scans Open, Narrow, Plateau, Closed



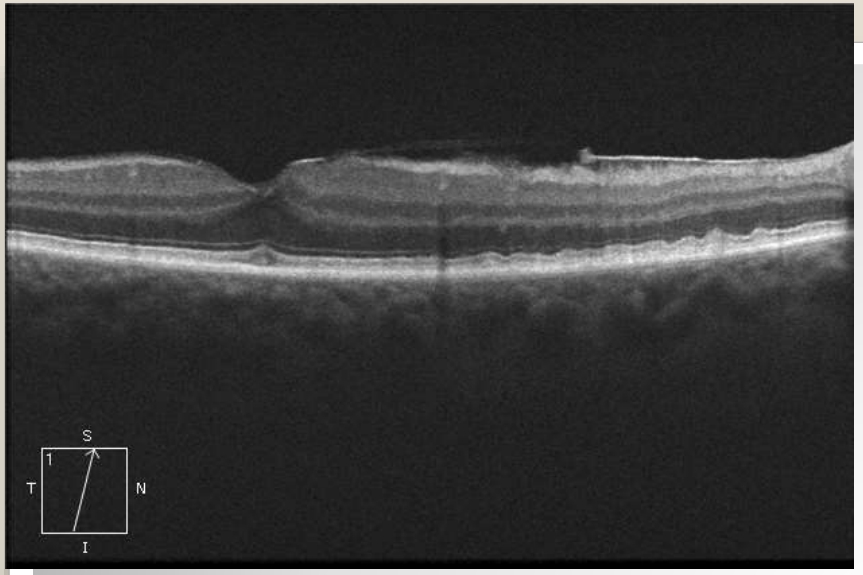
PI

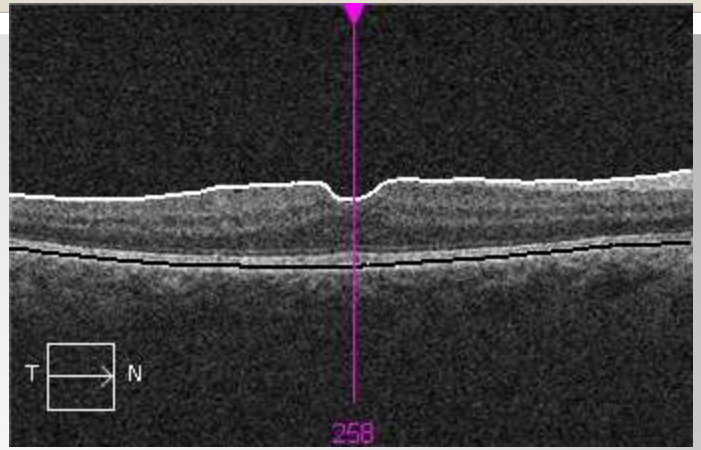


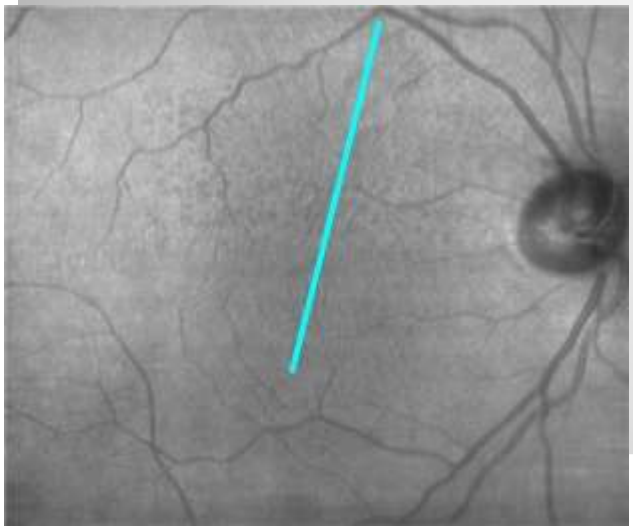




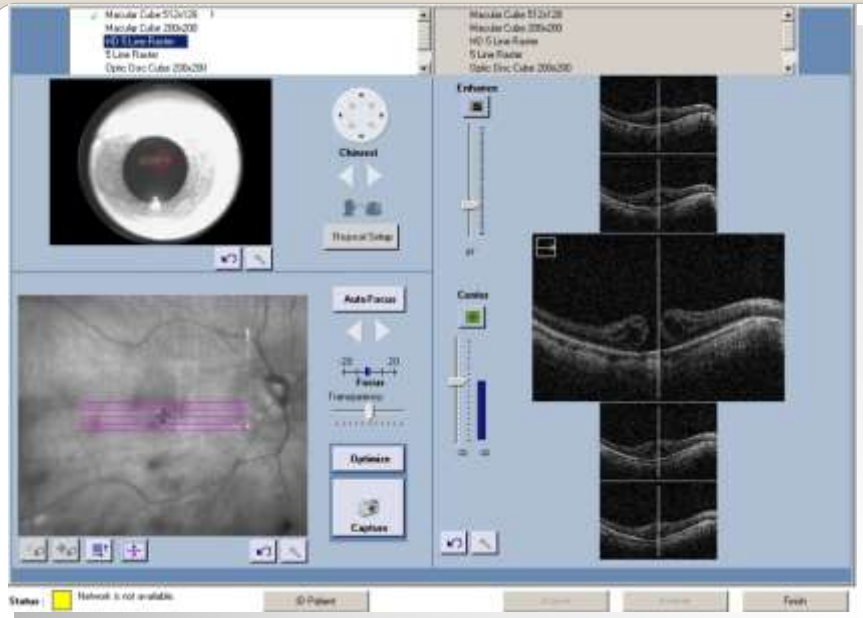
Normal Optical Coherence Tomography Scan

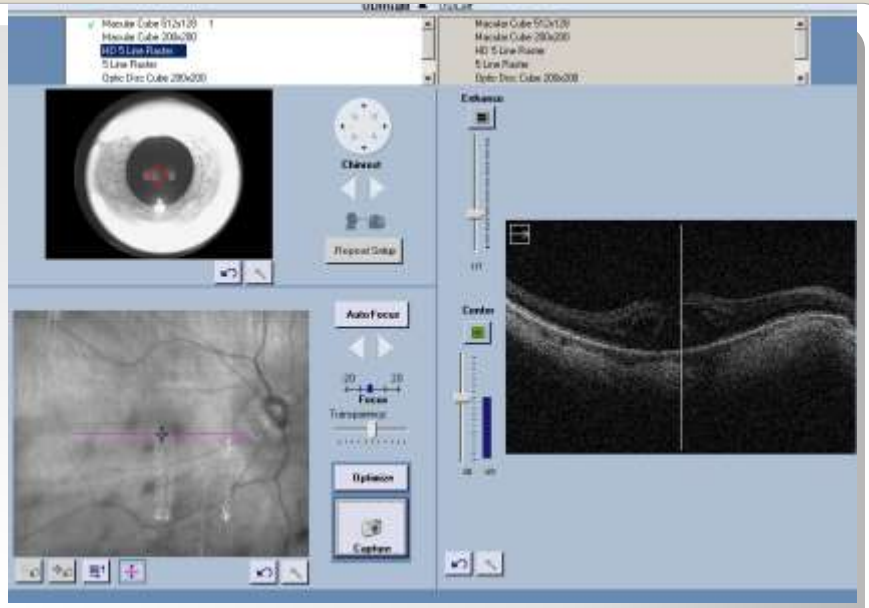


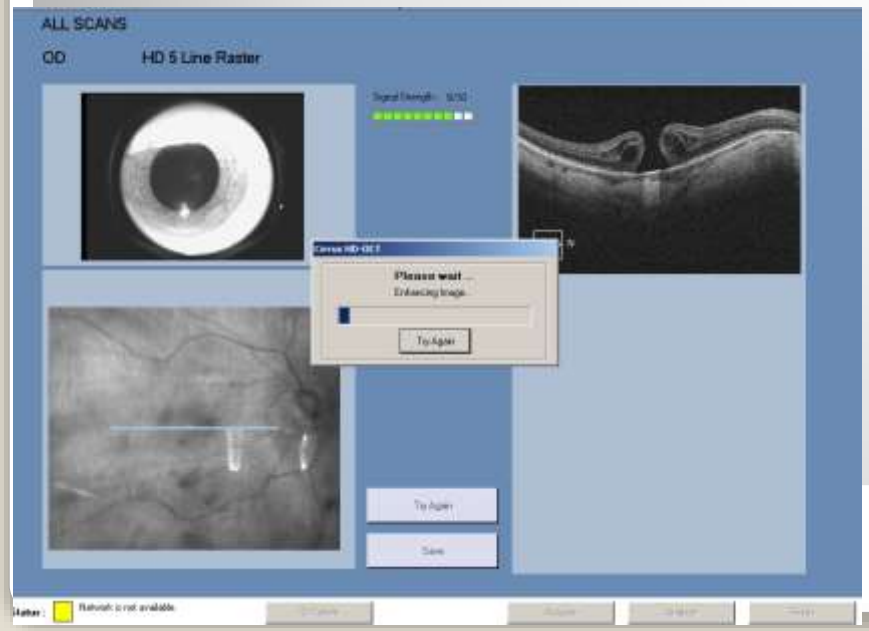


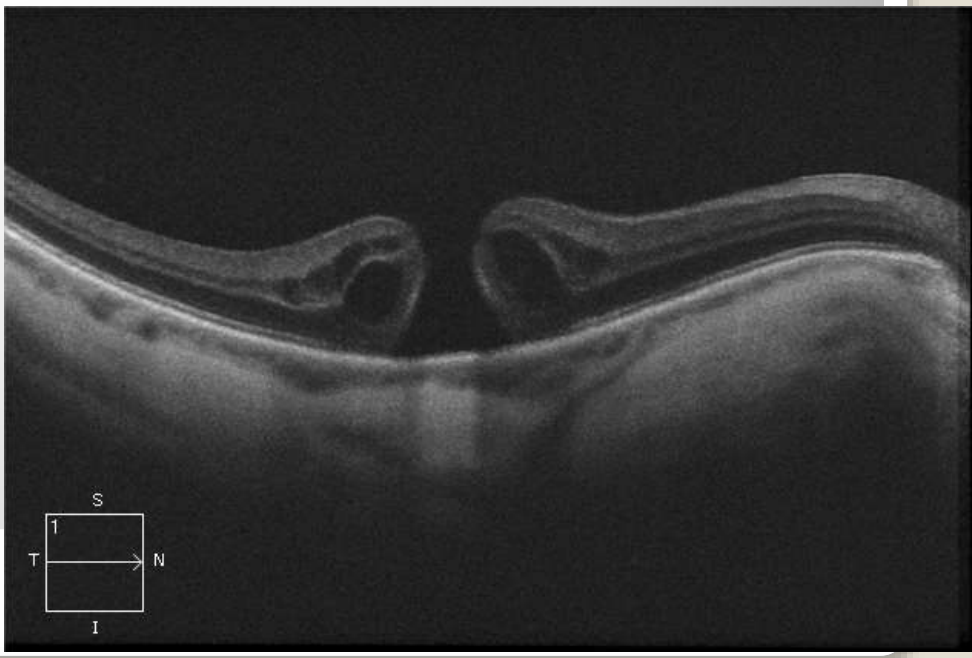


- 3 Quality of line scans
- 3D
- Single Line Scan
- HD Line Scans

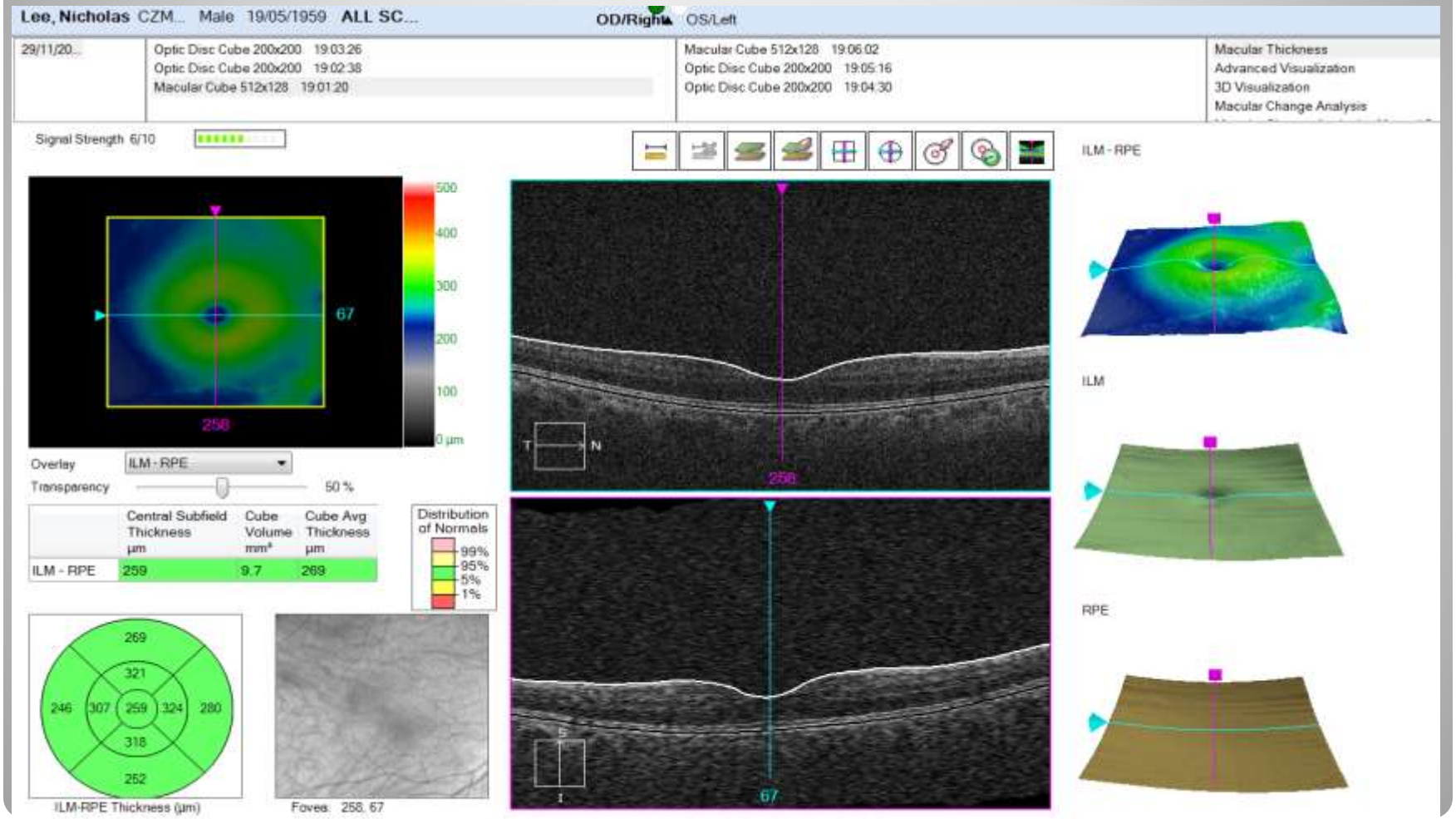


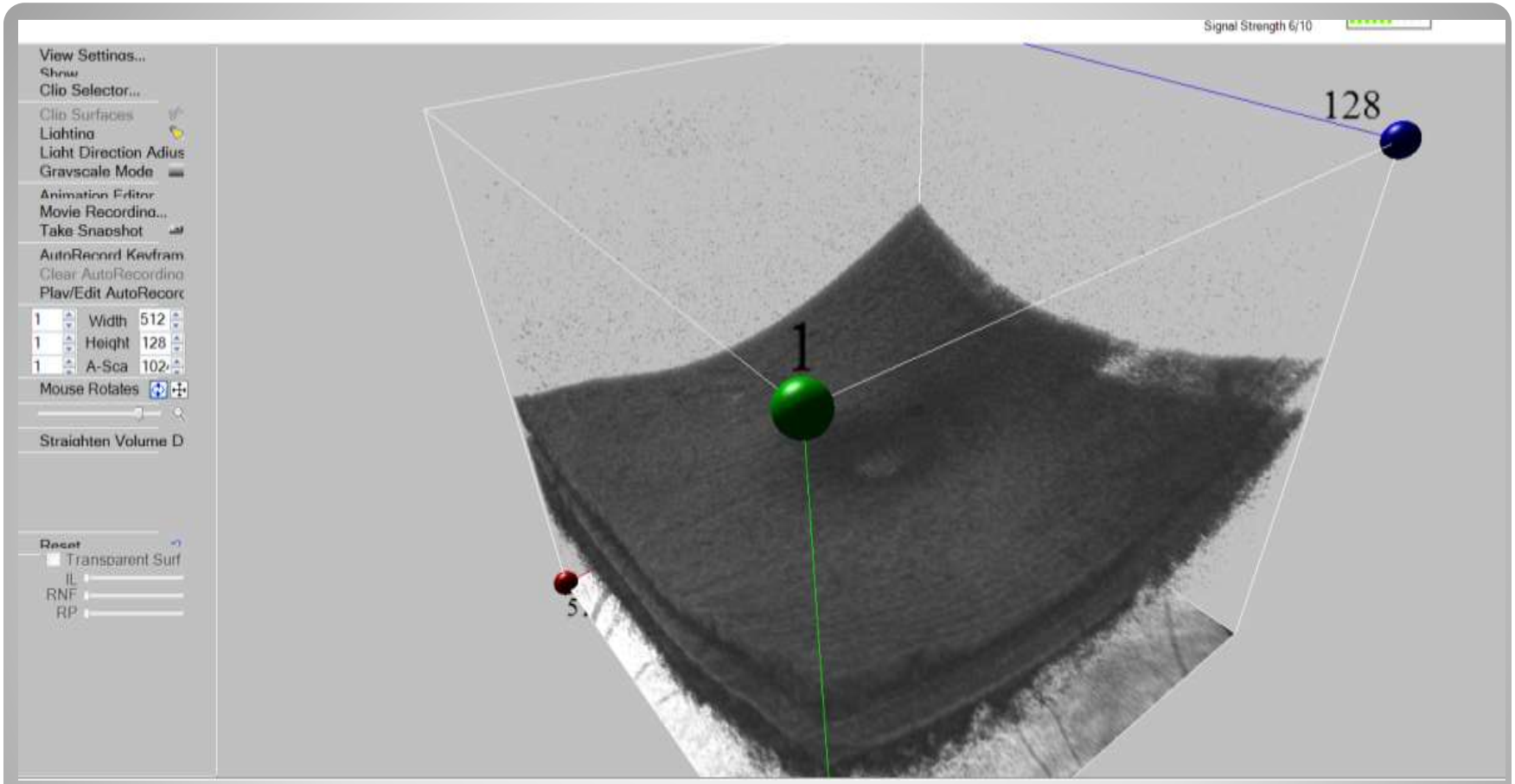



ALL SCANS
OD
HD 5 Line Raster
Please wait...
Try Again

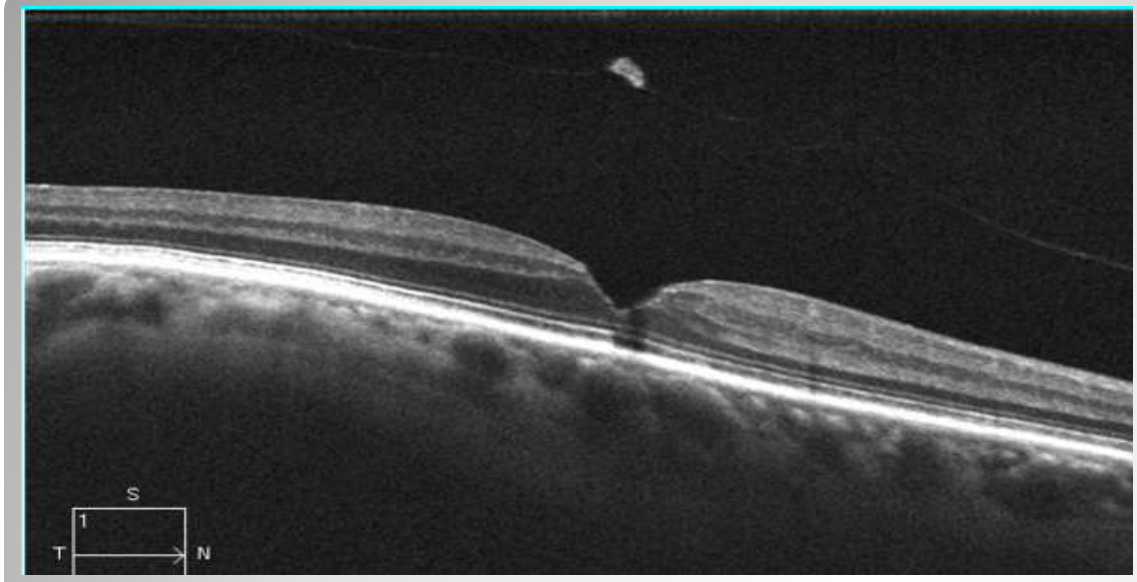

S
T
N
I

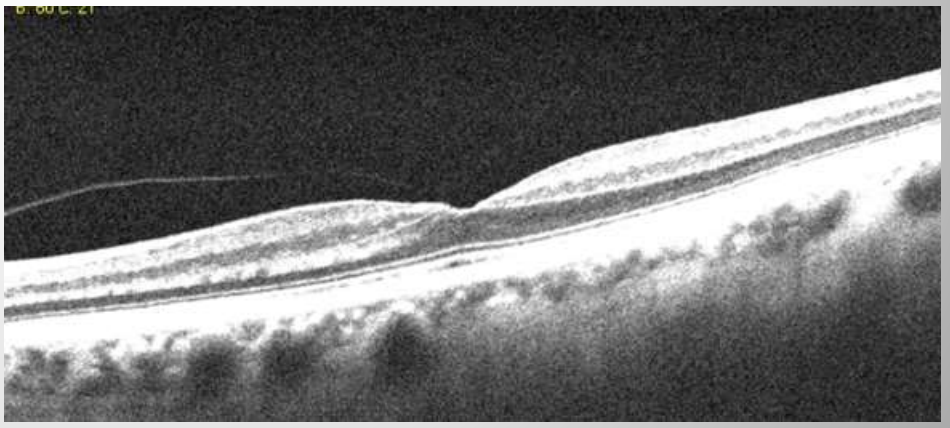
Standard Macular Analysis view





3D Visulisation
Viterous Pathology





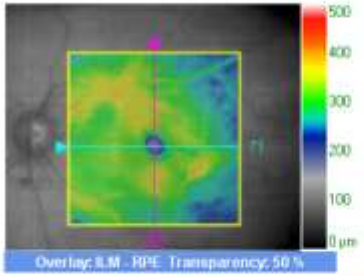
Macular Hole with operculum

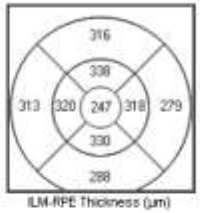
[redacted]

Doctor:
Signal Strength: 6/10

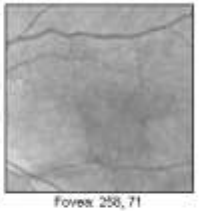
Macula Thickness : Macular Cube 512x128

OD ○ | OS ●

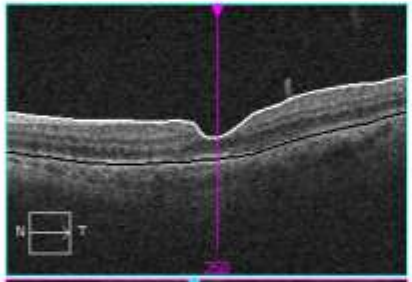


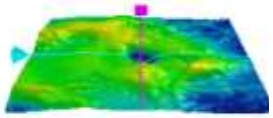


ILM-RPE Thickness (µm)

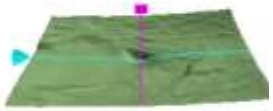


Fovea: 258, 71

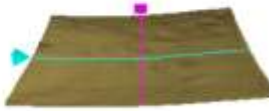




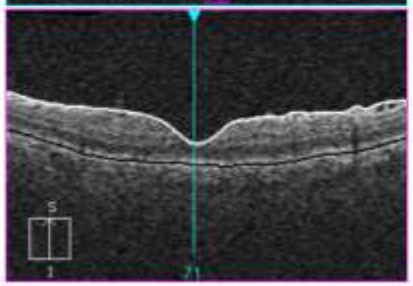
ILM - RPE



ILM



RPE



	Central Subfield Thickness (µm)	Cube Volume (mm³)	Cube Average Thickness (µm)
ILM - RPE	247	10.7	298

Comments

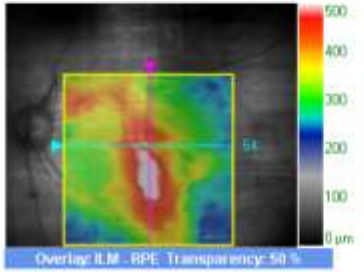
Doctor's Signature

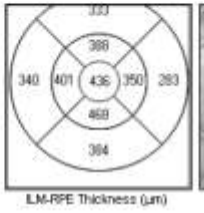
ZEISS

Exam Date: 27.01.2009 CZM
Exam Time: 08:49
Technician: Operator, Cirrus
Doctor:
Signal Strength: 10/10

Macula Thickness : Macular Cube 512x128

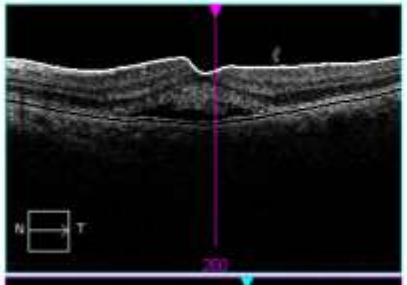
OD ○ | OS ●

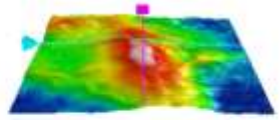




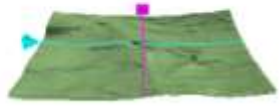
ILM-RPE Thickness (µm)

Fovea: 260, 54

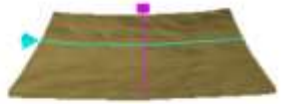




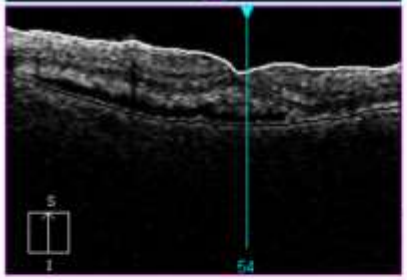
ILM - RPE



ILM



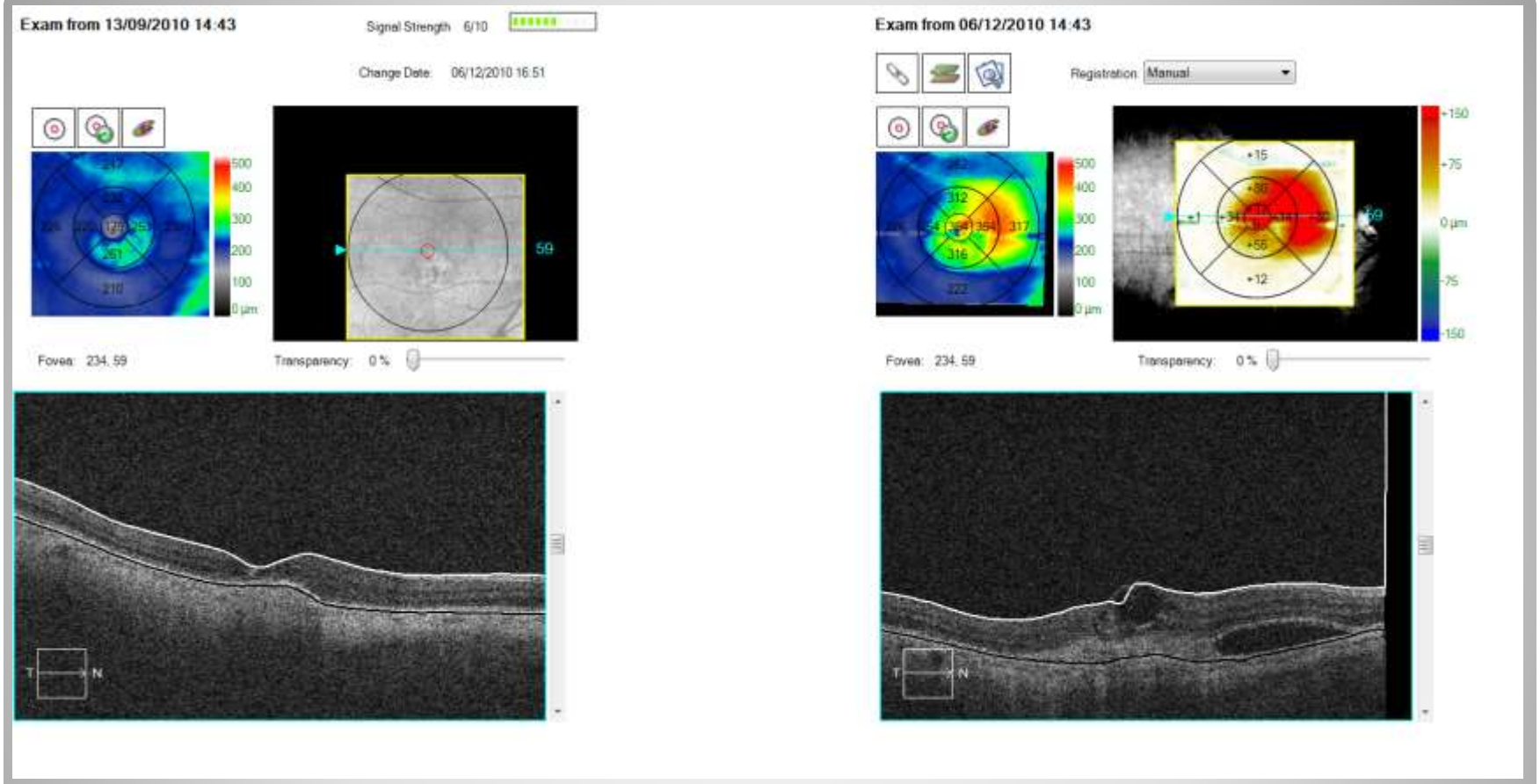
RPE



	Central Subfield Thickness (µm)	Cube Volume (mm³)	Cube Average Thickness (µm)
ILM - RPE	436	12.1	337

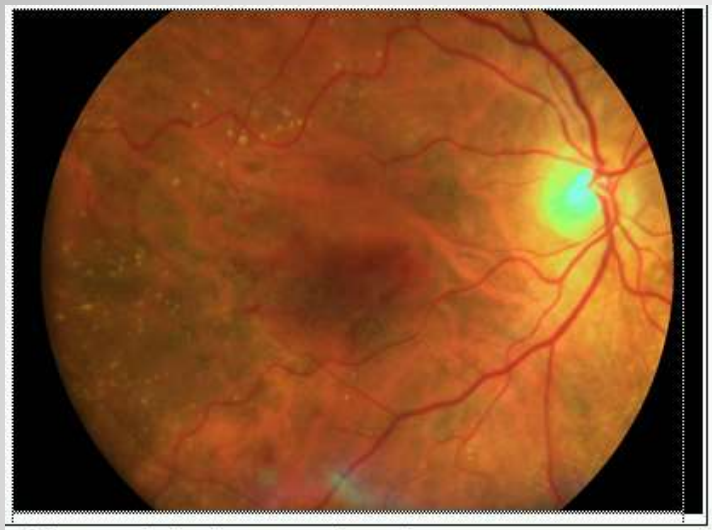
Comments

Doctor's Signature

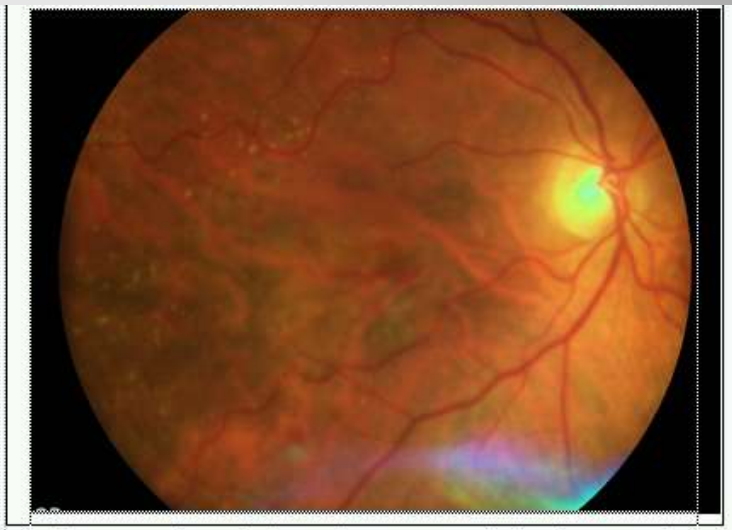


Macular Change analysis Mainstay for AMD service. Dry since July 2010 after 17 Injectrions of Lucentis.

6/18, 7 Lucentis last July 14

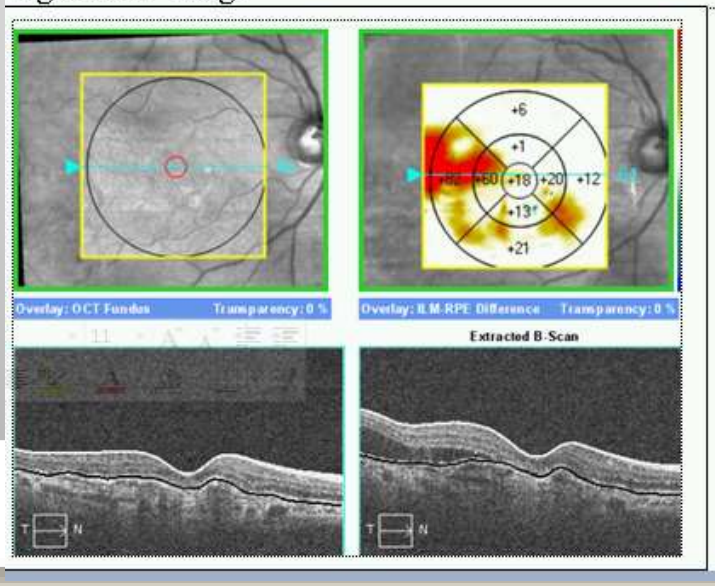


Right Fundal Photograph today

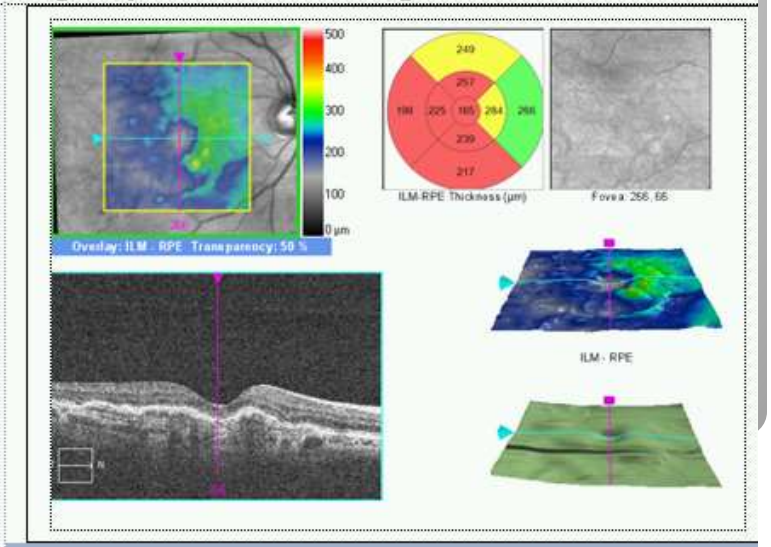


Right Eye last visit no haem Fundal Photograph

Right OCT Image



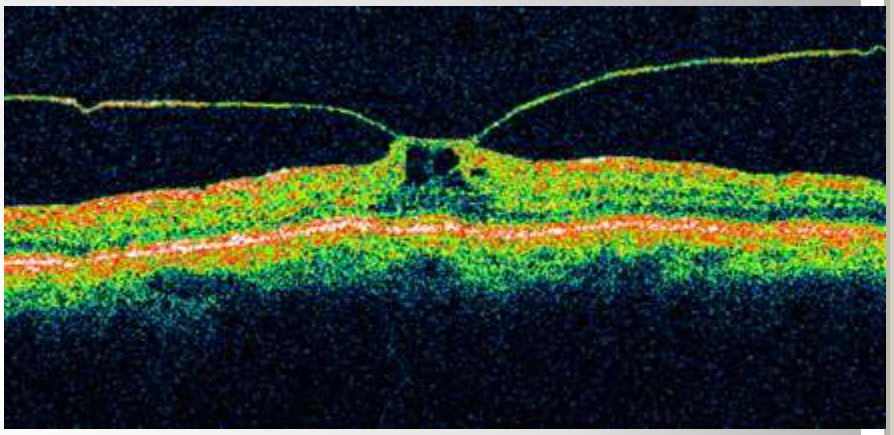
Right Eye March OCT Image



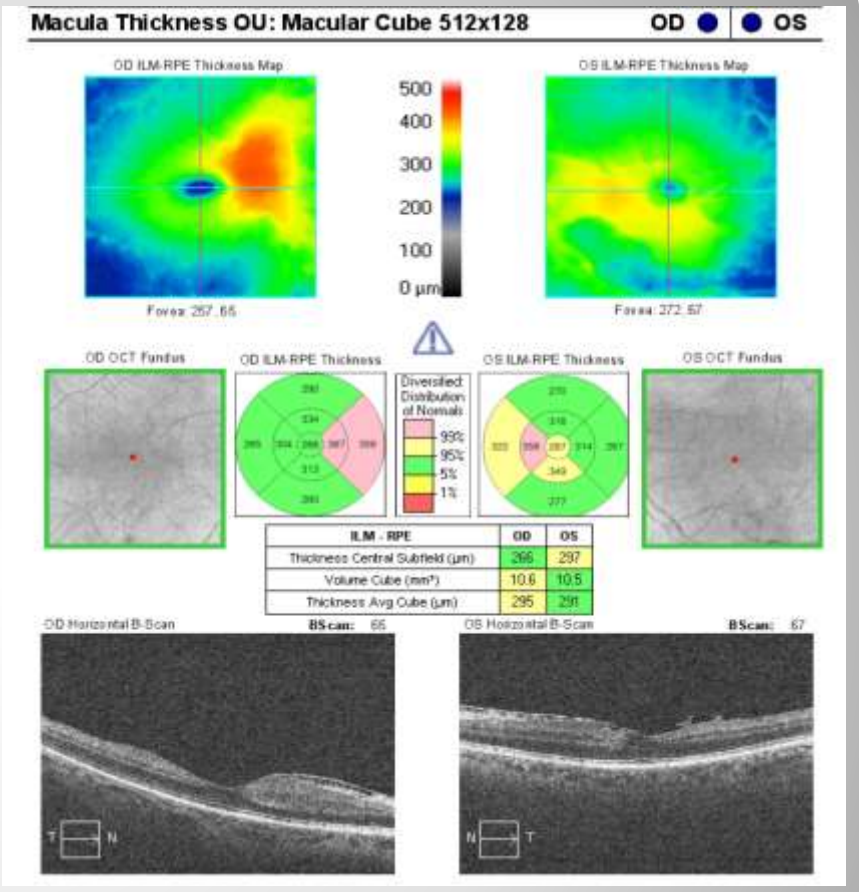
Central Vitreo-Retinal Adhesion Theory of Wet AMD Formation

- Number with adhesion
- Exudative AMD 36%
- Dry ARMD 7%
- Controls 10%

- Chronic VR traction may lead to increased chemical changes leading to wet AMD.
- ? Injection of Microplasmin to separate VR? Role



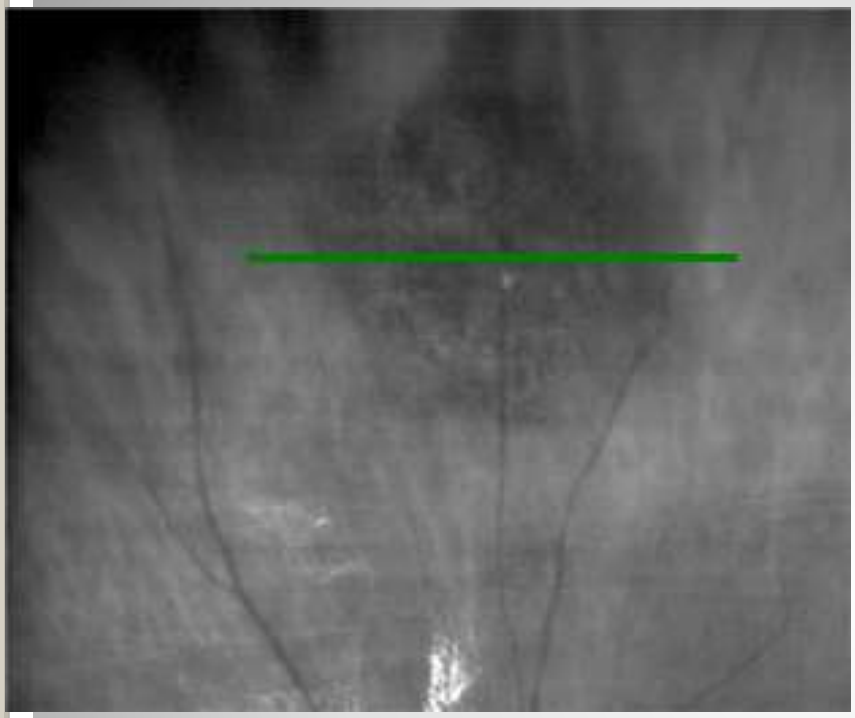
- ? Also pathogensis of Macular holes
- Microplasmin Trials underway 12/08 -2010
- 125ug Microplasmin Intravitreal injection.



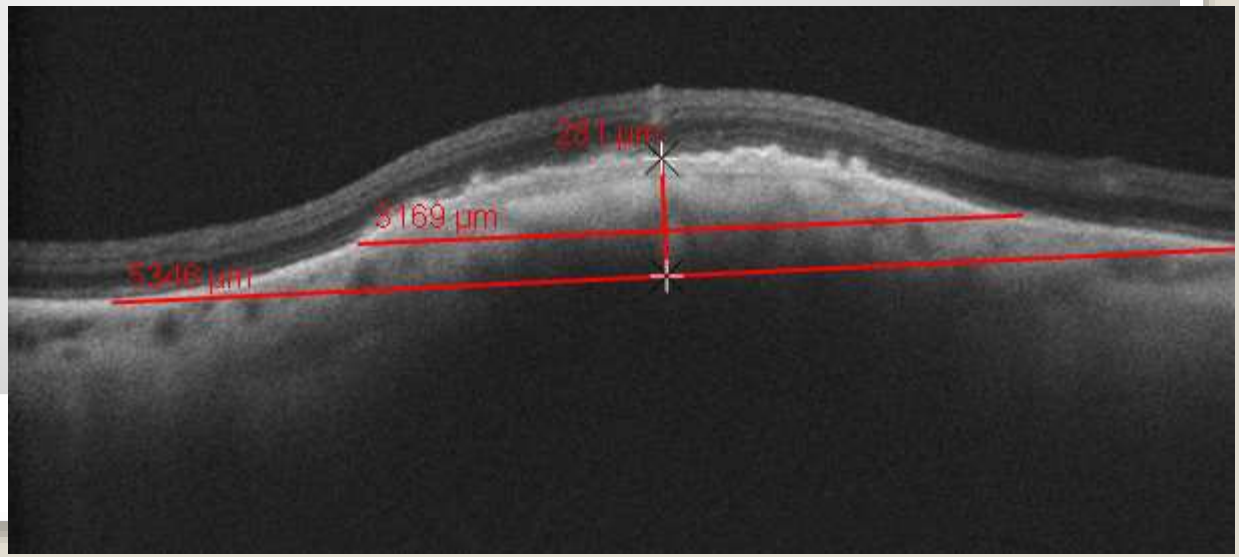
77

0.08 & 0.08

Mild distortion

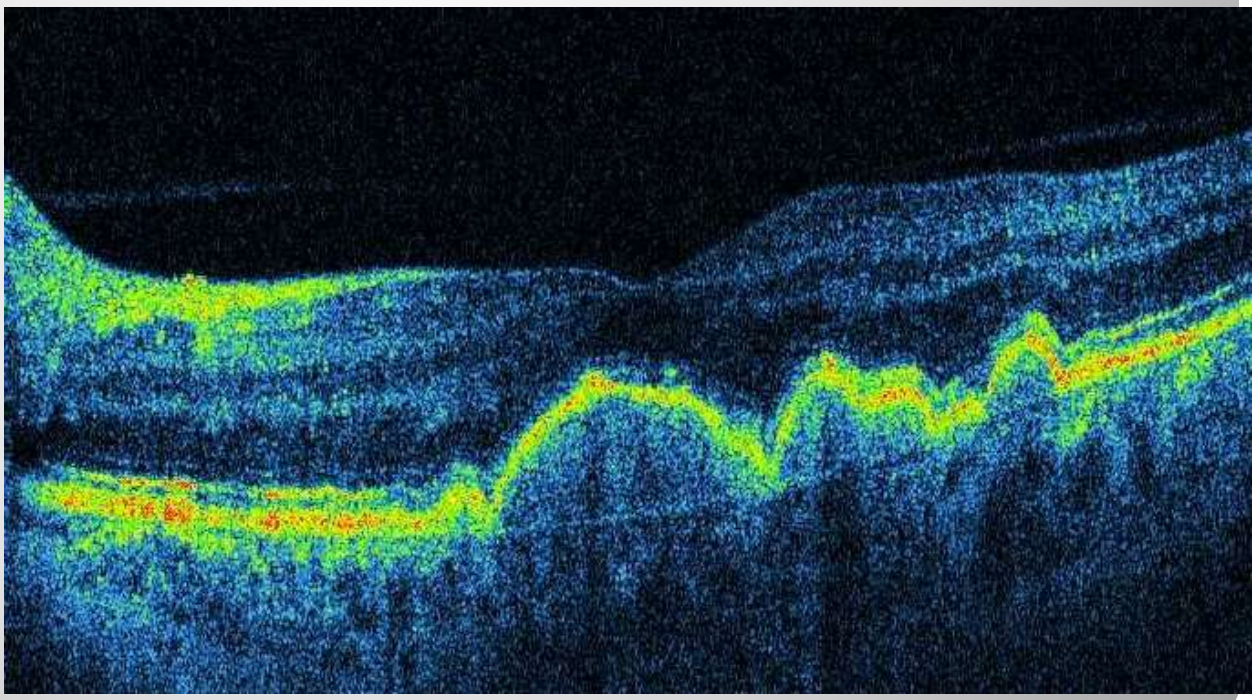


- Choroidal Naevi on HD Optical Coherence Tomography

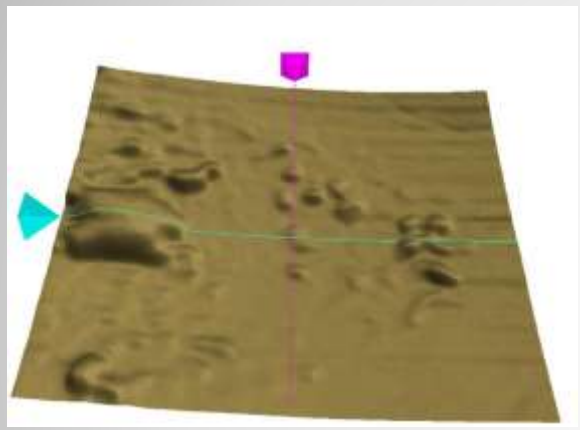


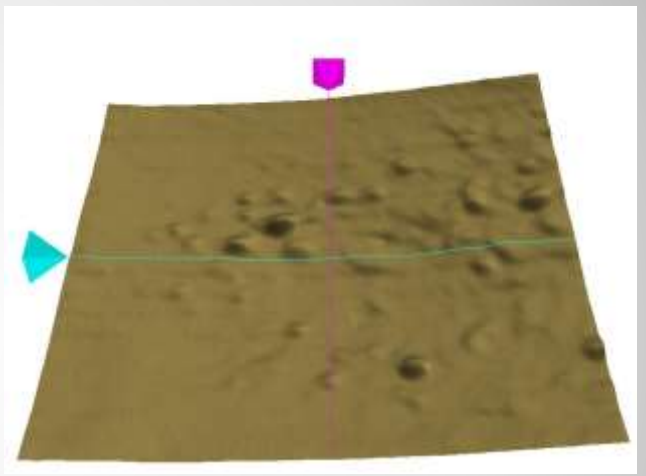
Drusen

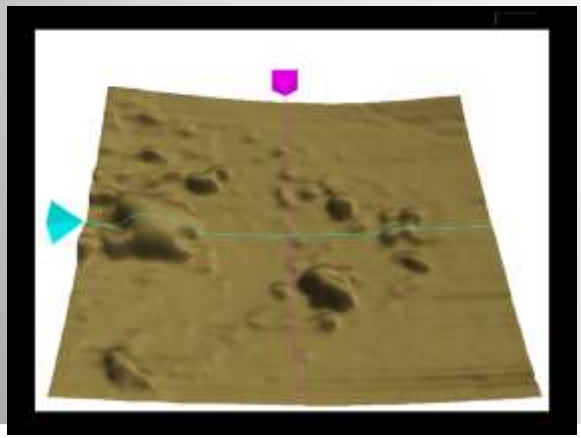
- Beginning early in life,.
- Remnants of the incomplete degradation of abnormal molecules which have been damaged within the RPE cells or derived from phagocytized rod and cone membranes.
- Further deterioration of the RPE.
- Dry AMD
- Wet AMD

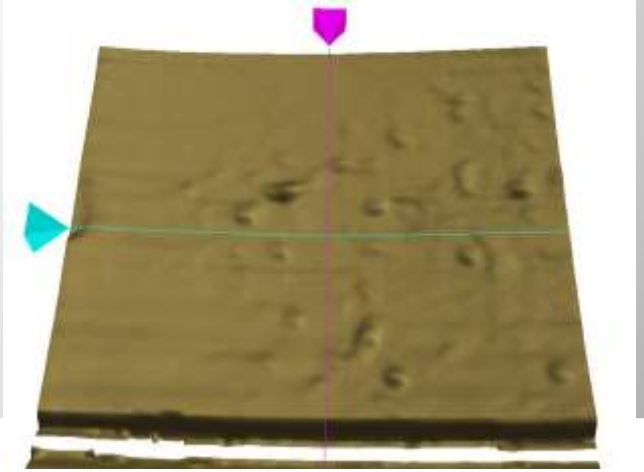


Change in drusen over one year



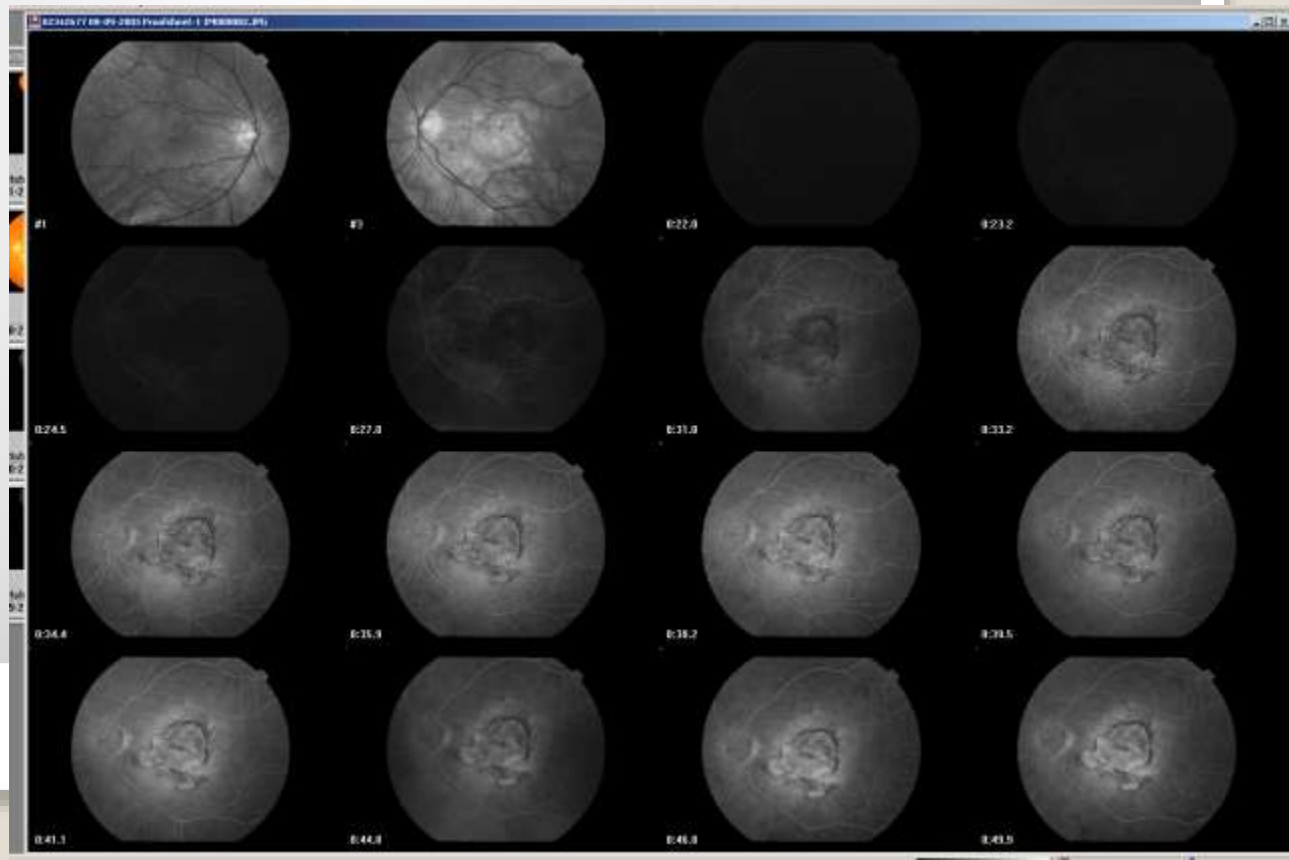




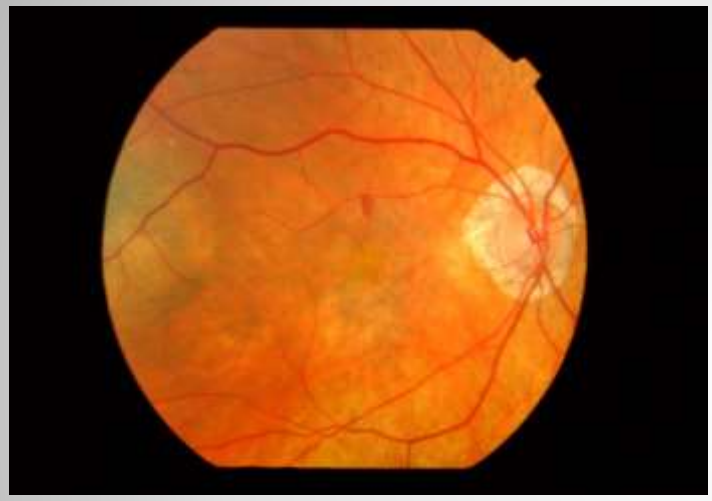


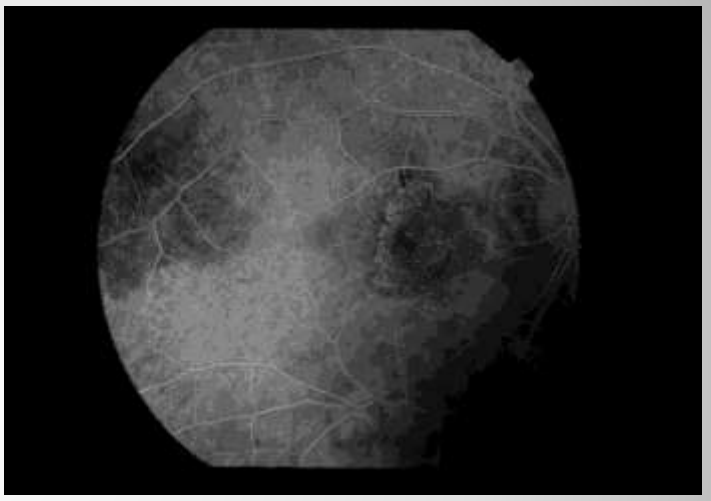
Fundus fluorescein angiography

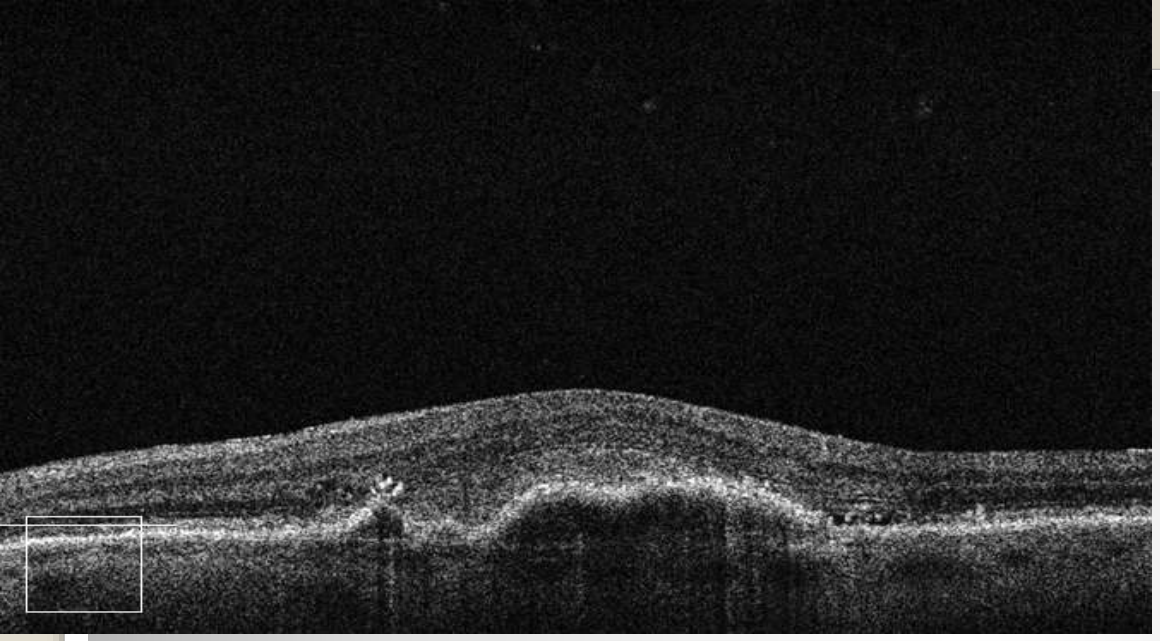
- Key investigation
- Looks at Retinal circulation



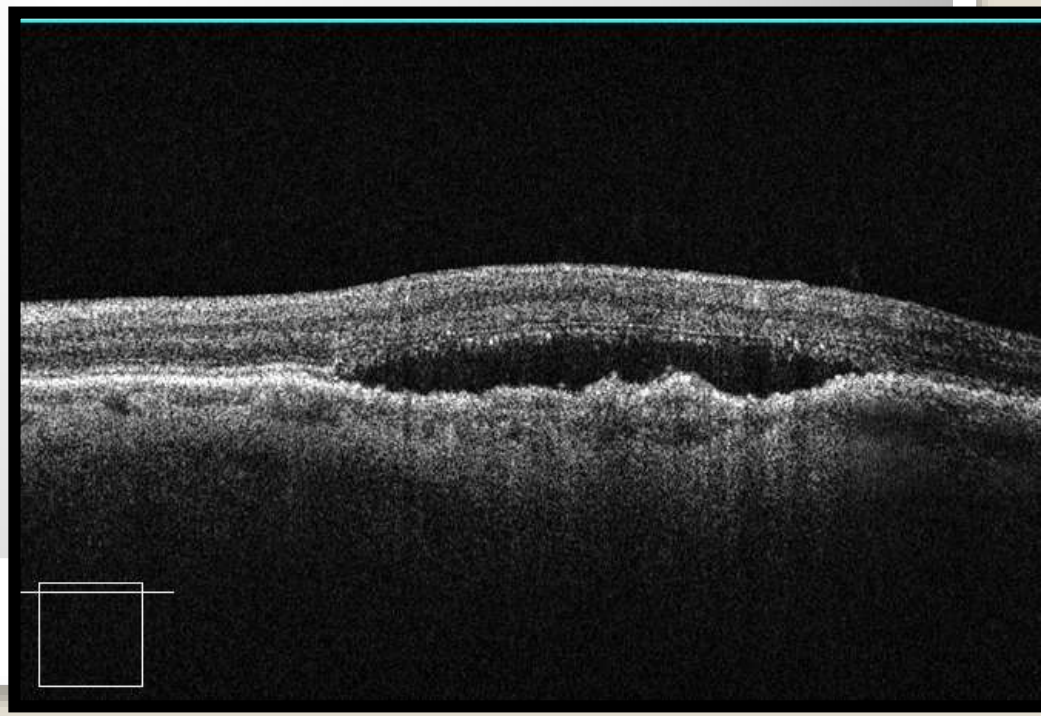
02510479
100% Classic Lesion





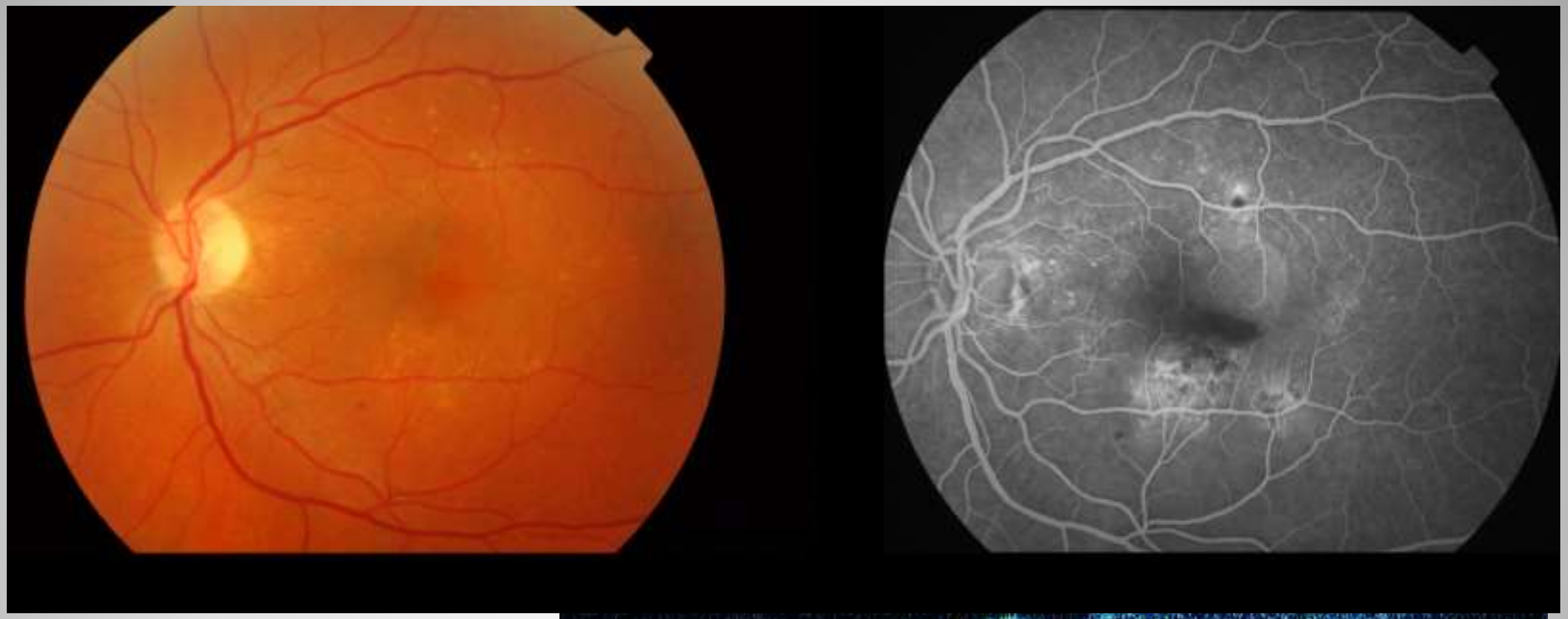


Wet AMD formation

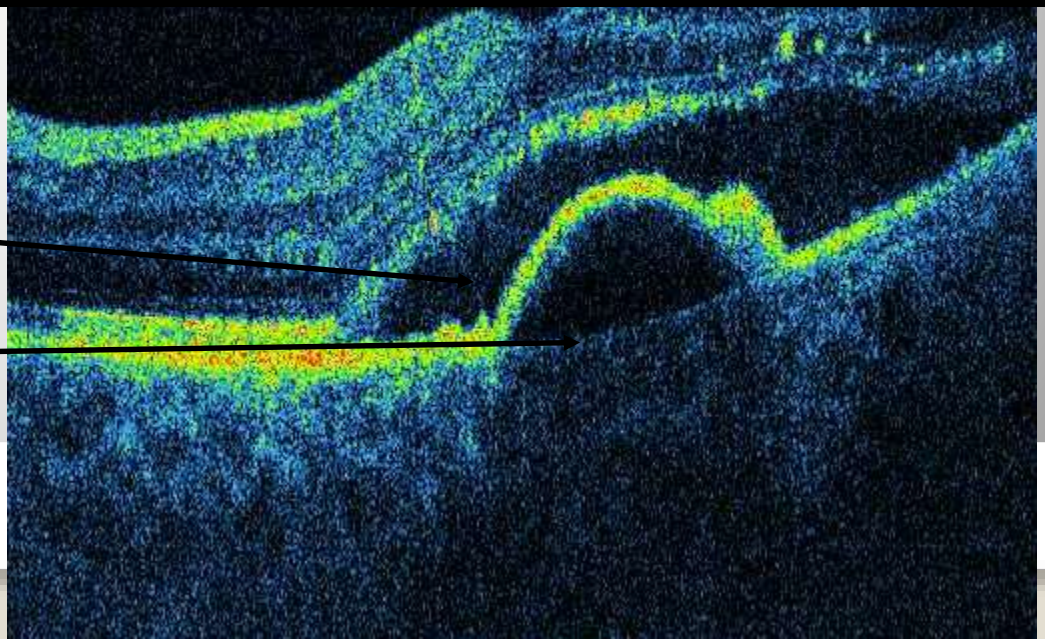


Rapid change
1 Week!
Warn Patients of rapid Onset
DO not wait till next appointment/exam

Wet AMD 6/12+2 62 F



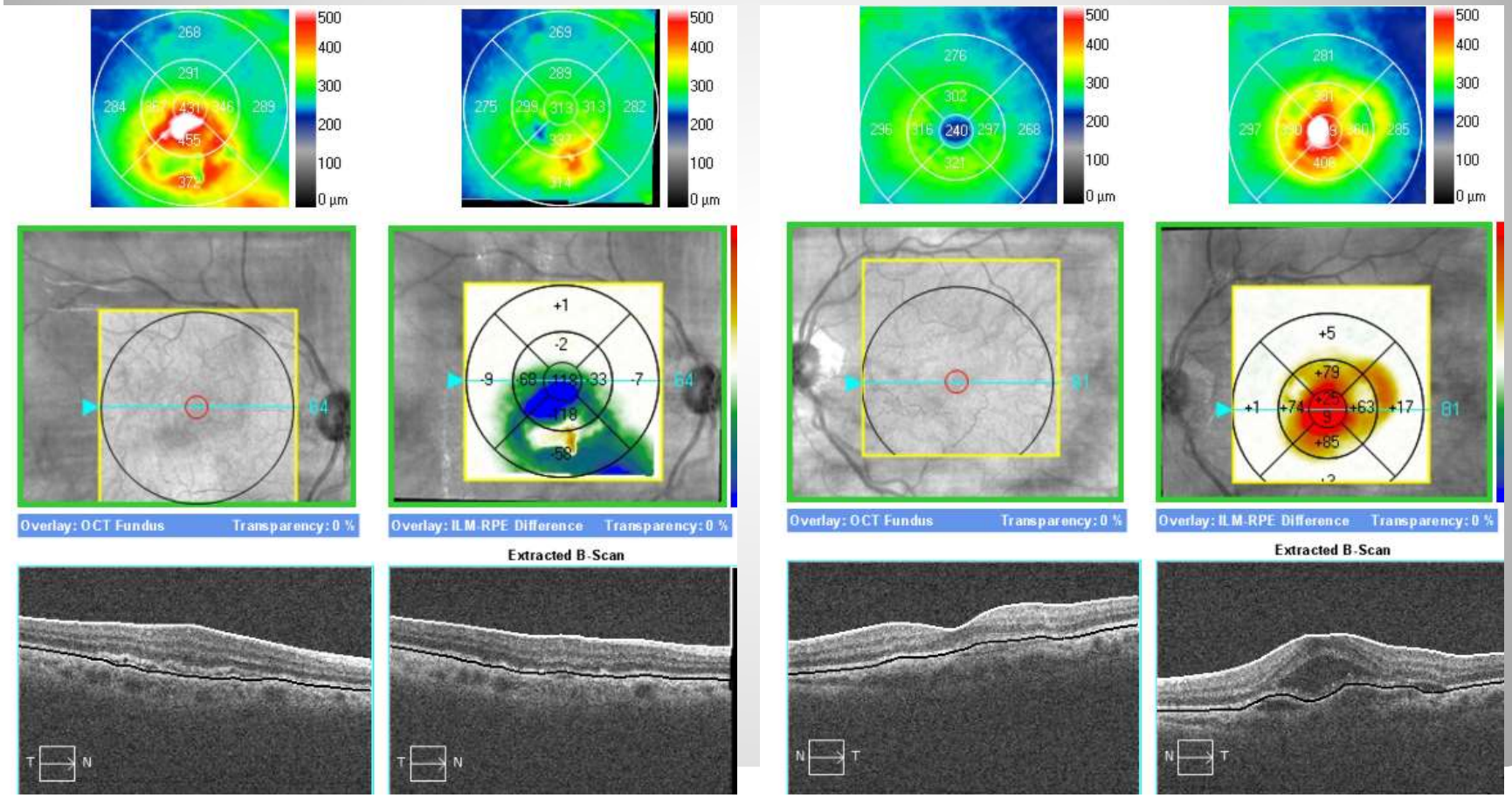
- Sub retinal Fluid
- PED



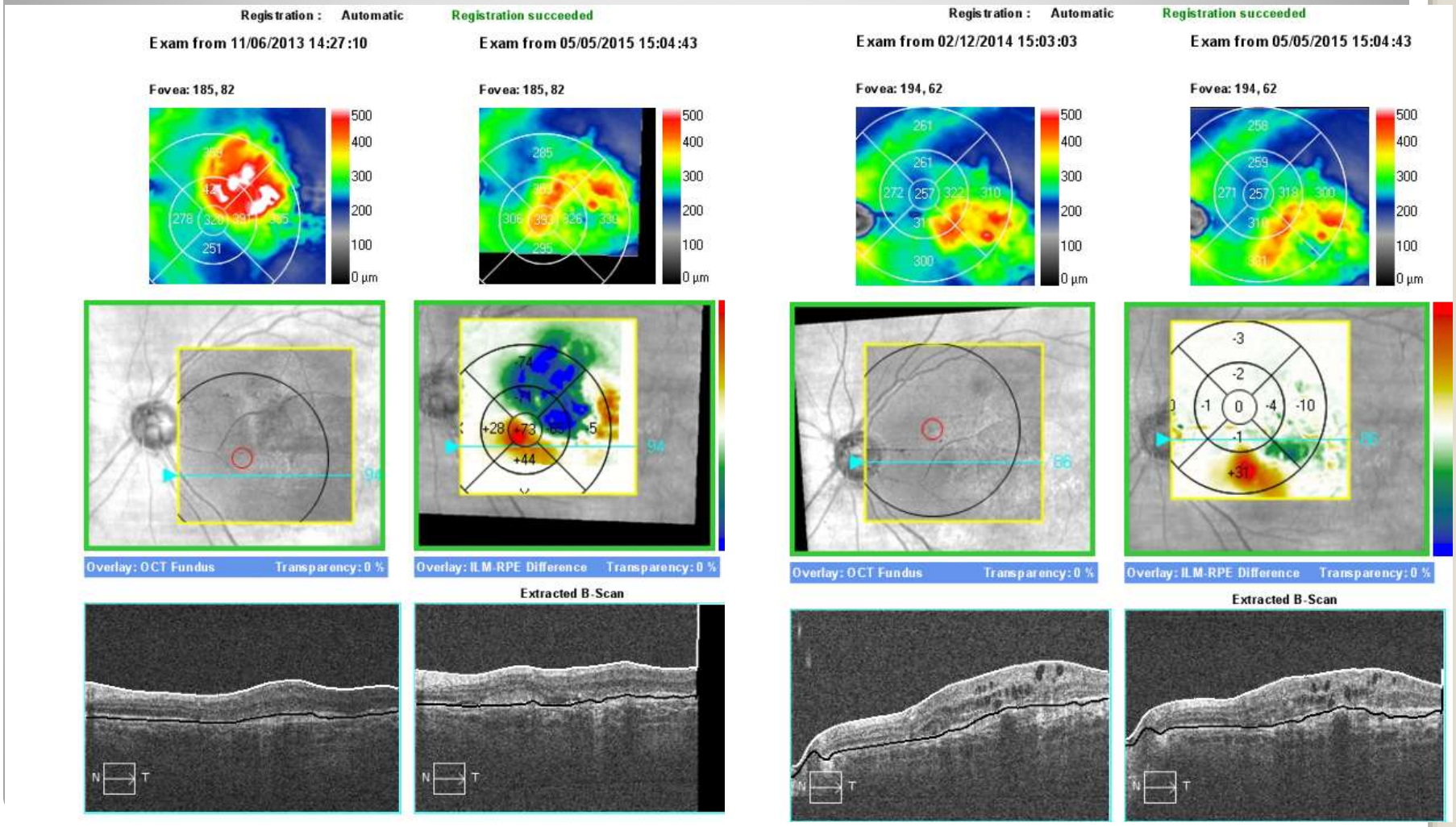
86 F

.5 Apri .3

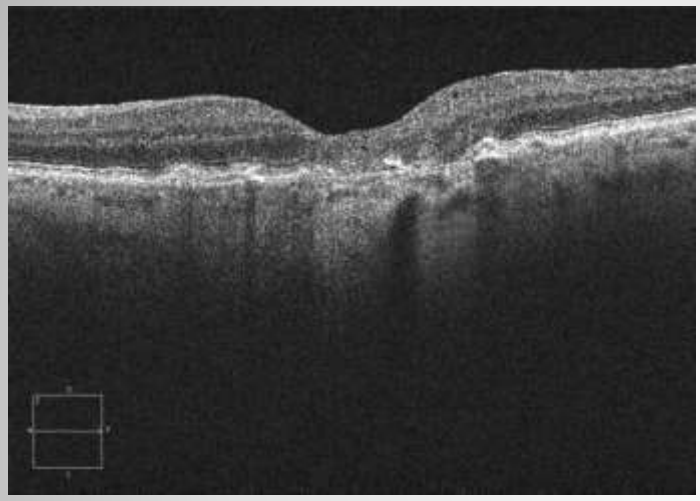
.36 May .8

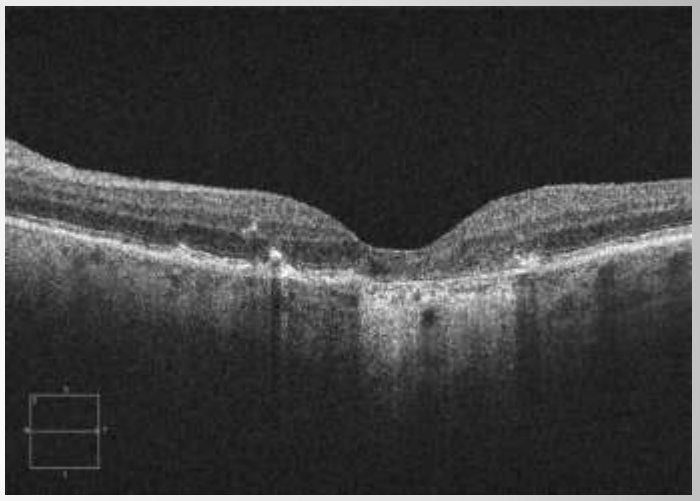


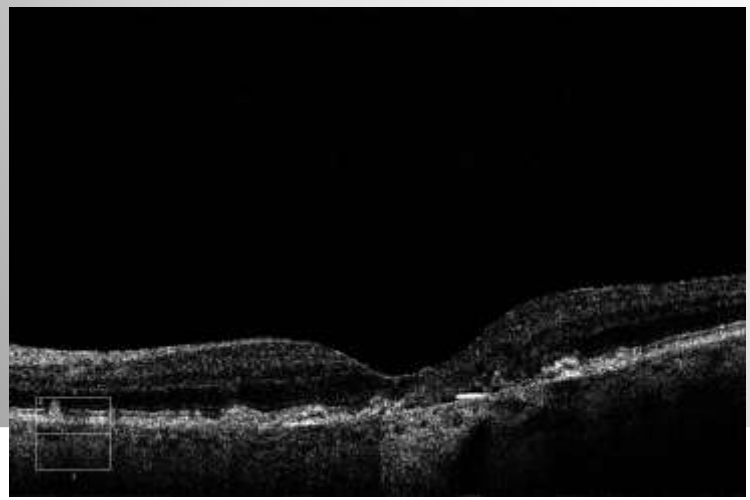
3d Look at slices as well

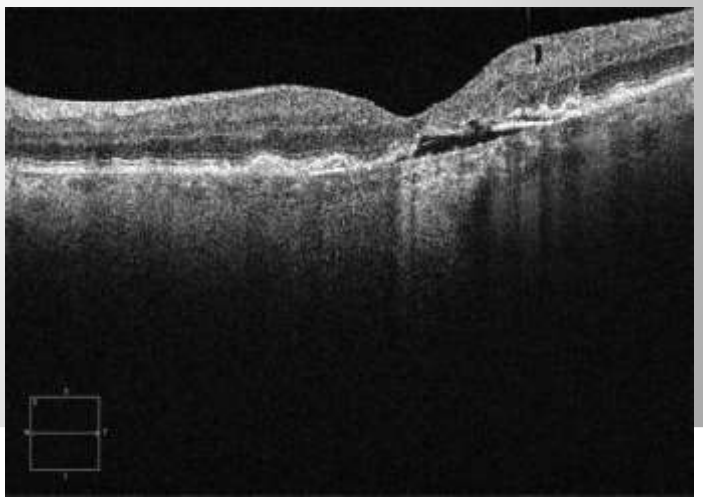


4 up comparisons between visits

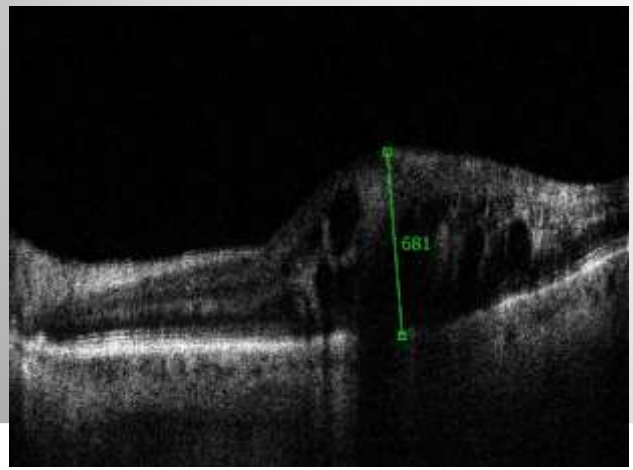








Zeiss Cirrus HD-OCT Change analysis



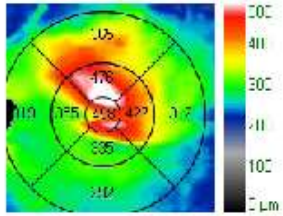
Name:	BINDON-WRIGHT, RITA		Previous	Current	
ID:	S/10220	Exam Date:	19/09/2009	17/10/2009	The Lee Medical Practice
DOB:	16/02/1930	Exam Time:	12:18	13:51	
Gender:	Other	Technician:	Lee, Nicholas		
Doctor:		Signal Strength:	6/10	8/10	

Macular Change:Macular Cube 512x128 OD ○ ● OS

Registration : Manual

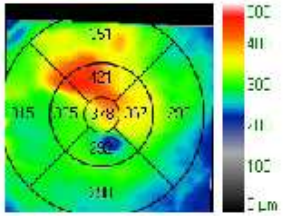
Exam from 19/09/2009 12:18

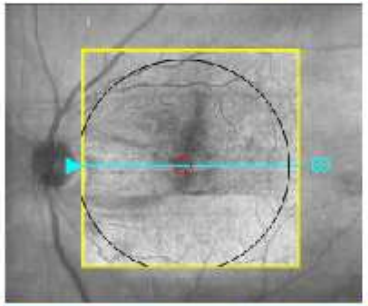
Fovea: 237, 69



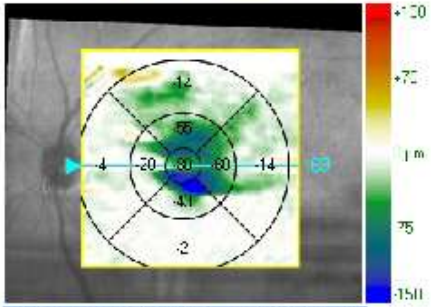
Exam from 17/10/2009 13:51

Fovea: 237, 69



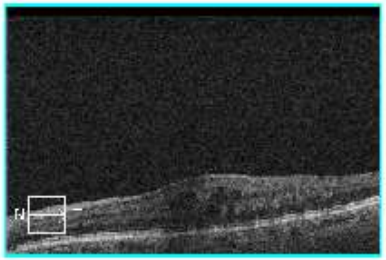


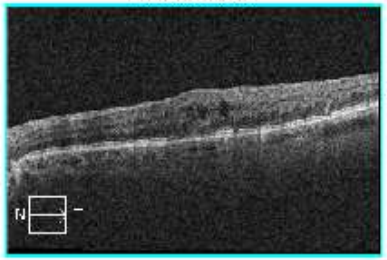
Overlay: OCT Fundus Transparency: 0 %



Overlay: ILM-RPE Difference Transparency: 0 %

Extracted B-Scan





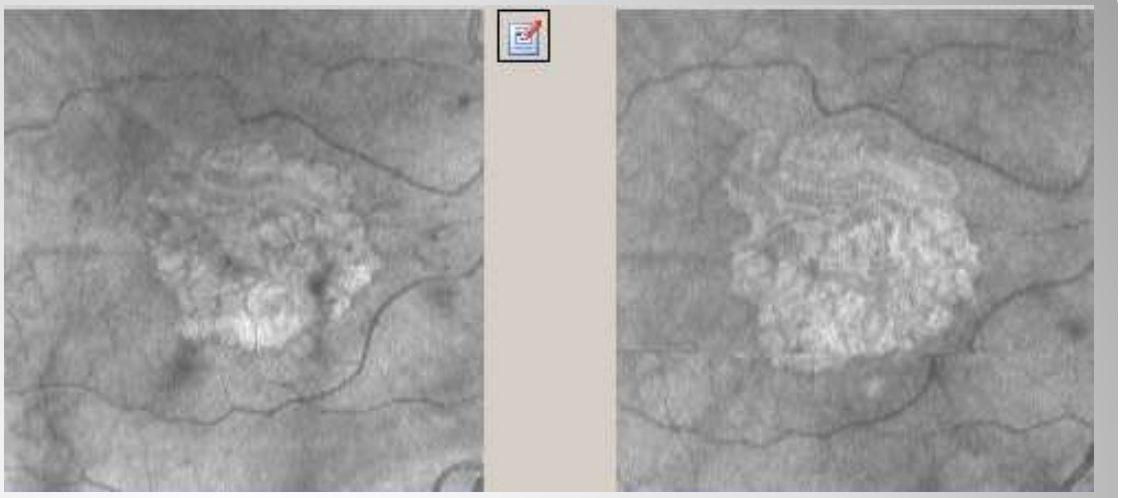
Comments

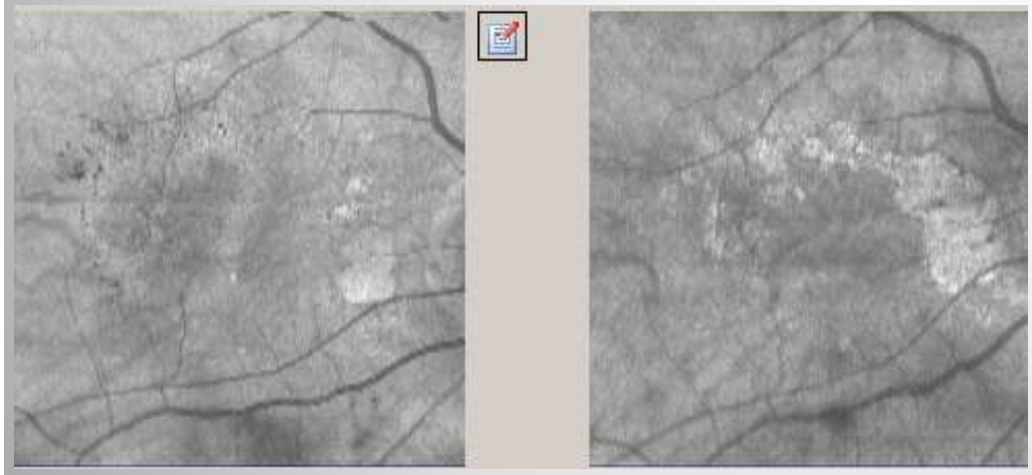
Analysis Altered: 17/10/2009 13:53

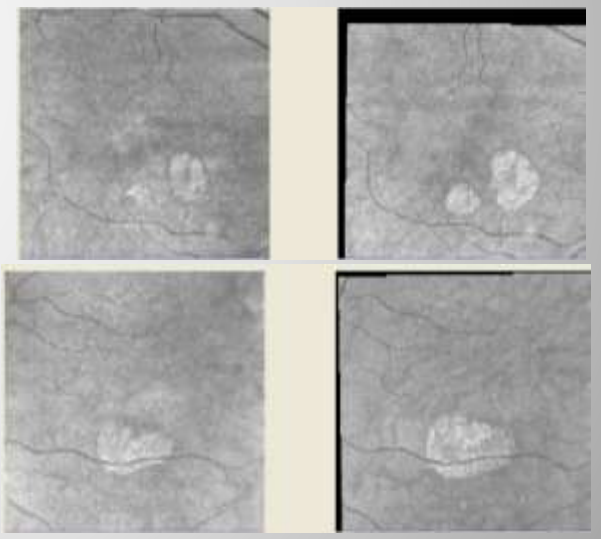
Doctor's Signature

K9
SW Ver: 4.0.1.3

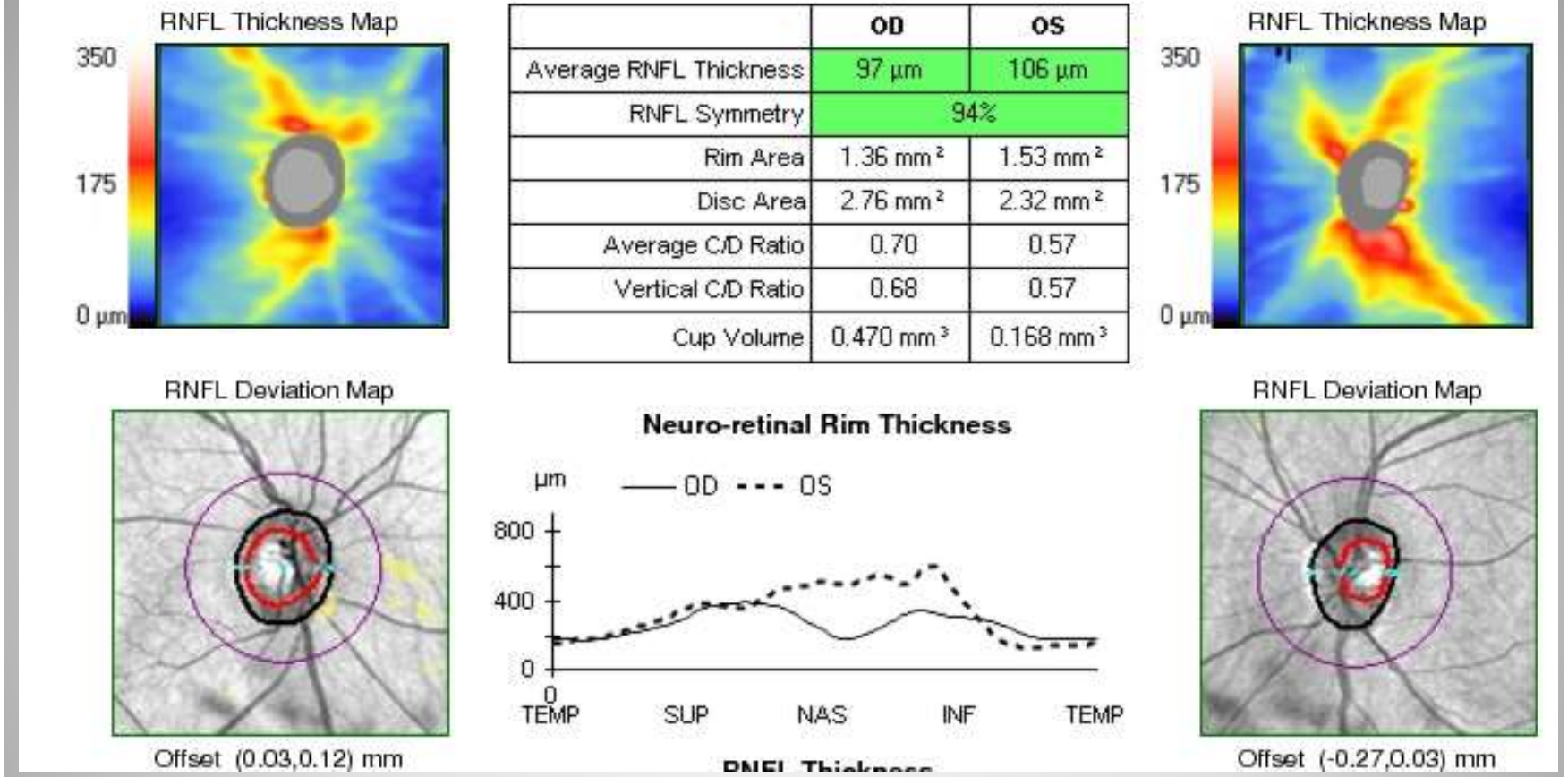
- Increasingly
- Important







Changes in Geographic atrophy
Area measurments in next release



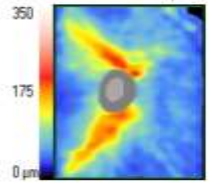
GDx – Optic Nerve Head examination.

Name:	Dixon, Arthur		OD	OS	
ID:	S/11021	Exam Date:	22/09/2010	22/09/2010	The Lee Medical Practice
DOB:	21/01/1930	Exam Time:	19:37	19:36	
Gender:	Unknown	Technician:	L, N		
Doctor:		Signal Strength:	5/10	6/10	

RNFL and ONH:Optic Disc Cube 200x200

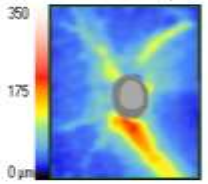
OD ● | ● OS

RNFL Thickness Map

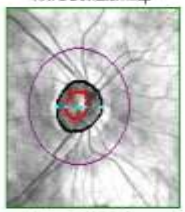


	OD	OS
Average RNFL Thickness	89 µm	76 µm
RNFL Symmetry	87%	
Rim Area	1.29 mm²	1.01 mm²
Disc Area	1.78 mm²	1.82 mm²
Average C/D Ratio	0.52	0.66
Vertical C/D Ratio	0.53	0.65
Cup Volume	0.107 mm³	0.221 mm³

RNFL Thickness Map

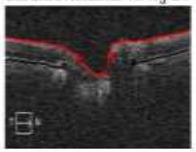


RNFL Deviation Map

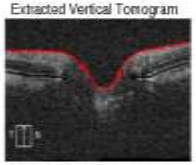


Offset (-0.51,0.06) mm

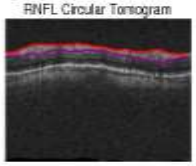
Extracted Horizontal Tomogram



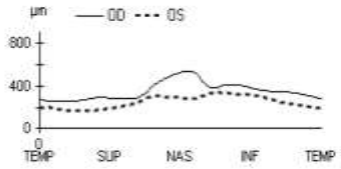
Extracted Vertical Tomogram



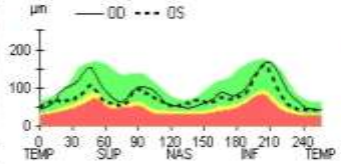
RNFL Circular Tomogram



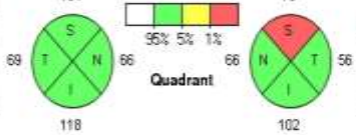
Neuro-retinal Rim Thickness

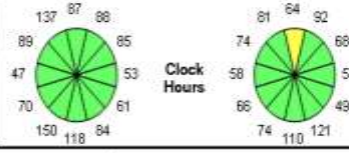


RNFL Thickness

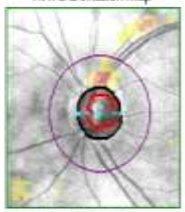


Distribution of Normals



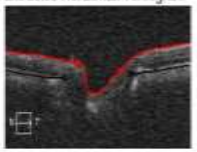


RNFL Deviation Map

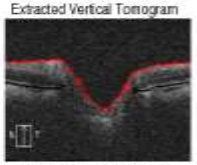


Offset (0.21,-0.15) mm

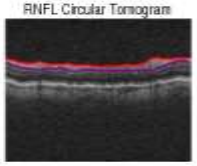
Extracted Horizontal Tomogram



Extracted Vertical Tomogram



RNFL Circular Tomogram



Comments

Doctor's Signature

Single Field Analysis

Eye: Left

Name: Dixon Arthur Mr
DOB: 21-01-1930
ID: s/11021

Central 24-2 Threshold Test

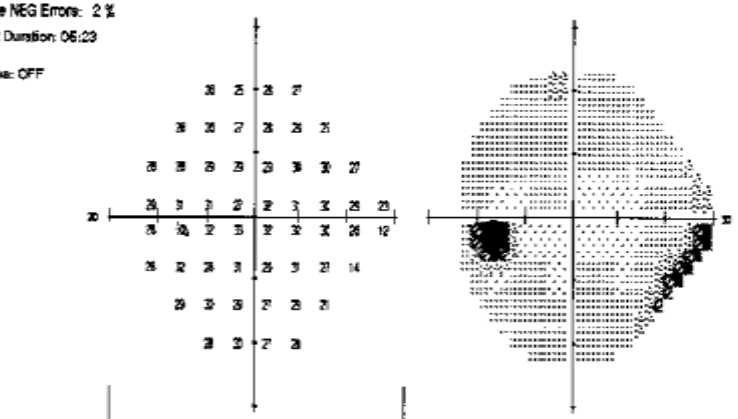
Fixation Monitor: Gaze/Blind Spot
Fixation Target: Central
Fixation Losses: 0/14
False POS Errors: 1 %
False NEG Errors: 2 %
Test Duration: 06:23

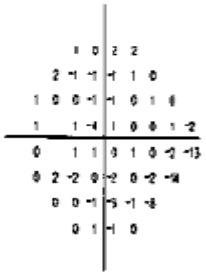
Stimulus: III, White
Background: 31.5 ASB
Strategy: SITA-Standard

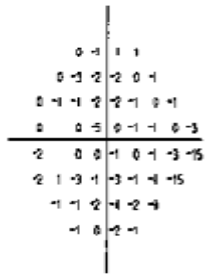
Pupil Diameter:
Visual Acuity:
Rx: +3.00 DS DC: X

Date: 11-10-2010
Time: 19:55
Age: 80

Fovea: OFF







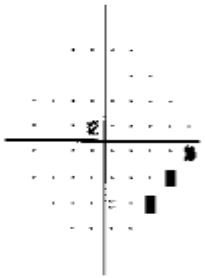
GHT
Outside normal limits

VFI 96%

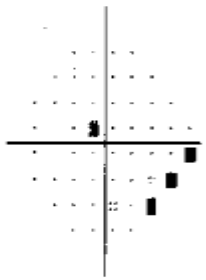
MD -0.61 dB

PSD 2.62 dB P < 2%

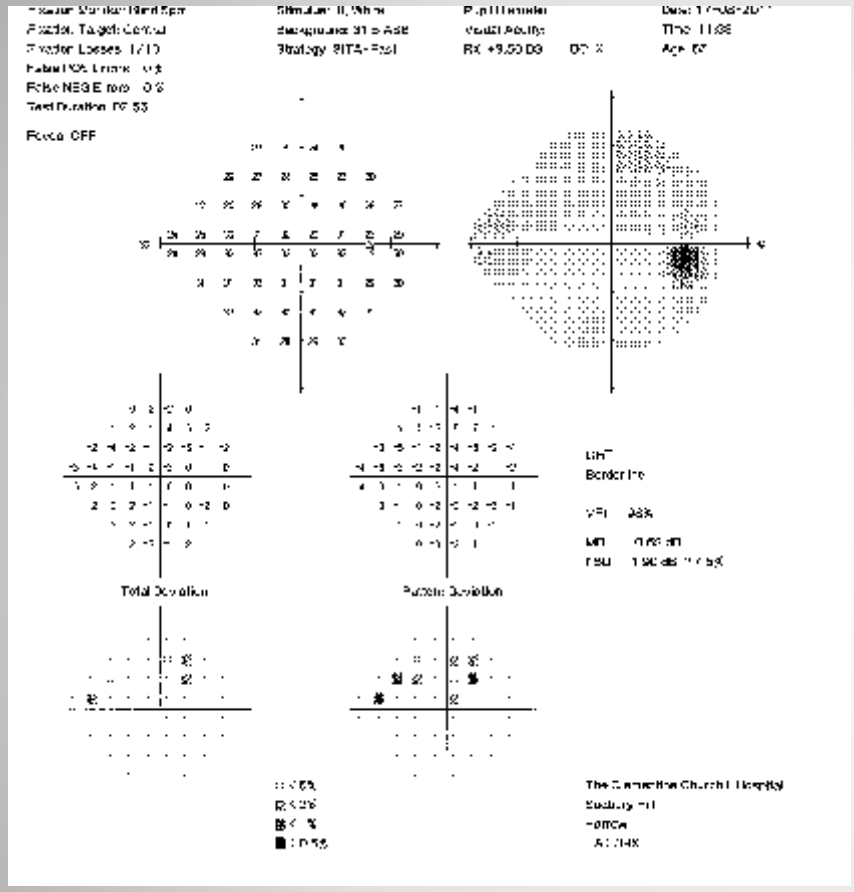
Total Deviation

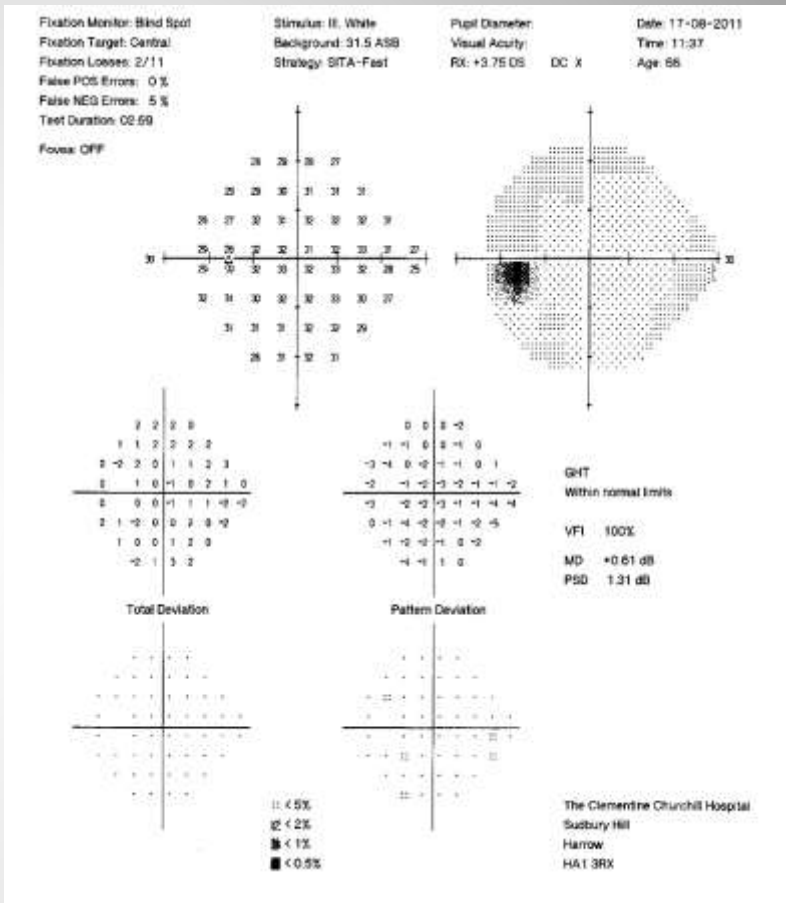


Pattern Deviation



: < 5%
: < 2%
: < 1%
: < 0.5%



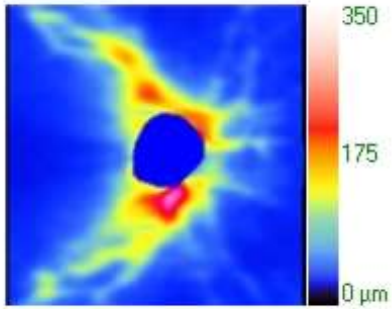


IOP 42 Right 27
Subtle field chnanges in Ry

RNFL Thickness Analysis:Optic Disc Cube 200x200

OD ● | ● OS

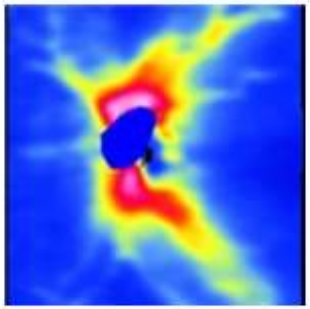
RNFL Thickness Map



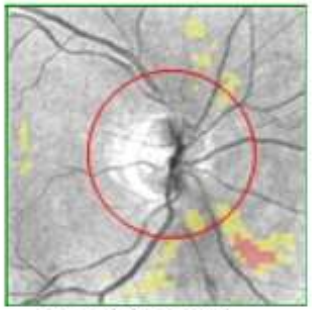
Average Thickness

Quadrants

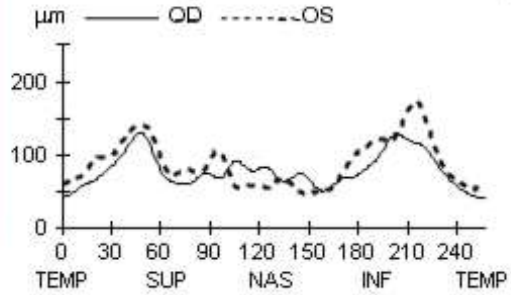
Clock Hours

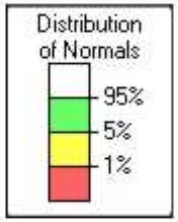


RNFL Thickness Deviation



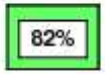
Offset (0.27; 0.06) mm



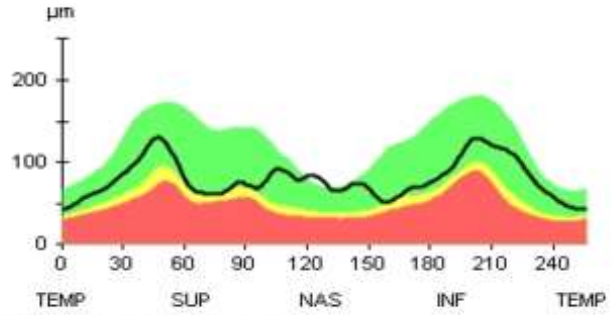


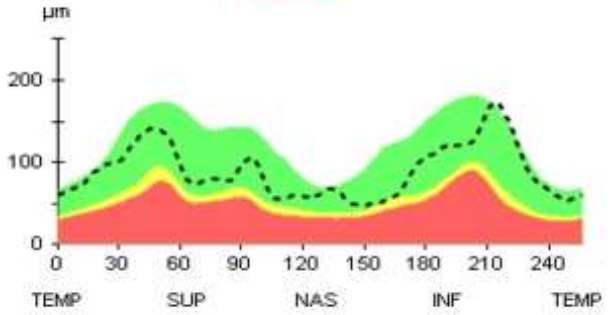
Offset (-0.51; 0.33) mm

Symmetry



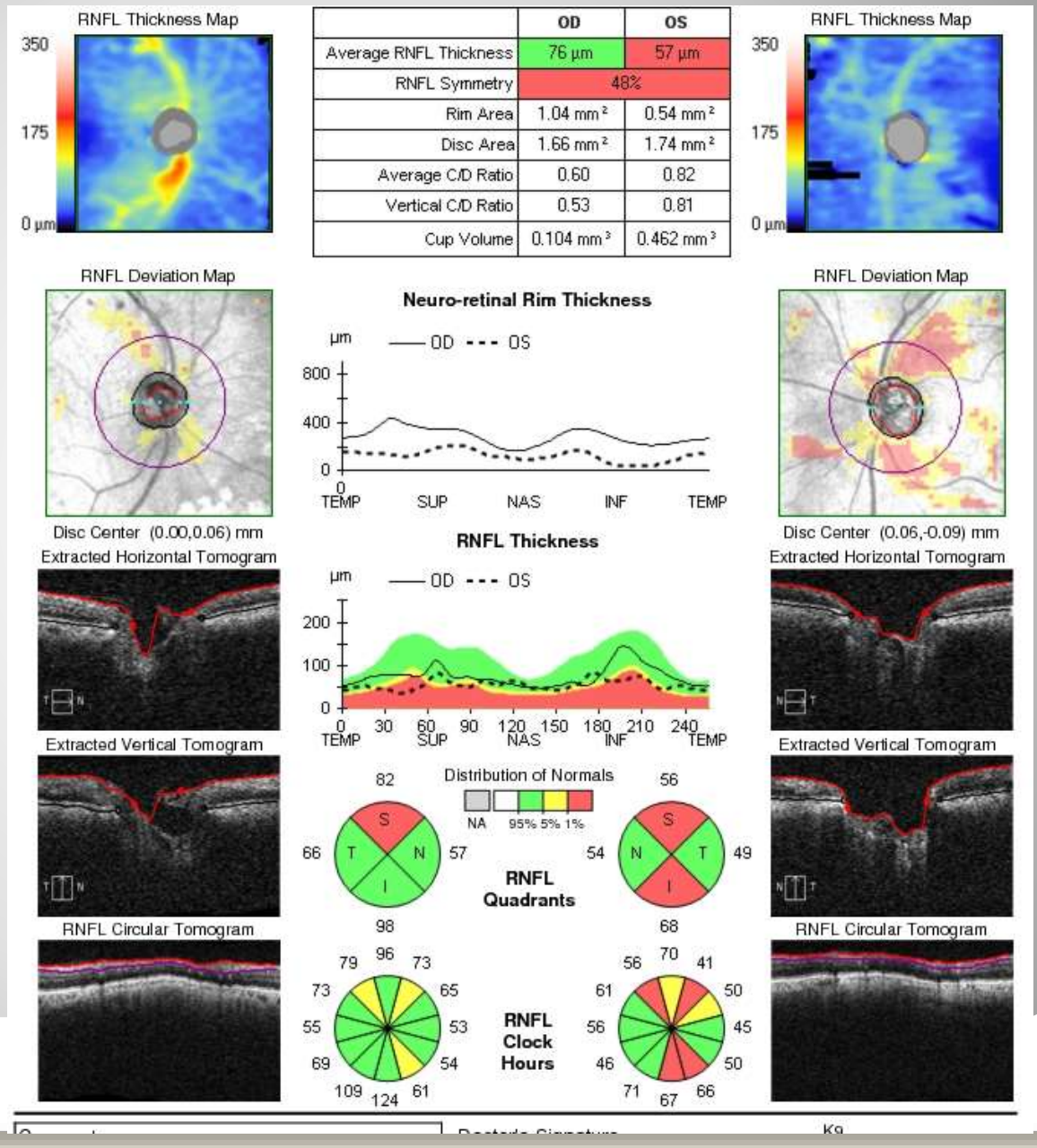
RNFL TSNIT Normative Data



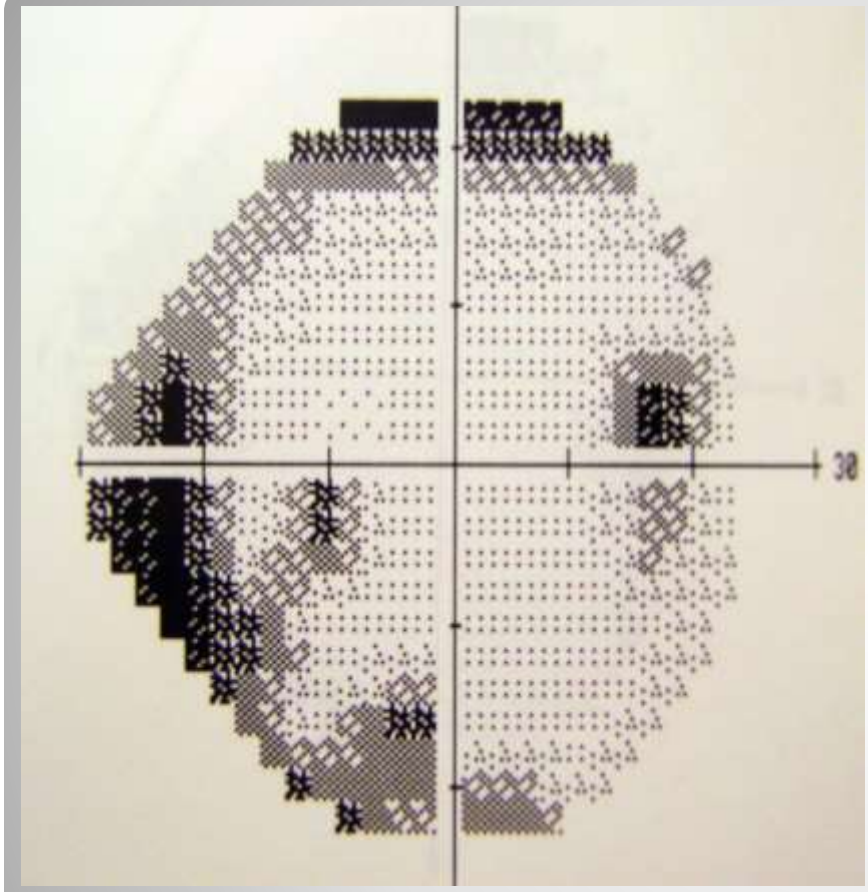


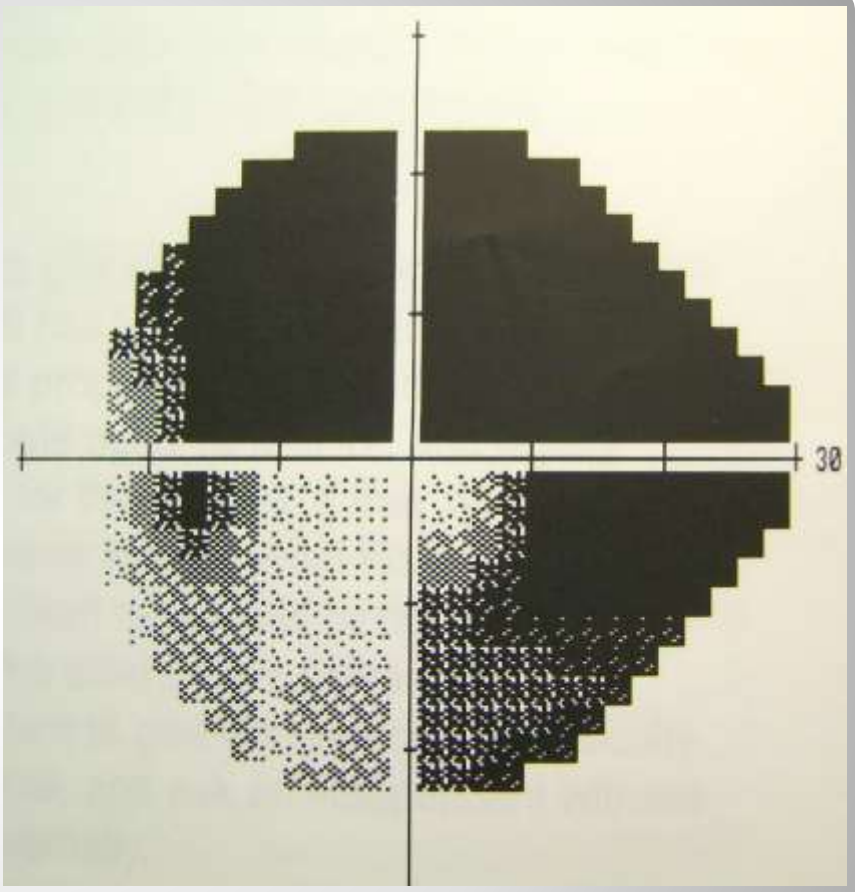
Extracted RNFL Tomogram

- 68 yr male
- 15 yrs diabetic
- IOP R15 L32
- Field defect
- Trabeculectomy Left eye



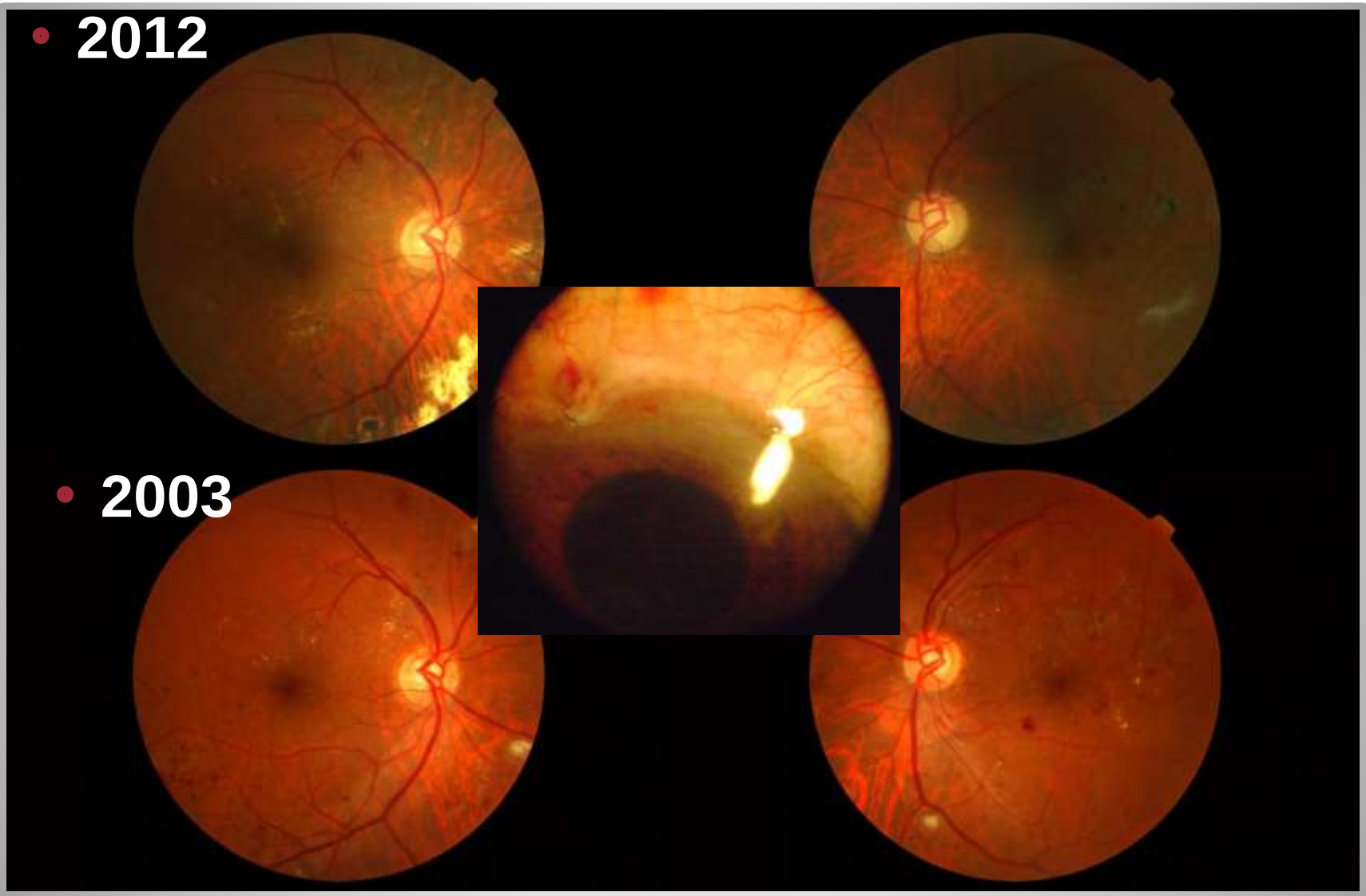
	OD	OS
Average RNFL Thickness	76 µm	57 µm
RNFL Symmetry	48%	
Rim Area	1.04 mm²	0.54 mm²
Disc Area	1.66 mm²	1.74 mm²
Average C/D Ratio	0.60	0.82
Vertical C/D Ratio	0.53	0.81
Cup Volume	0.104 mm³	0.462 mm³



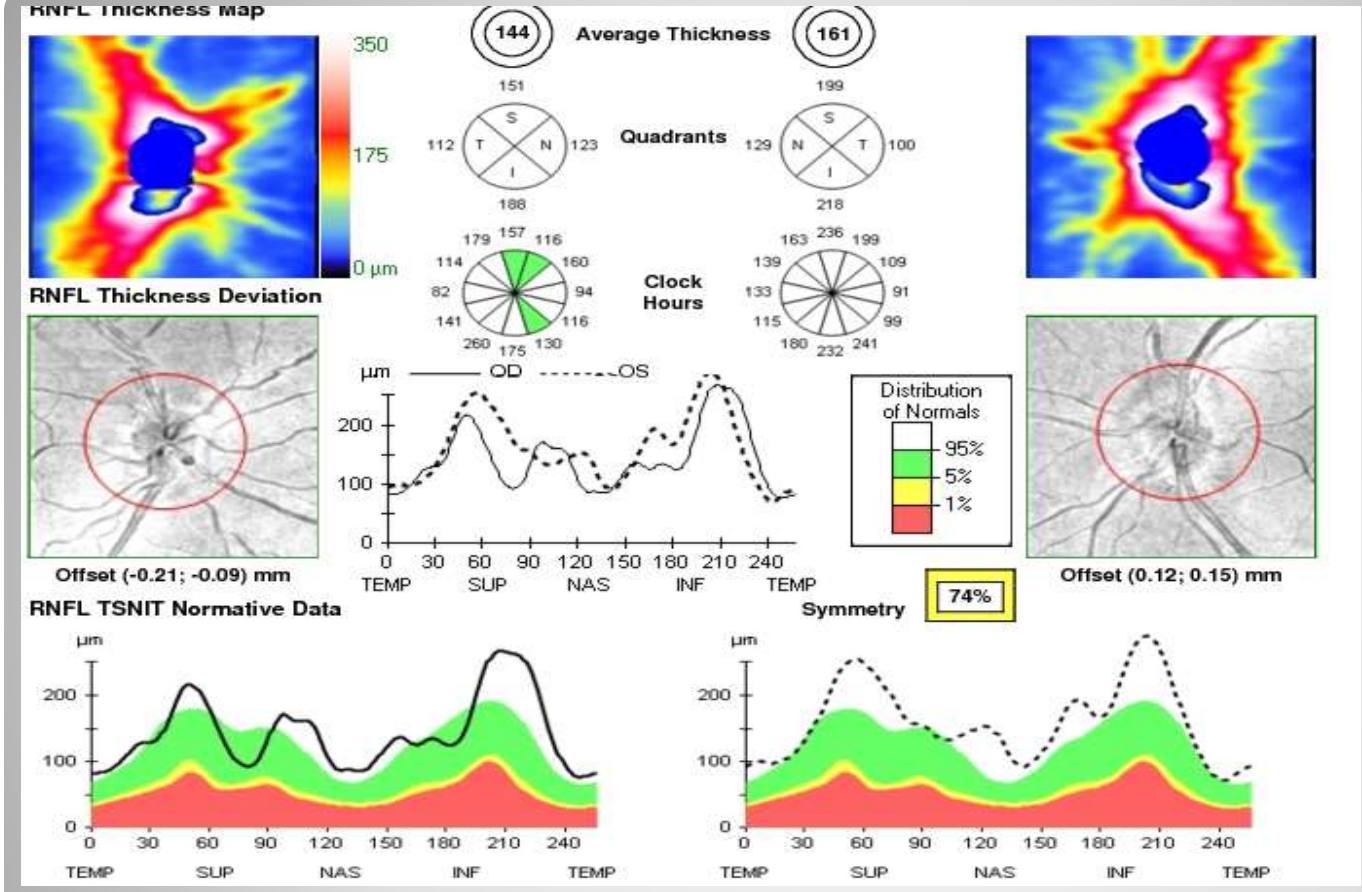


Fields

- 2012
- 2003



Had Trabeculectomy Left eye
iop 23 now.

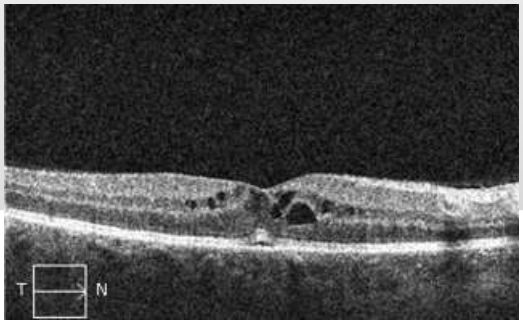


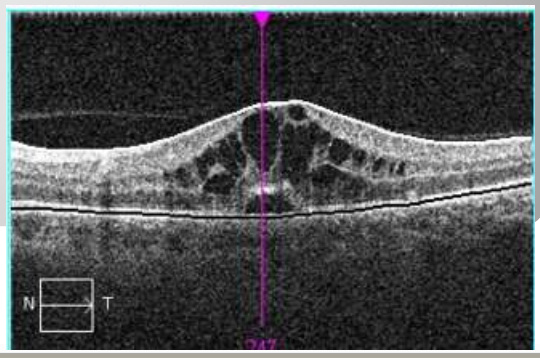
BIH

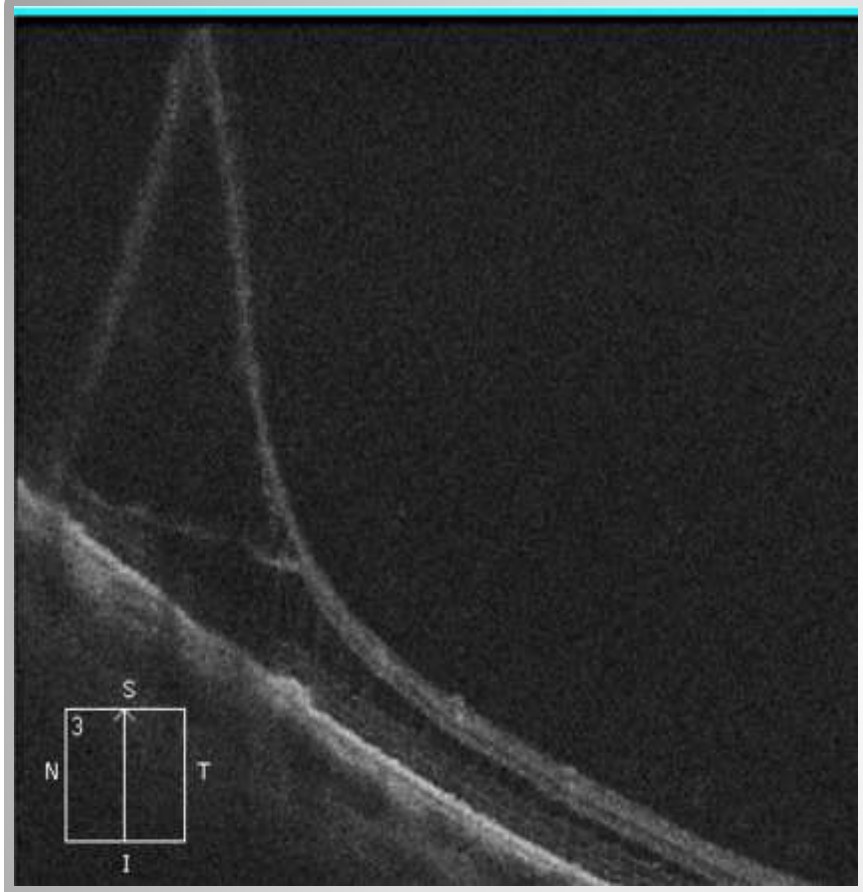
40

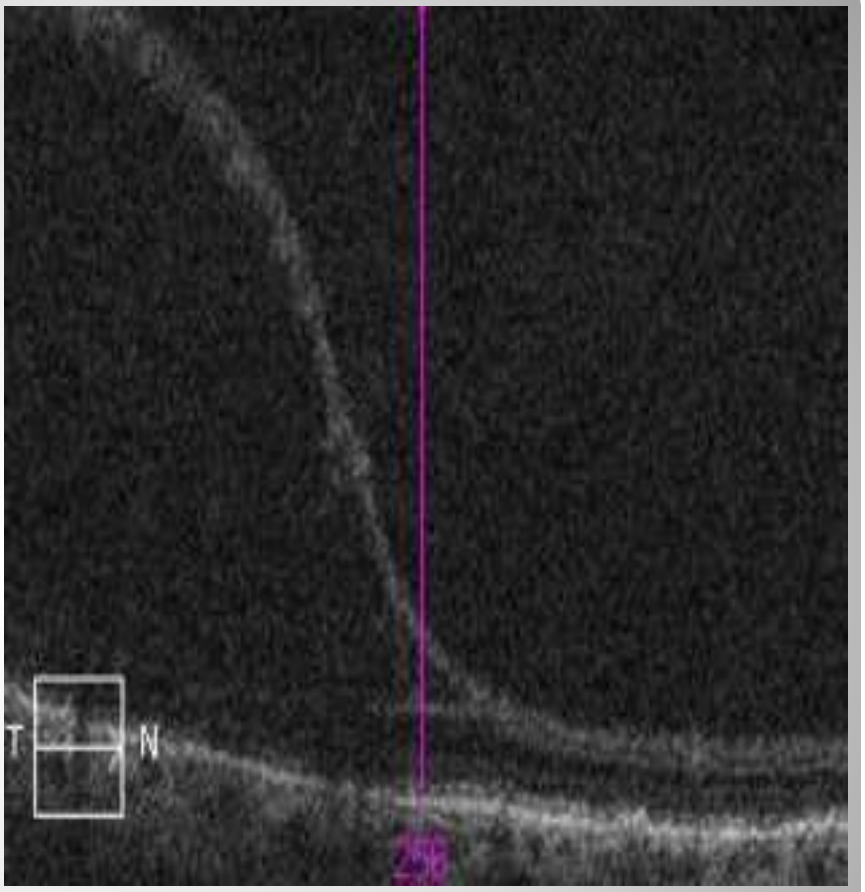
Overweight

Blond





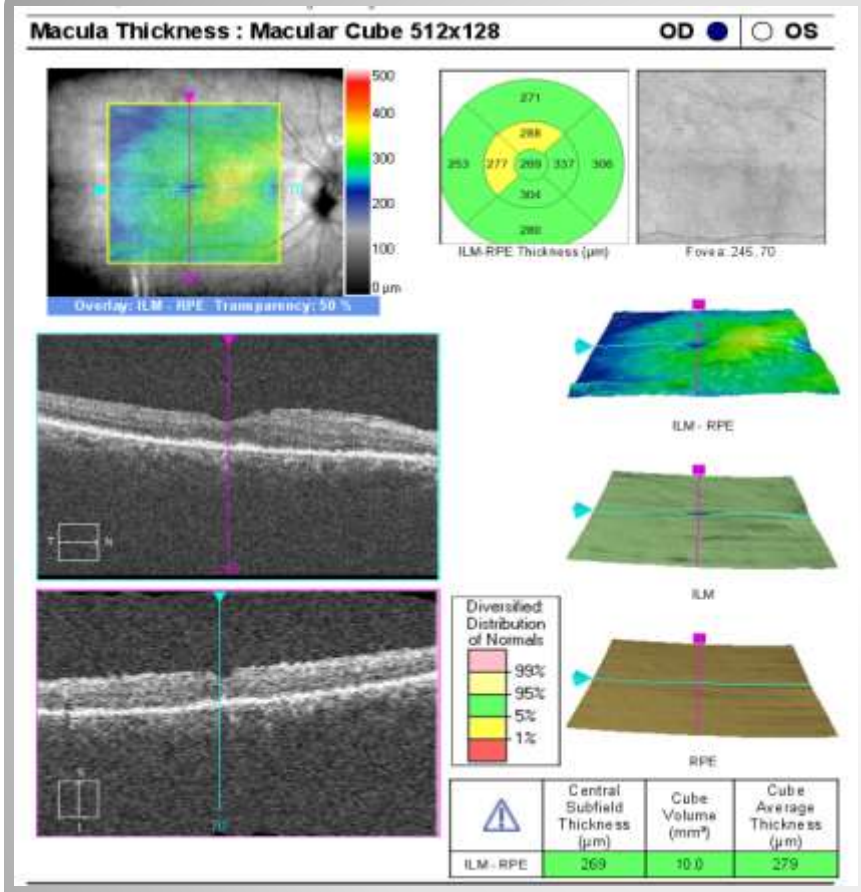


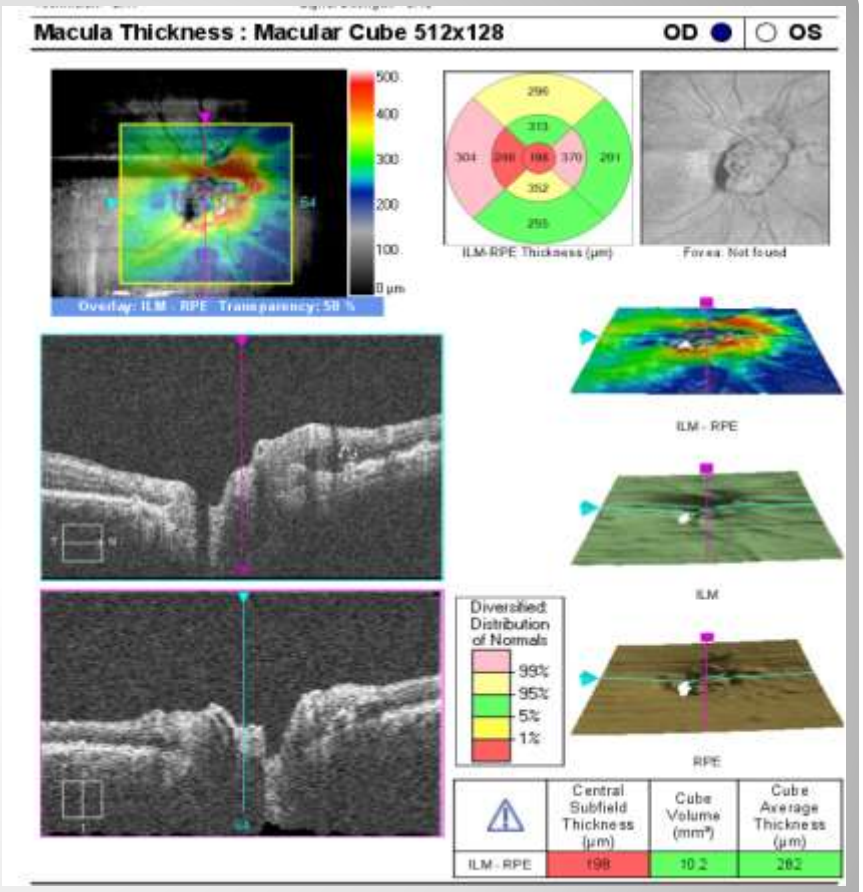


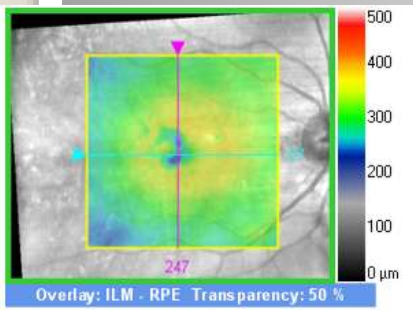
Retinoschisis

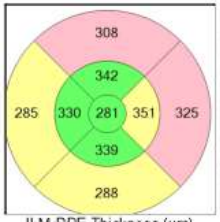
- 88 year old diabetic R0M0
- 6/60 and 6/60
- Inactive disciform around the optic disc
- See OCT
- Obliveates the need for Fundus fluorescein angiography.

PeripPapillary Disciform

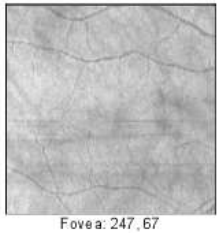

Macula Thickness : Macular Cube 512x128
OD
OS
500
400
300
200
100
0 µm
Overlay: ILM - RPE Transparency: 50 %
271
288
253
277
269
337
306
304
280
ILM-RPE Thickness (µm)
Fovea: 245, 70
ILM - RPE
ILM
RPE
Diversified Distribution of Normals
99%
95%
5%
1%
Central Subfield Thickness (µm)
Cube Volume (mm³)
Cube Average Thickness (µm)
ILM - RPE
269
10.0
279

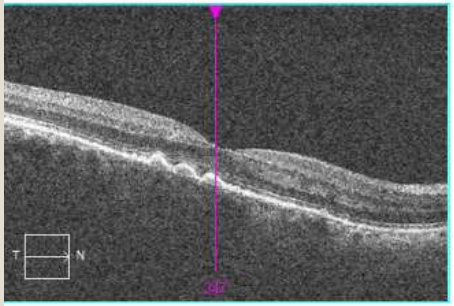

Macula Thickness : Macular Cube 512x128
OD
OS
500
400
300
200
100
0 µm
Overlay: ILM - RPE Transparency: 50 %
296
313
304
298
198
370
291
352
255
ILM-RPE Thickness (µm)
Fovea: Not found
ILM - RPE
ILM
RPE
Diversified Distribution of Normals
99%
95%
5%
1%
Central Subfield Thickness (µm)
Cube Volume (mm³)
Cube Average Thickness (µm)
ILM - RPE
198
10.2
282

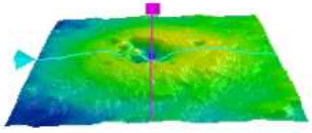


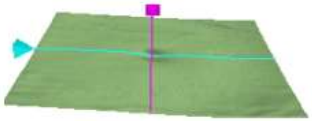


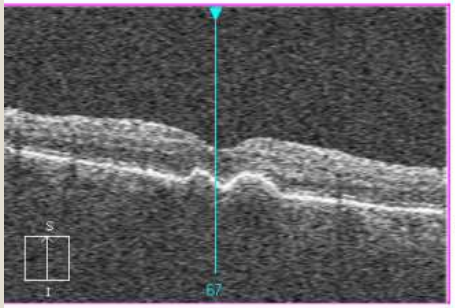
ILM-RPE Thickness (µm)

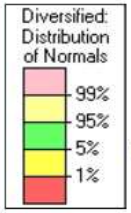

Fovea: 247, 67

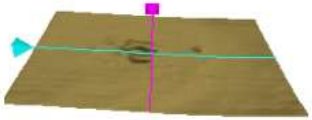



ILM - RPE


ILM





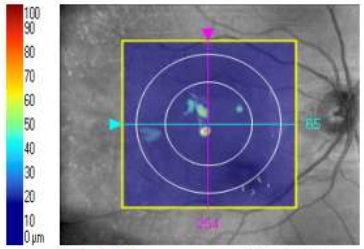

RPE

⚠	Central Subfield Thickness (µm)	Cube Volume (mm³)	Cube Average Thickness (µm)
ILM - RPE	281	10.9	304

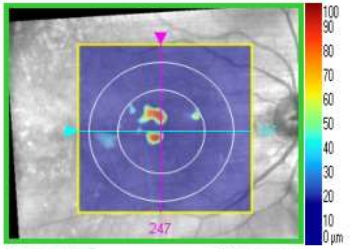
Advanced RPE Analysis : Macular Cube 512x128 OD ● ○ OS

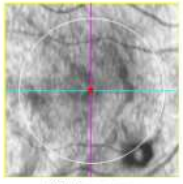
Prior Visit

Current Visit

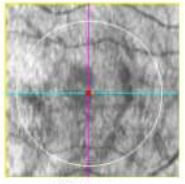


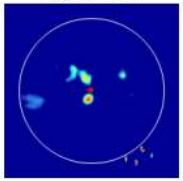
RPE Elevation Map



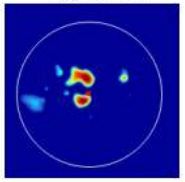

30% Transparency

Sub-RPE Slab


30% Transparency

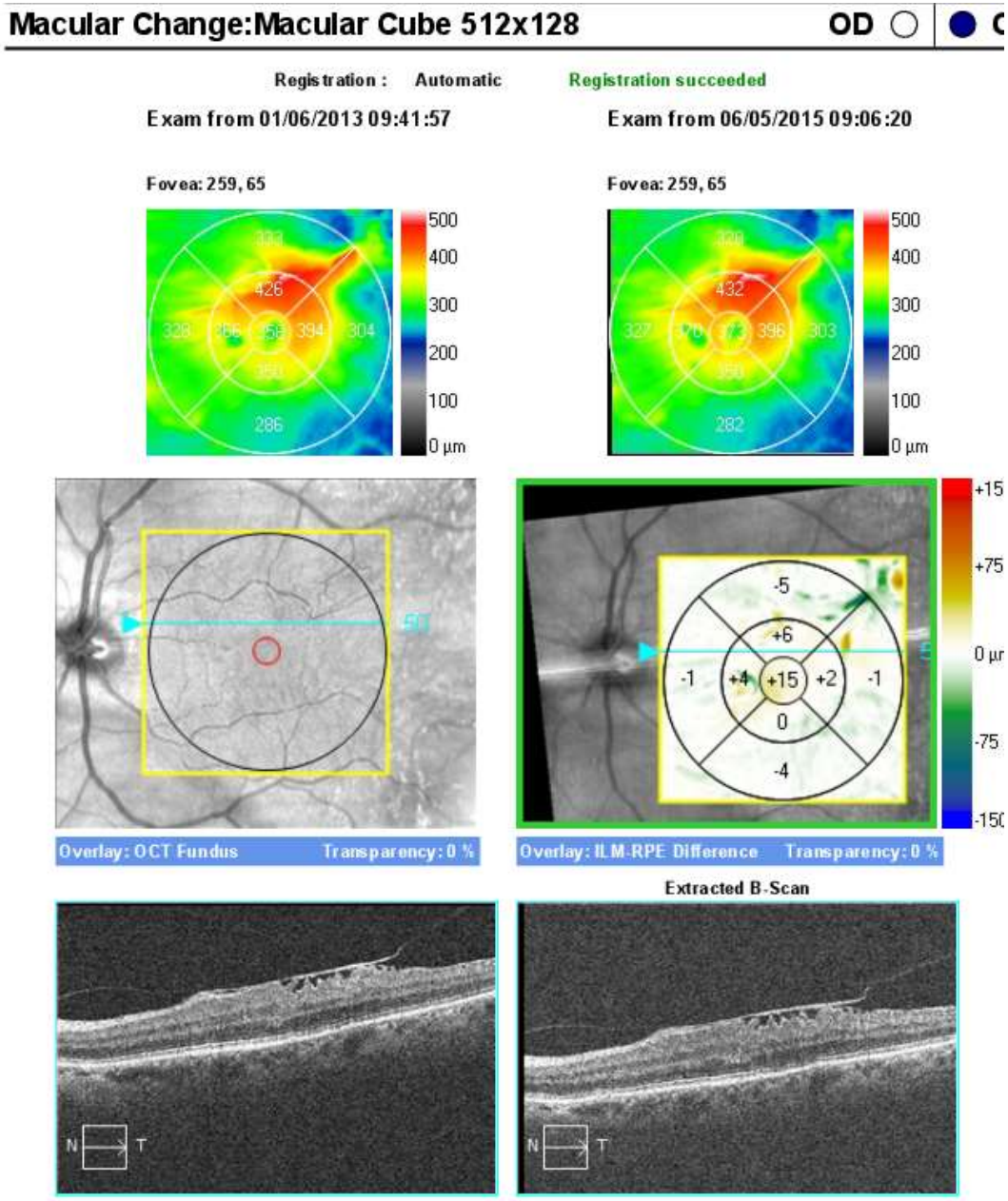


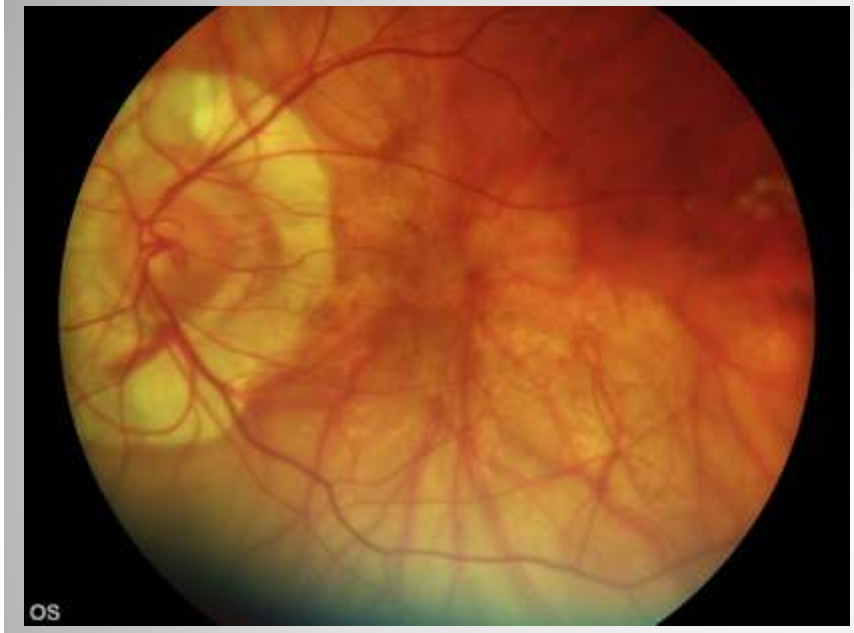
RPE Profile ™

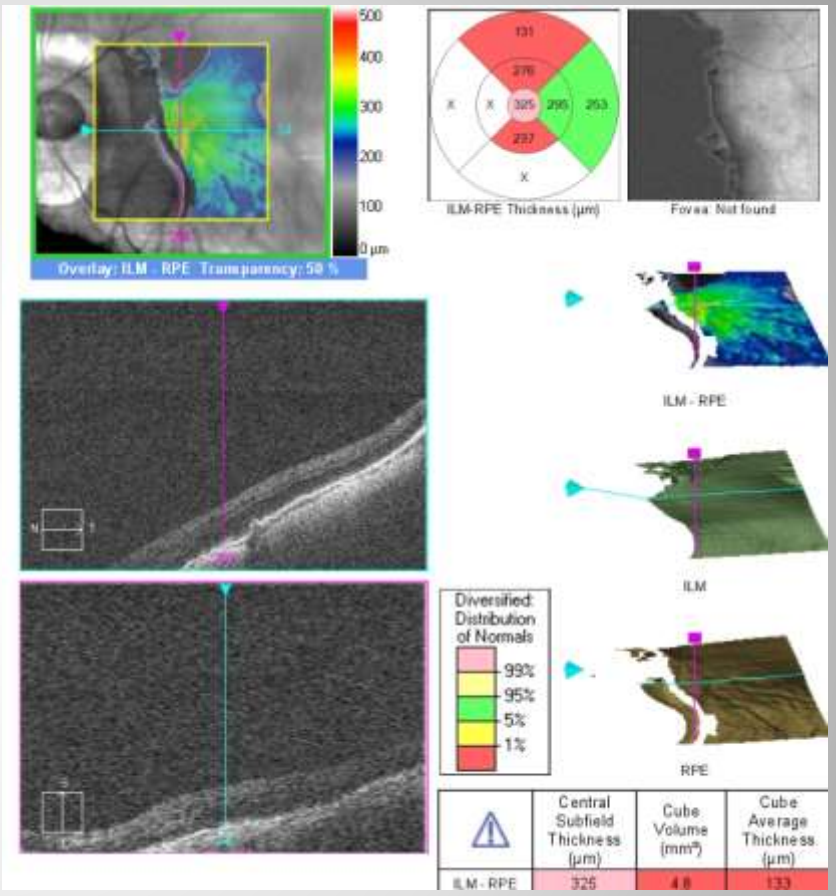


*The calculated difference does not consider test-retest variability.

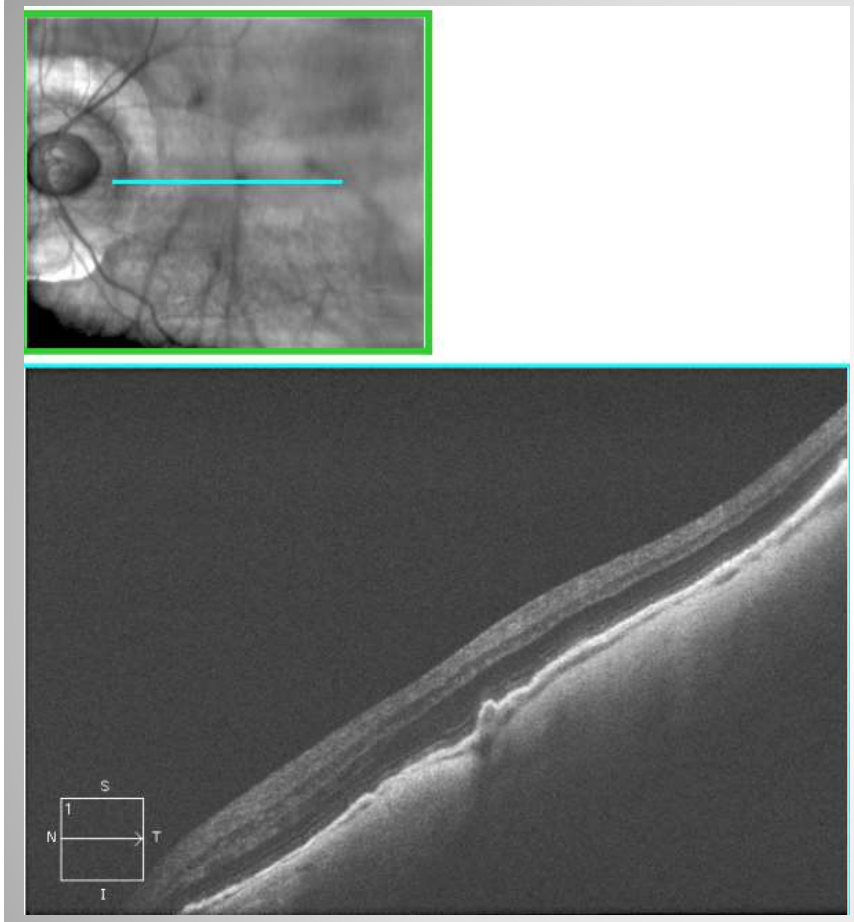
RPE Elevations	Prior	Current	Difference*	% Change
Area in 3 mm Circle (mm²)	0.5	1.0	0.5	100.0%
Area in 5 mm Circle (mm²)	0.7	1.3	0.6	85.7%
Volume in 3 mm Circle (mm³)	0.02	0.05	0.03	150.0%
Volume in 5 mm Circle (mm³)	0.03	0.06	0.03	100.0%
Sub-RPE Illumination	**Prior**	**Current**	**Difference***	**% Change**
Area in 5 mm Circle (mm²)	0.0	0.0	0.0	xxx
Closest distance to Fovea (mm)	xxx	xxx	xxx	xxx

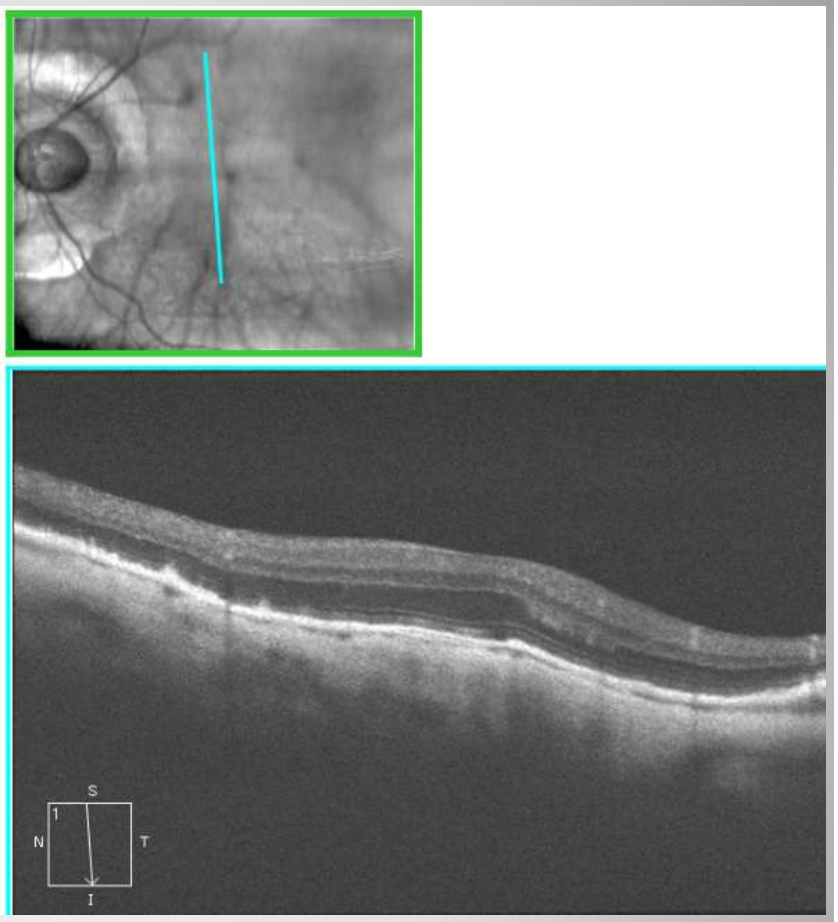

Macular Change:Macular Cube 512x128
OD
Registration : Automatic
Registration succeeded
Exam from 01/06/2013 09:41:57
Exam from 06/05/2015 09:06:20
Fovea: 259, 65
Fovea: 259, 65
500
400
300
200
100
0 µm
426
328
394
304
286
432
327
396
303
282
-5
+6
-1
+4
+15
+2
-1
0
-4
+15
+75
0 µr
-75
-150
Overlay: OCT Fundus
Transparency: 0 %
Overlay: ILM-RPE Difference
Transparency: 0 %
Extracted B-Scan
N
T
N
T



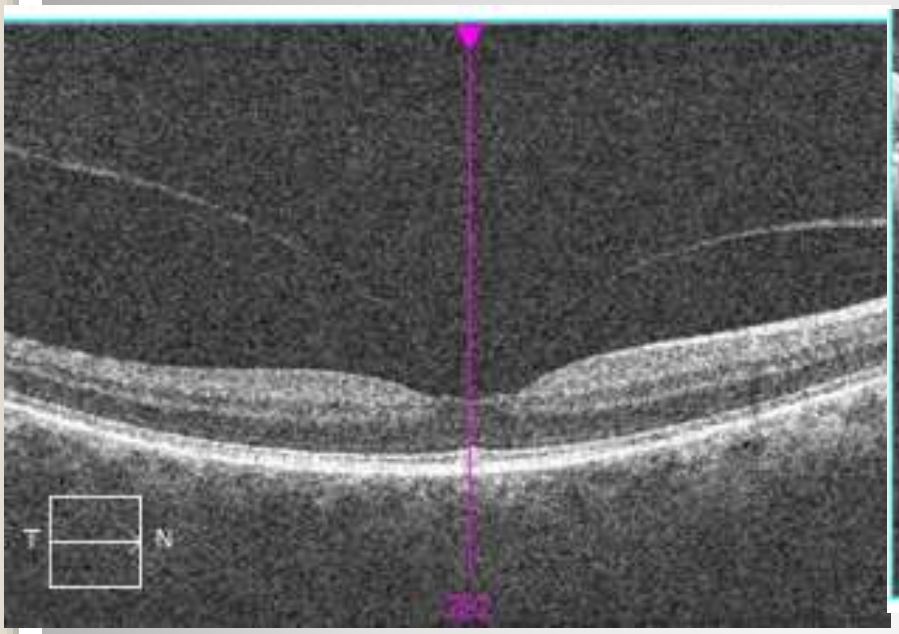


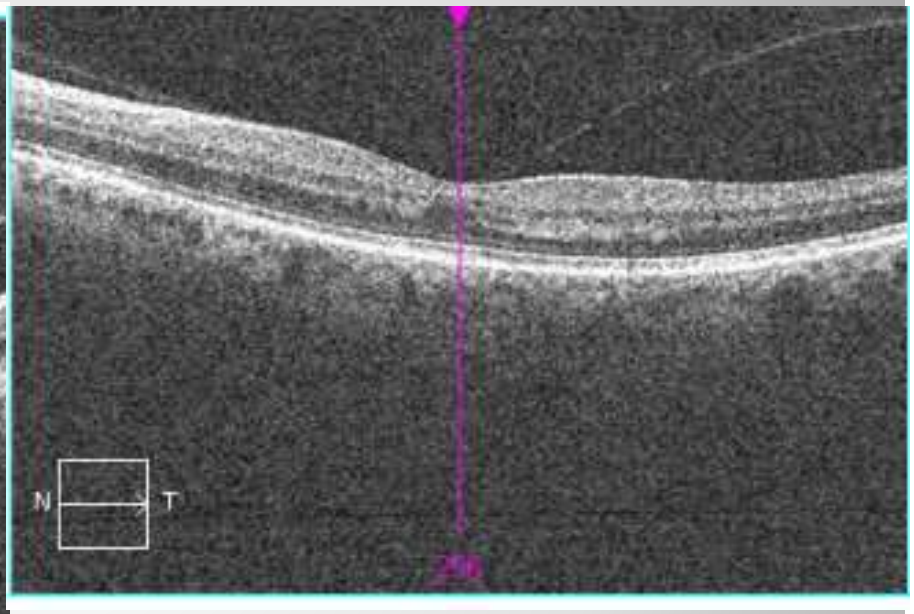
Myopic Fundus



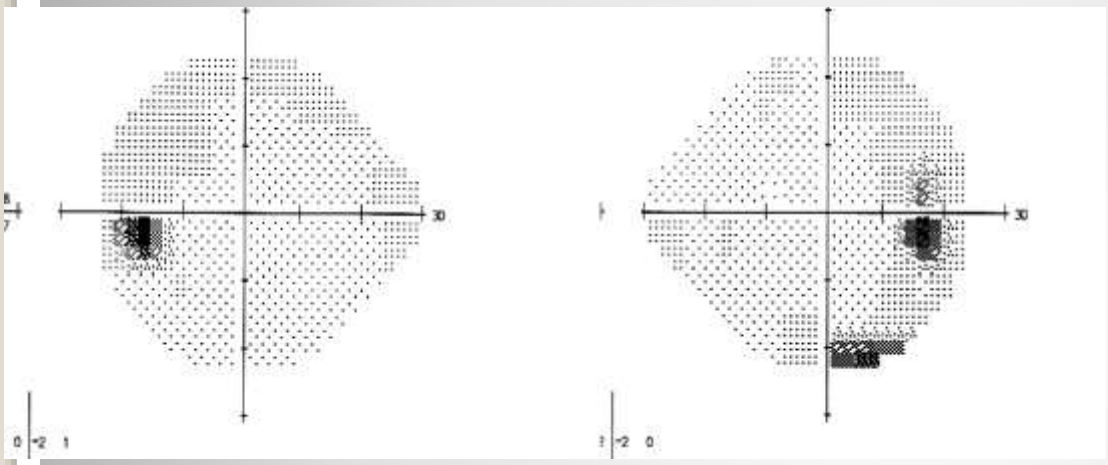


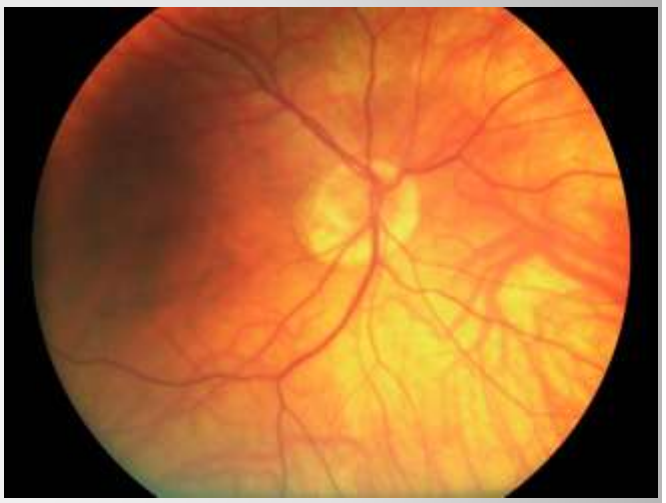
High Myope – Rotate the line scan

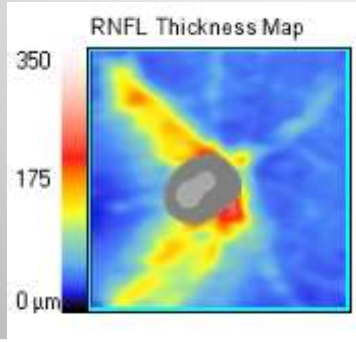




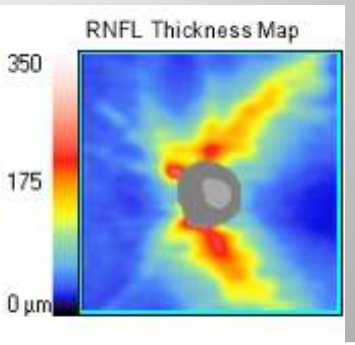
Viteromauclar traction







	OD	OS
Average RNFL Thickness	74 µm	84 µm
RNFL Symmetry	80%	
Rim Area	1.66 mm²	1.42 mm²
Disc Area	2.17 mm²	1.81 mm²
Average C/D Ratio	0.48	0.46
Vertical C/D Ratio	0.45	0.46
Cup Volume	0.036 mm³	0.068 mm³

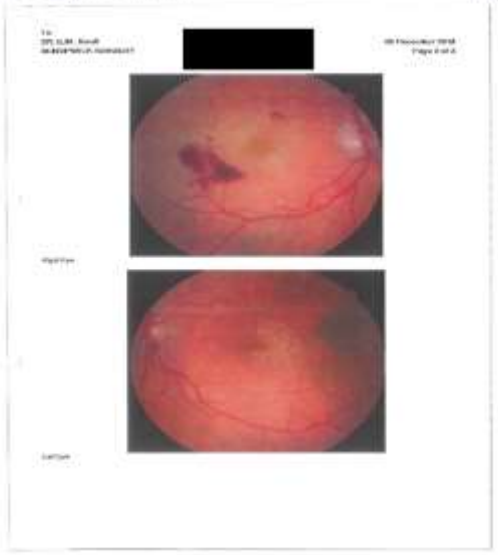


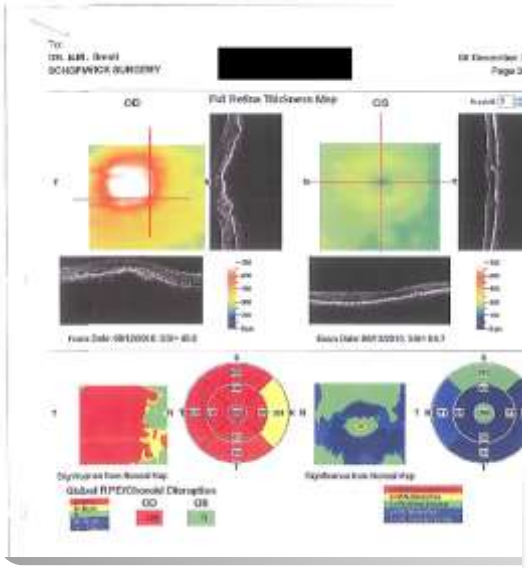
Referrals

- Fax – Black images
- Paper to patient
- Email
- CD
- Internet Web hosting/Remote access

K9

- OCT Essential diagnostic tool
- Unavailability of Scans
  - NHS
  - Privately
- Compact, Sturdy Design
- Modified to be Mobile
  - Pneumatic Wheels
  - OCT & Table separate
  - Shogun Transport
  - Shopping Trolley design
  - Wireless Node
    - Wireless Review stations





(08/12/2010) Parcip Grewal - DR15120-3959.doc Page 1

Radlett Opticians
69 Watling Street
Radlett, Herts. WD7 7AB
Tel: 01923 855888

08 December 2010

To:
DR. N.M. Small
SCHOPWICK SURGERY
EVERETT COURT
ROMELAND
ELSTREE HERTS WD6 3BJ

[redacted]

R				6/30				6/60
L	+1.00	-2.25	80				+3.00	6/9-2 & n9

R	20mmHg (11am)
L	20mmHg

Right Eye	Left Eye
R1 - Mild Diabetic Retinopathy: Blot or round haemorrhages (3) M0 - Urgent Maculopathy: Neovascular membrane (0) Sub-retinal haemorrhage (0) Pigment epithelium detachment (0)	R1 - Mild Diabetic Retinopathy Blot or round haemorrhages (2)

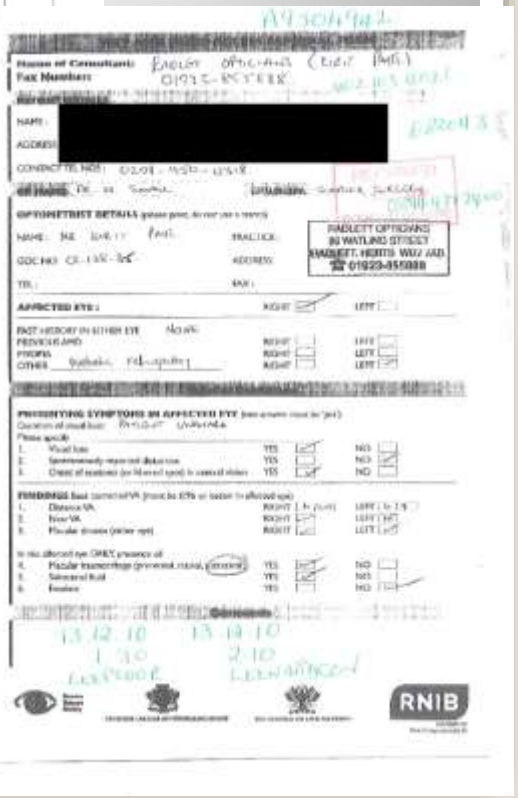
Right Eye	Left Eye
Wet Senile Macula Degeneration: (Mild)	Choroidal Nevous: (Mild)

ADVICE
Dear Mr. Lee,
I would be most grateful if you could see Phyllis for wet macula degeneration in the right eye. She fe
vision has gradually deteriorated?
On thorough examination today, she revealed central retinal pigment epithelium detachment. Inferio
temporal there is a sub retinal haemorrhage and corresponding serous retinopathy.
I believe she has occult choroidal neovascular membrane which has caused the leakage and macula
Her central macula thickness is 555 microns.
She has signs of R1 diabetic retinopathy in each eye and the left shows slight dry AMD changes and
previous focal photocoagulation close to the fovea.

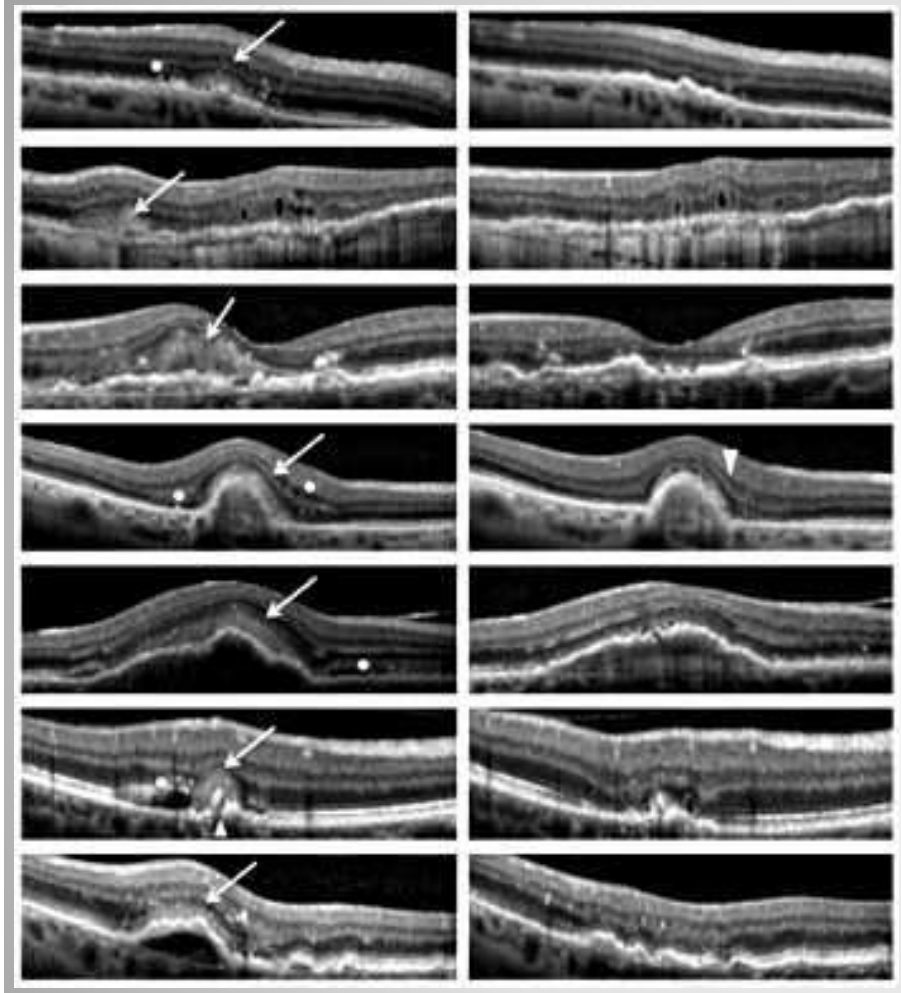
REASSESSMENT
one years time.

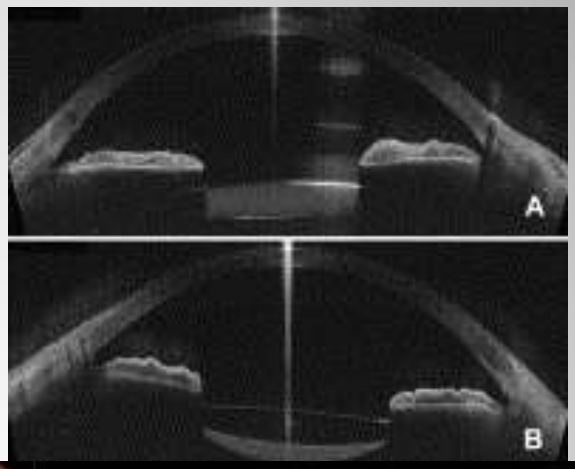
Yours sincerely

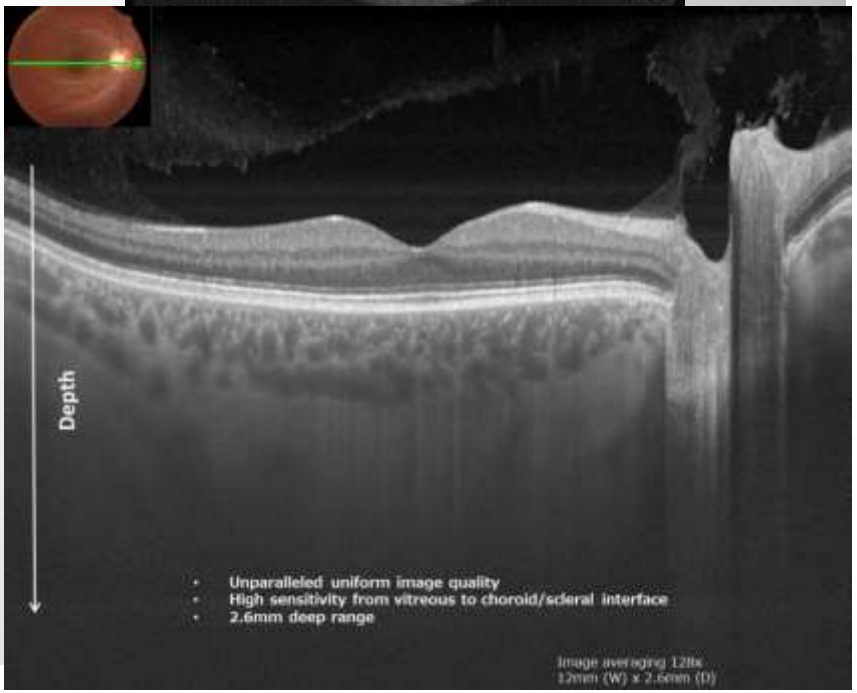
Kirti Patel MBCO BSc (Hons)



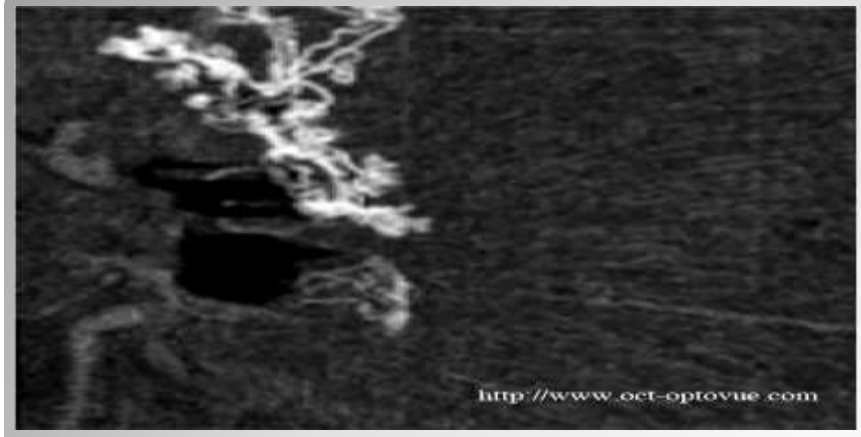
- **Quality Referral**

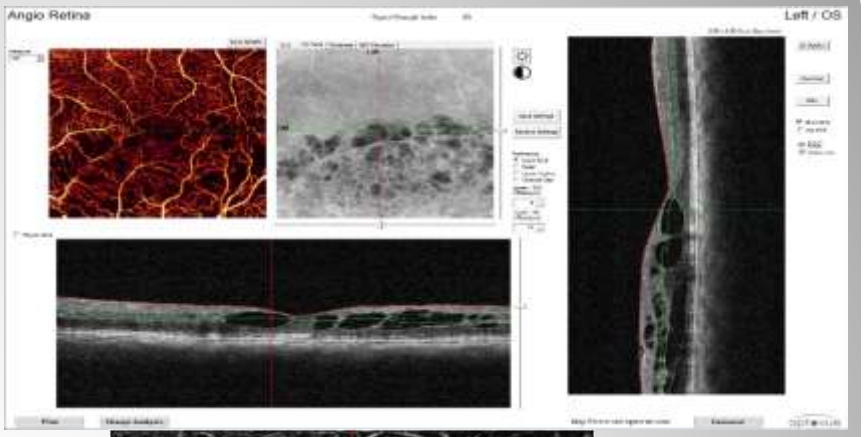


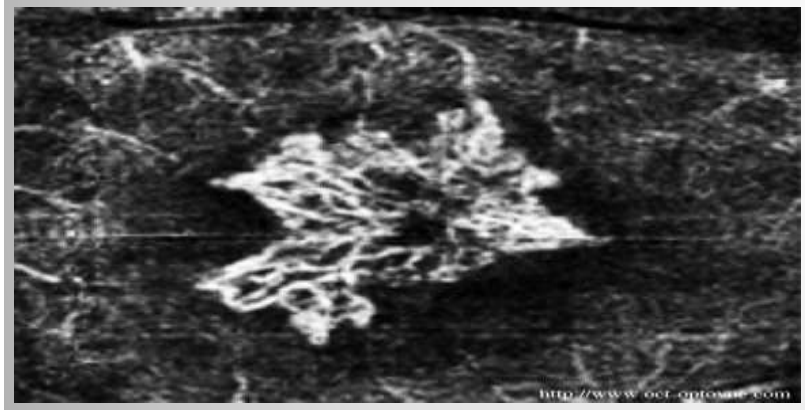

A
B

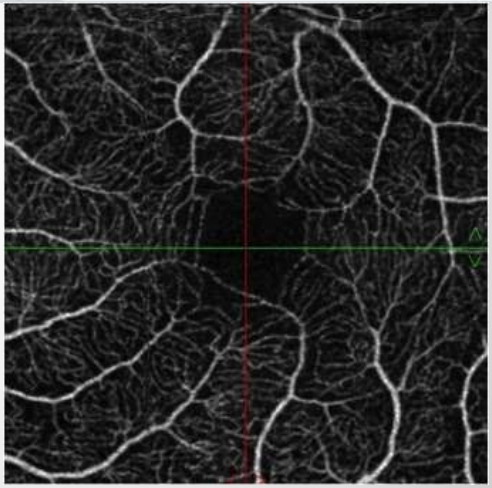

Depth
Unparalleled uniform image quality
High sensitivity from vitreous to choroid/scleral interface
2.6mm deep range
Image averaging 12fix
12mm (W) x 2.6mm (D)

The Future









The Future? Swept Source OCT angiography – No Dye.

- OCT Technology has opened a New World
- Essential Diagnostic
- It sees things you cannot see
- Patient Expectations
- This technology Dove Tails with the Next generation of Drugs for Ophthalmology
- Education is a Journey
- Don’t be left behind
- Embrace the new technology
- Visionix VX120