

Roma, 7 ottobre 2022

## LEGGERE E INTERPRETARE L'OCT: TIPS AND TRICKS

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Ospedale San Giuseppe Milano  
Università degli Studi di Milano



#1

**Cosa posso valutare con OCT**

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# Cosa valuta posso valutare con OCT

ESCAVAZIONE  
PAPILLARE

SPESSORE RNFL

SPESSORE CELL  
GANGLIONARI

AMPIEZZA ANGOLO

STUDIO DELLA BOZZA

VASCULARIZZAZIONE  
NERVO OTTICO

# Diagnosi di glaucoma

Valutazione funzionale



Valutazione strutturale

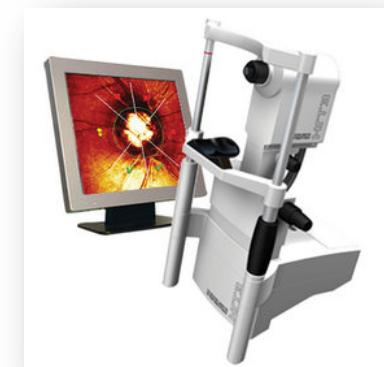


OCT



GDx

Analisi delle fibre  
(RNFL)



HRT

Analisi della  
testa del nervo ottico

# Diagnosi di glaucoma

## Valutazione funzionale



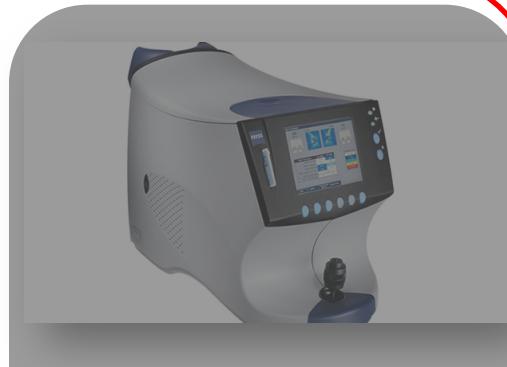
## Valutazione strutturale



OCT



Analisi delle fibre e della testa del nervo ottico  
(RNFL, complesso ganglionare, C/D ratio)



GDx



HRT

Analisi della  
testa del nervo ottico

# OCT

## ONH e RNFL

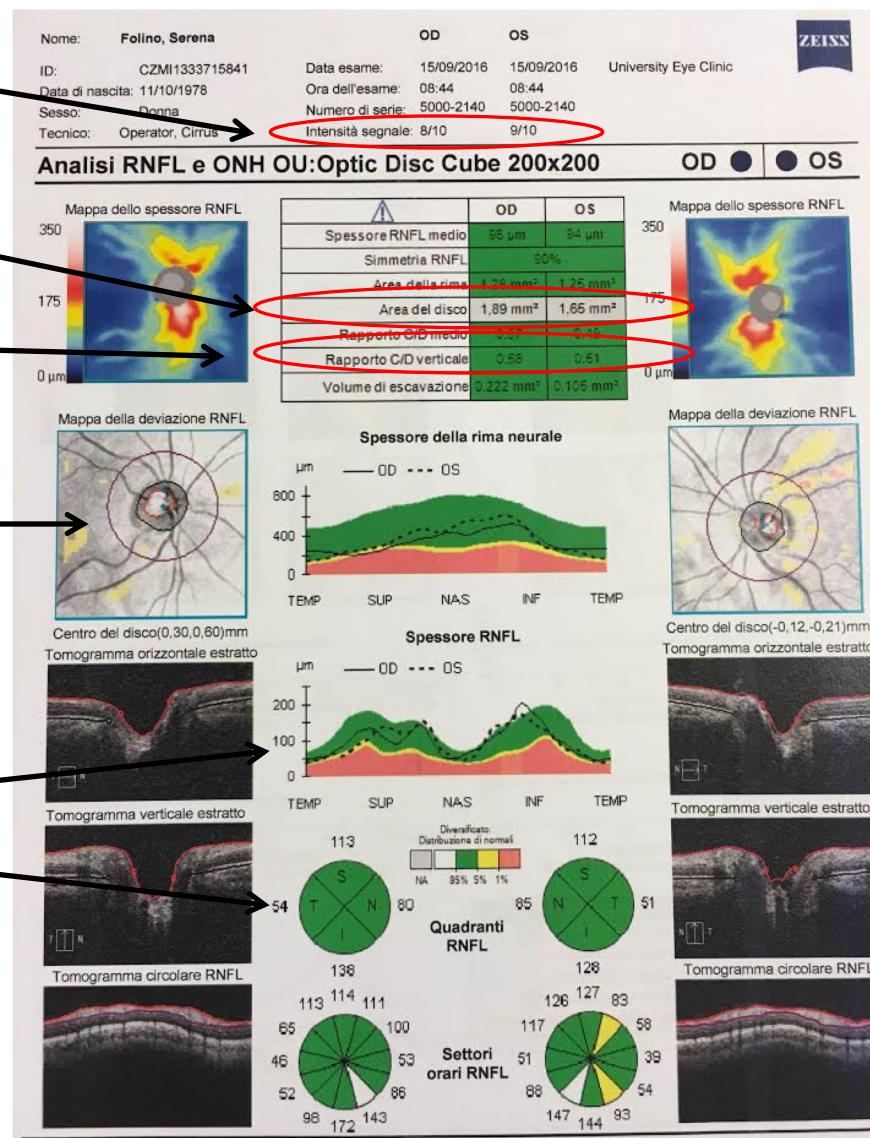
Forza del segnale

Dimensioni del  
disco ottico

Cup/disc  
ratio

Immagine della  
papilla

RNFL



#2

**Quale di questi parametri vi sembra il più  
importante?**

# OCT

## ONH e RNFL

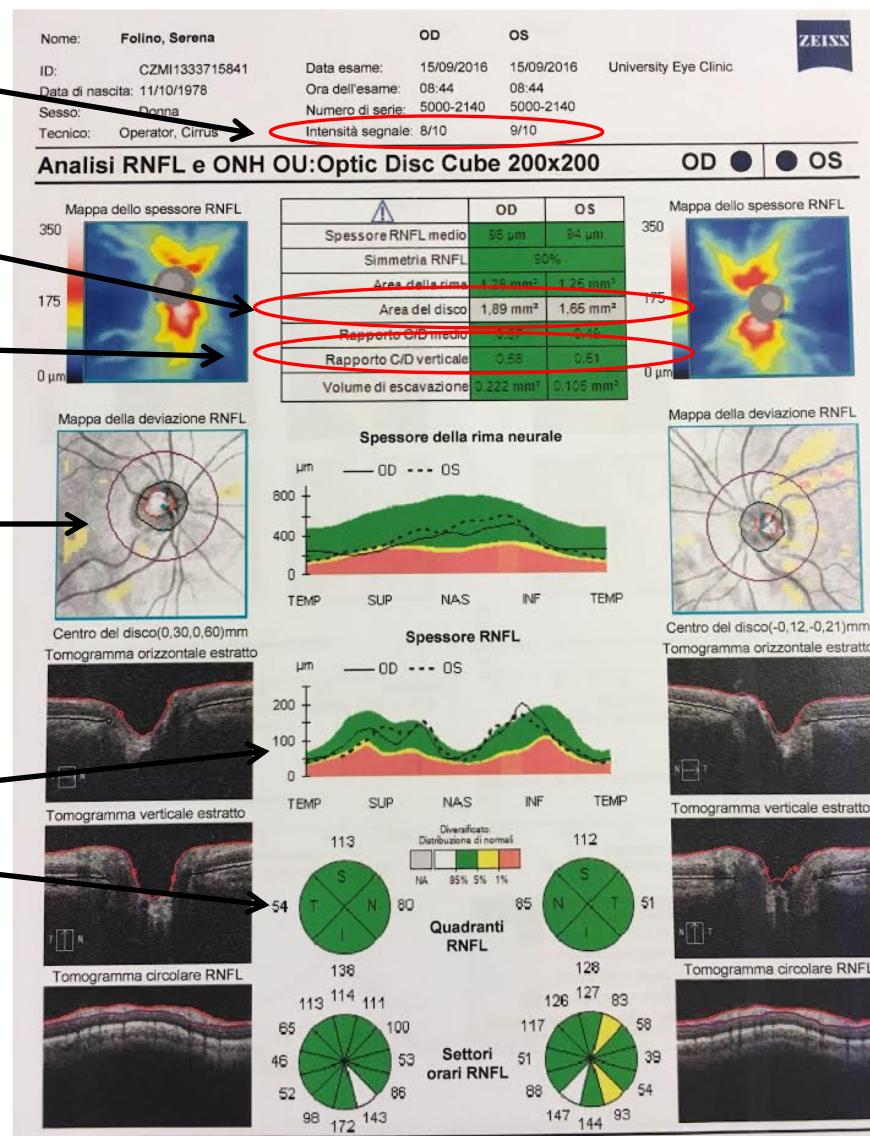
Forza del segnale

Dimensioni del  
disco ottico

Cup/disc  
ratio

Immagine della  
papilla

RNFL



# OCT

## ONH e RNFL

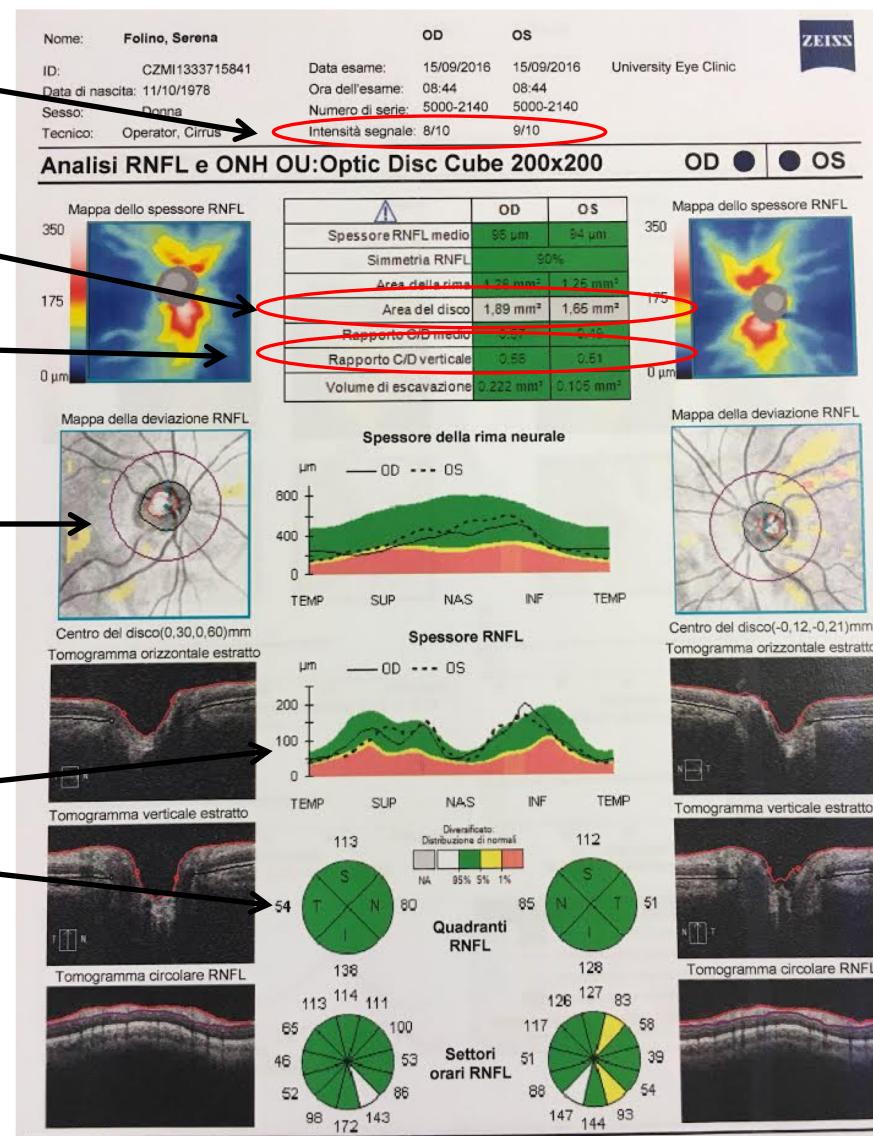
Forza del segnale

Dimensioni del  
disco ottico

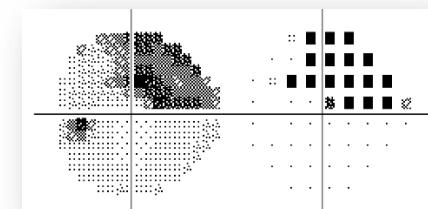
Cup/disc  
ratio

Immagine della  
papilla

RNFL



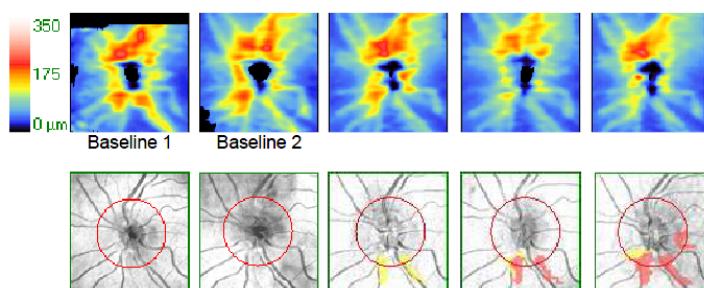
# OCT - progressione



GPA:Optic Disc Cube 200x200

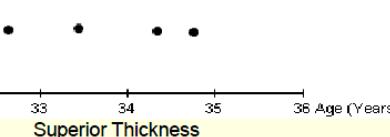
OD OS

Exam 1	Exam 2	Exam 3	Exam 4	Exam 5
9/26/2008 9:10:56 AM 4000-1496 8/10	5/25/2009 12:32:33 PM 4000-1496 7/10	3/17/2010 3:43:38 PM 4000-1496 9/10	2/11/2011 4:11:42 PM 4000-1496 8/10	7/14/2011 3:51:25 AM 4000-1496 7/10
Not Registered	Not Registered	Not Registered	Not Registered	Not Registered



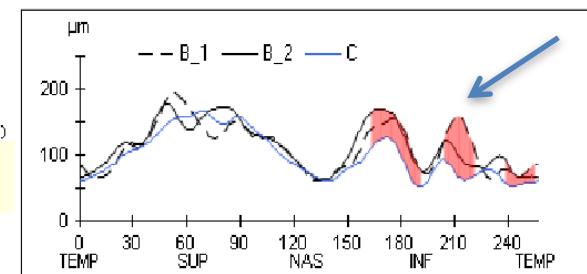
Average RNFL Thickness

Overall Thickness  
Rate of change:  $-5.7 \pm 3.5 \mu\text{m}/\text{Year}$   
Statistically significant  $P < 0.05$



Inferior Thickness  
Rate of change:  $-16.2 \pm 8.1 \mu\text{m}/\text{Year}$   
Statistically significant  $P < 0.01$

RNFL Thickness Profiles



RNFL Summary OS

- RNFL Thickness Map Progression
  - RNFL Thickness Profiles Progression
  - Average RNFL Thickness Progression
- Possible loss   Likely loss   Possible Increase

Progressione strutturale sia con analisi degli eventi che con il trend

# LIMITI

# RNFL OCT: artefatti e misinterpretazioni

## State-of-the-Art Review

**OPEN**

Section Editors: Valérie Blousse, MD  
Steven Galetta, MD

## Avoiding Clinical Misinterpretation and Artifacts of Optical Coherence Tomography Analysis of the Optic Nerve, Retinal Nerve Fiber Layer, and Ganglion Cell Layer

John J. Chen, MD, PhD, Randy H. Kardon, MD, PhD

Journal of Neuro-Ophthalmology 2016;36:417–438

✓ analisi RNFL: 26% falsi positivi

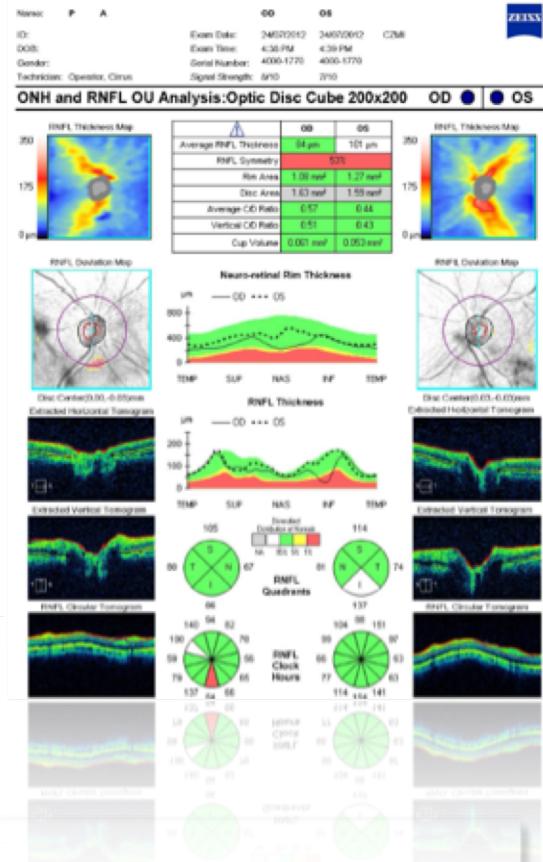
(Kim, Ophthalmology 2011)

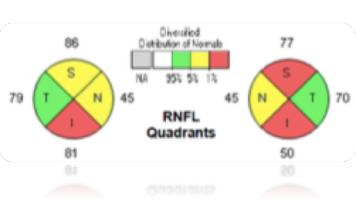
✓ artefatti OCT in pazienti valutati per glaucoma: 15-36%

(Asrani, JAMA Ophthalmology 2014)

✓ in pazienti sani: 40% artefatti nell'analisi complesso ganglionare

(Kim, Ophthalmology 2015)





## LIMITI – 1. Database normativo



### OCT Cirrus Zeiss

284 soggetti sani

19-84 anni

**-12.00 / +8.00**

Esclusione: diabete



### OCT RTVue Optovue

480 soggetti sani

18-84 anni

**-8.00 / +8.00, ± 2 cyl**



### OCT Spectralis Heidelberg

201 soggetti sani

18-78 anni

**-7.00 / +5.00**

Esclusione: diabete

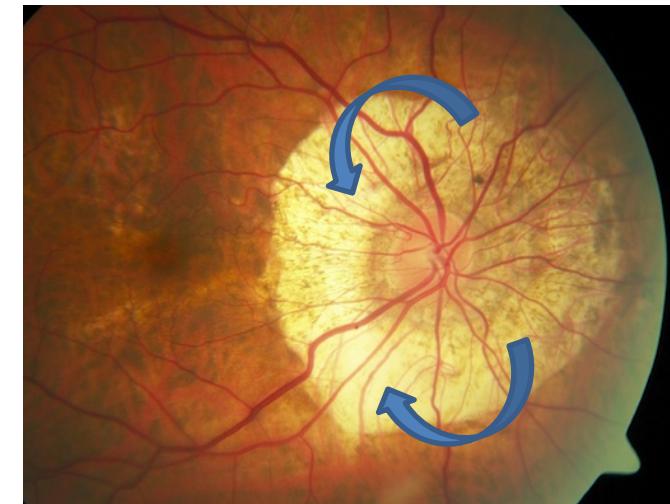
Due to this **relatively small normative database** and **wide variation of distribution of RNFL**, many results obtained by SD-OCT may be flagged as abnormal statistically in patients who are not represented in the database...

Clinicians should **use caution to avoid overtreating “red disease”** in these situations

## LIMITI – 2. Miopia elevata

### Papille tiltate , atrofia peripapillare

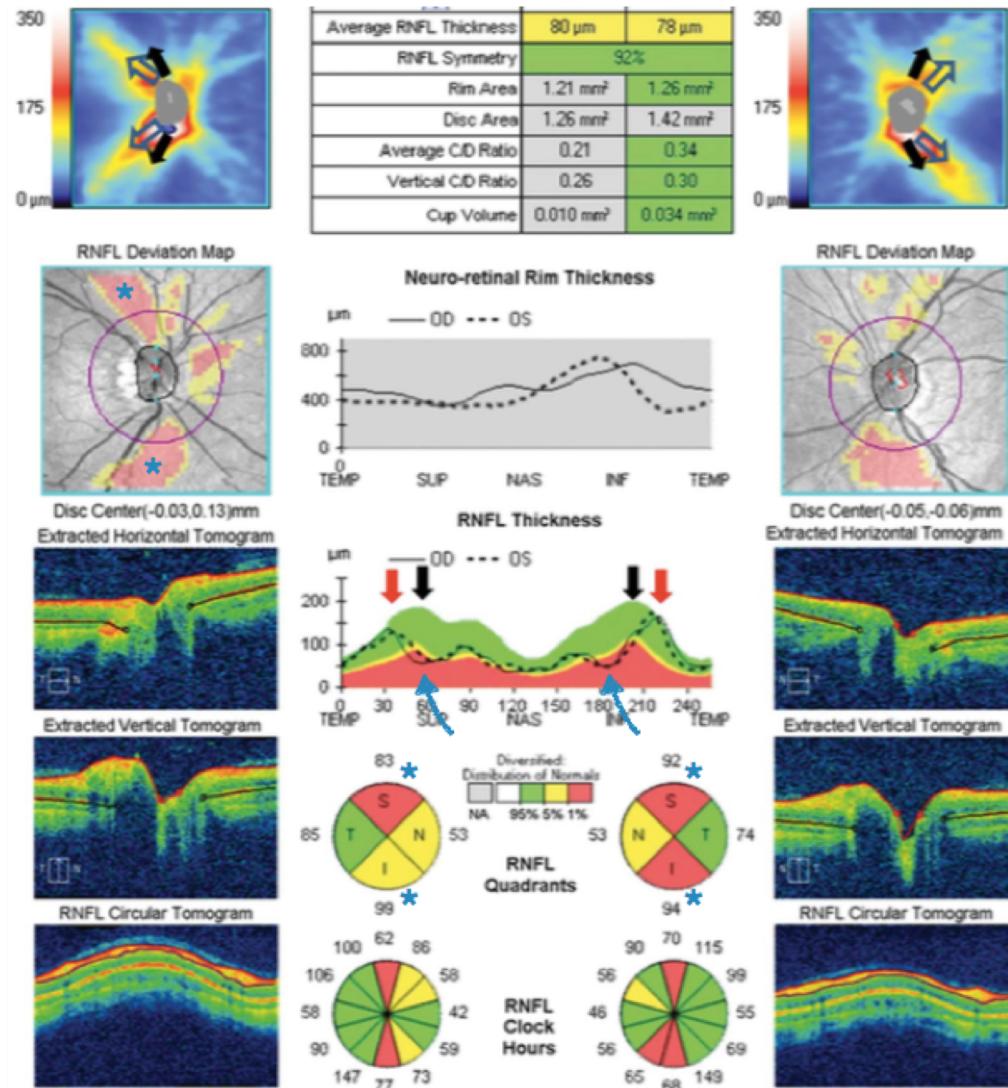
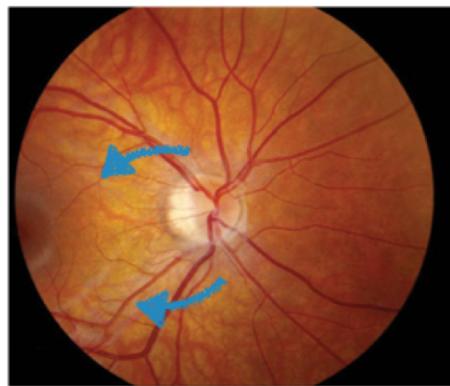
- OCT **non utile** per diagnosticare/monitorare glaucoma
- OCT **inattendibile**: strato delle fibre nervose (RNFL) più sottile – interpretato come patologico dal database
- I fasci superotemporali e inferotemporali convergono temporalmente (**temporal shift** del fascio superiore e inferiore delle RNFL)



# LIMITI – 2. Miopia elevata

temporal shift RNFL

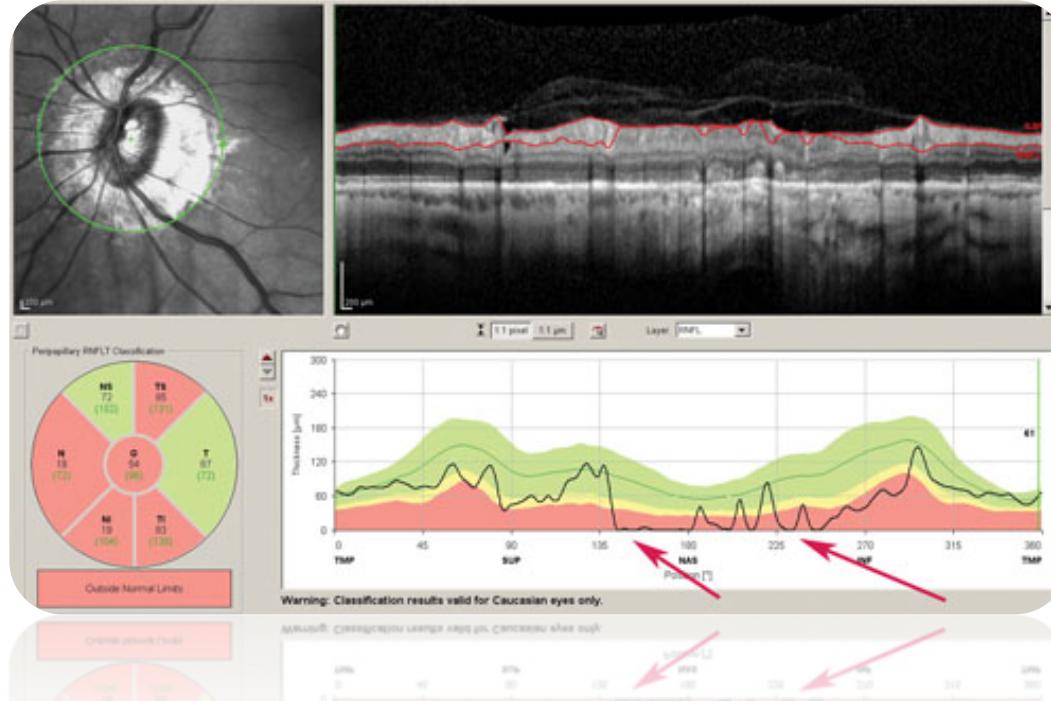
riduzione RNFL settori  
inferiori e superiori \*



# LIMITI – 2. Miopia elevata

- Red & green disease

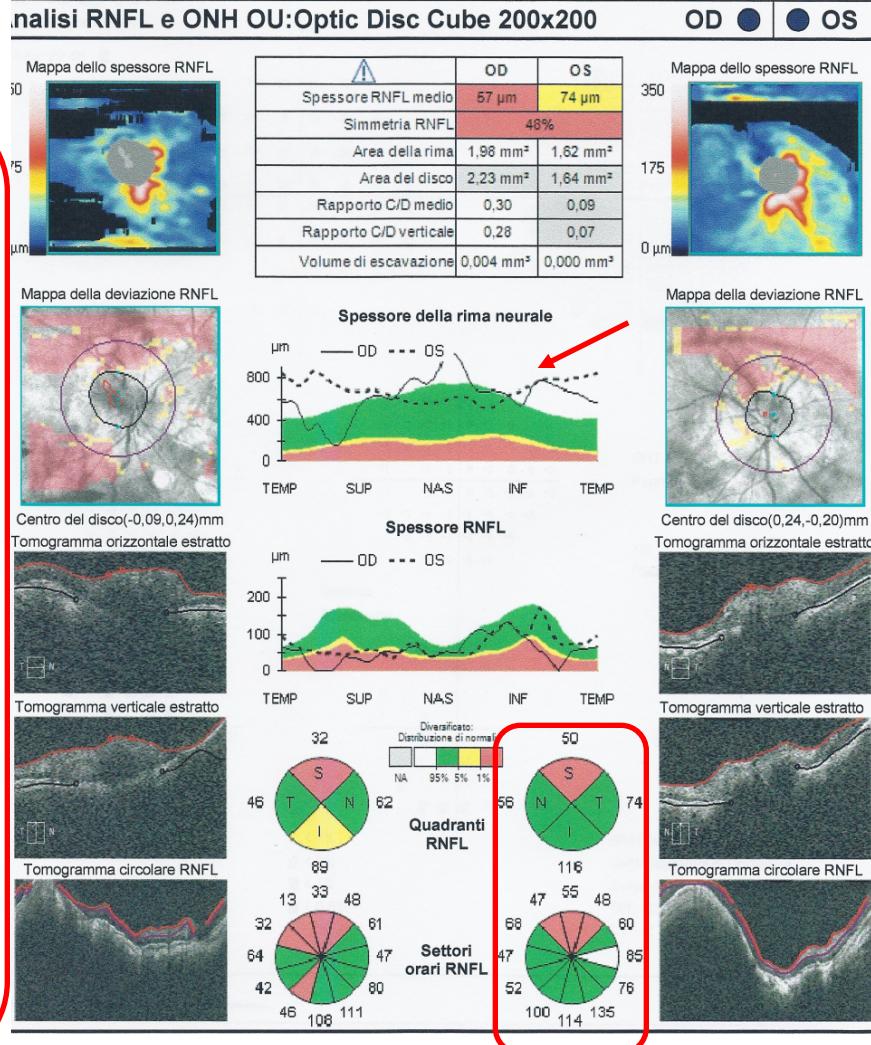
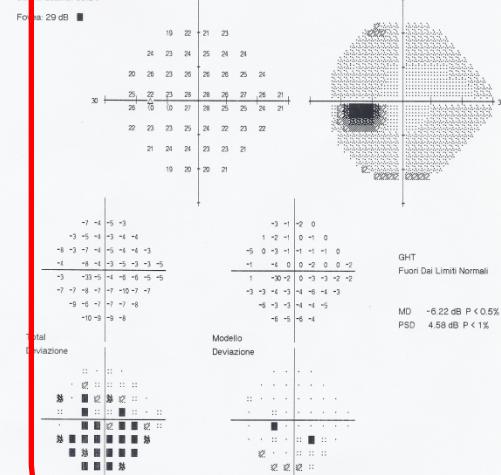
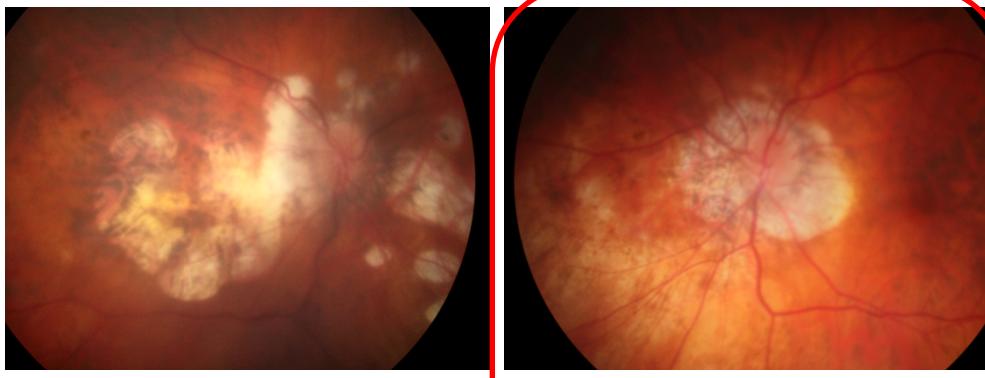
(Atrofia peripapillare, papille tiltate, dismorfiche)

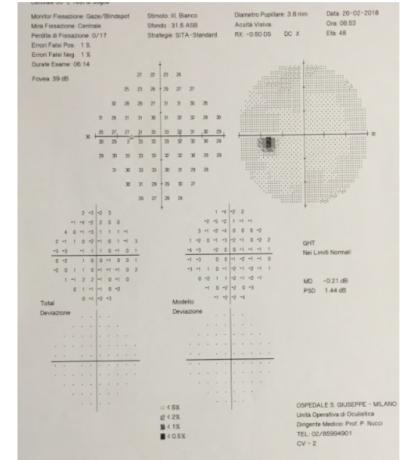
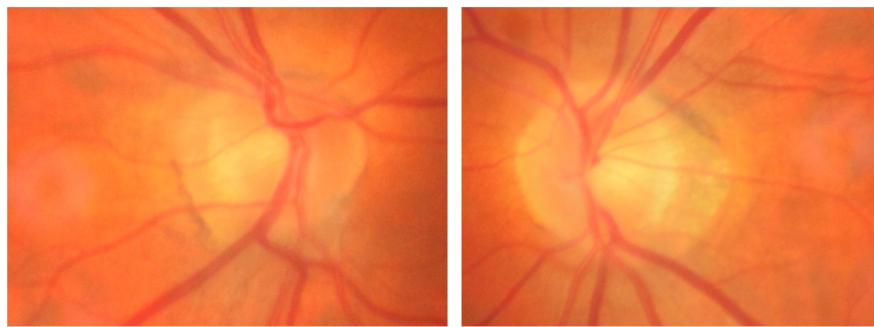
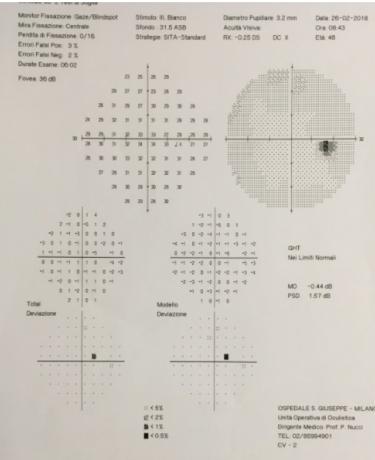


OCT **inattendibile**: strato delle fibre nervose (RNFL) più sottile  
interpretato come patologico dal database

# LIMITI – 2. Miopia elevata

- Red & green disease

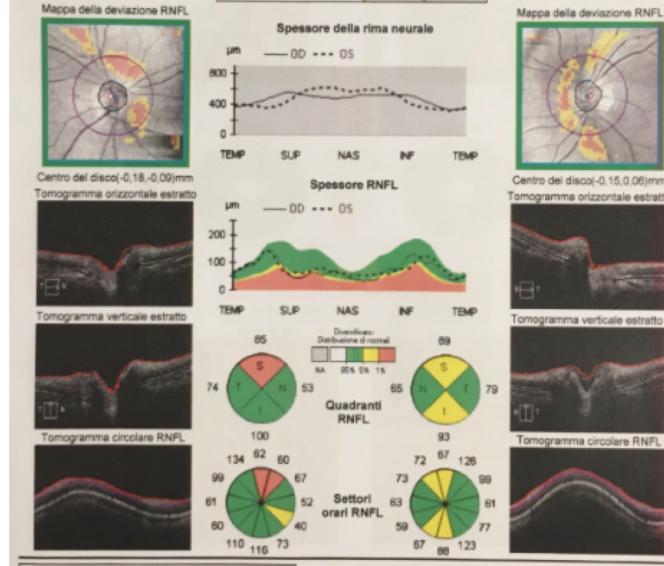
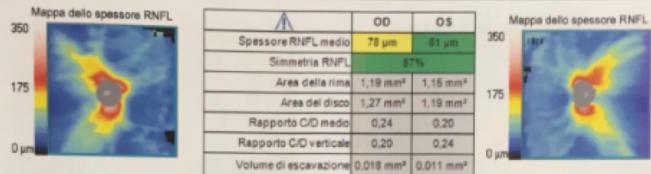




ID:	CZMI1716330337	Data esame:	26/02/2018	26/02/2018	University Eye Clinic
Data di nascita:	26/06/1969	Ora dell'esame:	09:10	09:13	
Sesso:	Uomo	Numero di serie:	5000-2140	5000-2140	
Tecnico:	Operator, Cirrus	Intensità segnale:	5/10	6/10	

### Analisi RNFL e ONH OU:Optic Disc Cube 200x200

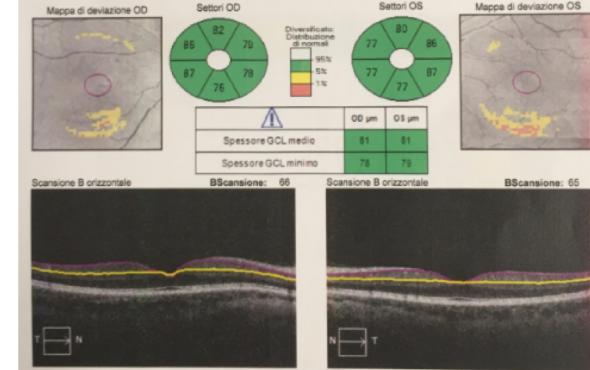
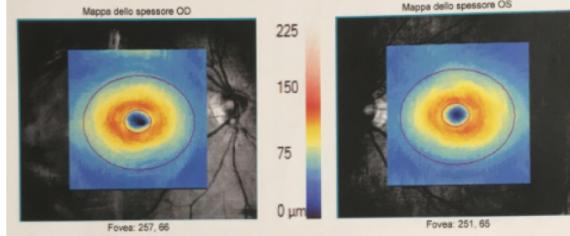
OD ● OS

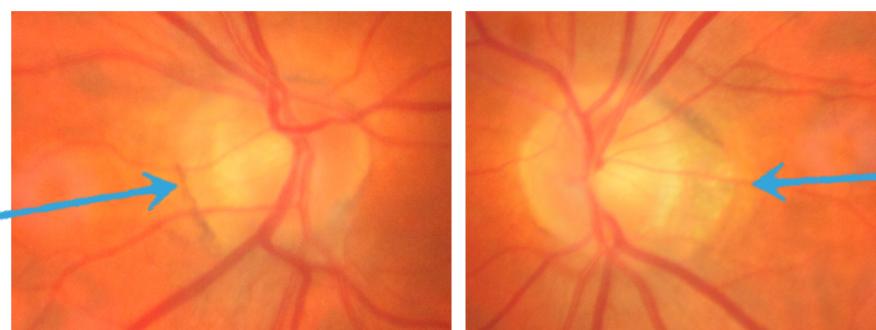
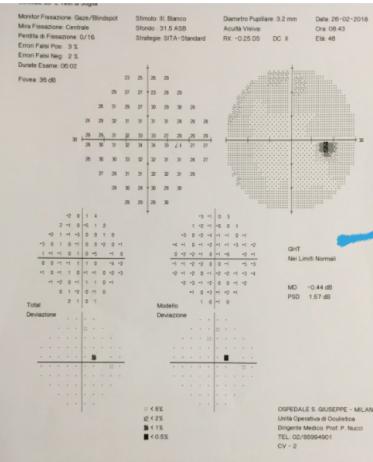


ID:	CZMI1716330337	Data esame:	26/02/2018	28/02/2018	University Eye Clinic
Data di nascita:	26/06/1969	Ora dell'esame:	09:15	09:16	
Sesso:	Uomo	Numero di serie:	5000-2140	5000-2140	

### Analisi cellula gangliare: Macular Cube 512x128

OD ● OS

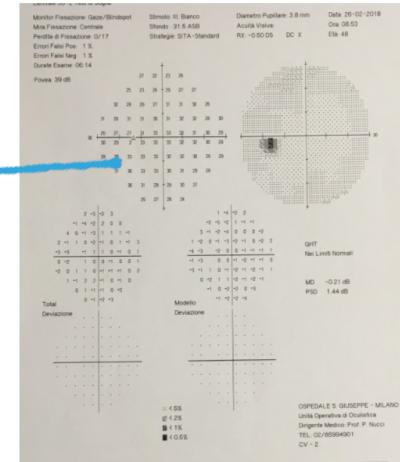
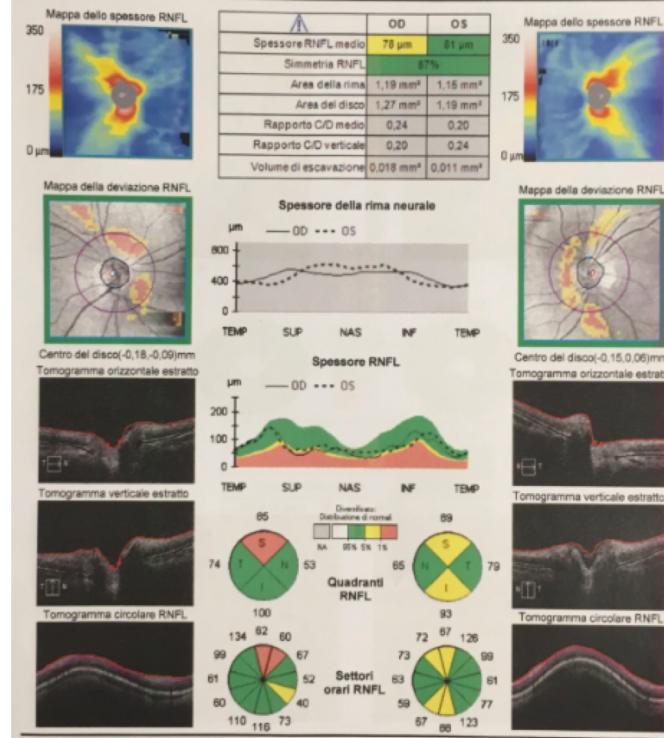




ID: CZMI1716330337  
Data di nascita: 28/06/1969  
Sesso: Uomo  
Tecnico: Operator, Cirrus  
Data esame: 26/02/2018 26/02/2018 University Eye Clinic  
Ora dell'esame: 09:10 09:13  
Numero di serie: 5000-2140 5000-2140  
Intensità segnale: 5/10 6/10

### Analisi RNFL e ONH OU: Optic Disc Cube 200x200

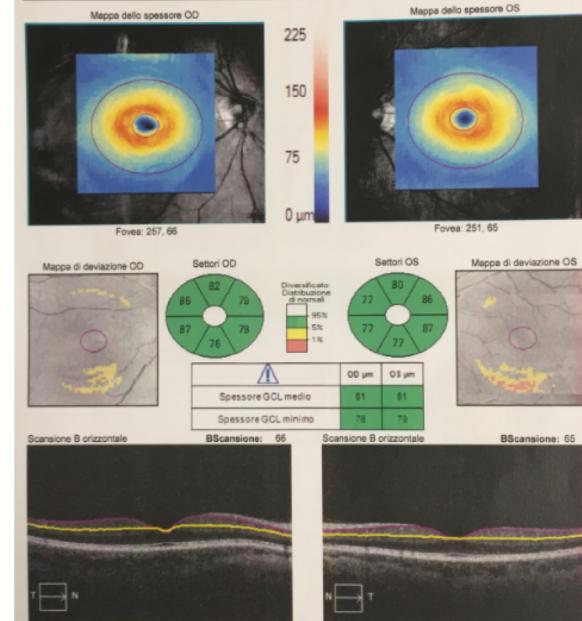
OD ● OS



ID: CZMI1716330337  
Data di nascita: 28/06/1969  
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Ora dell'esame: 09:15 09:16  
Numero di serie: 5000-2140 5000-2140  
Intensità segnale: 6/10 7/10

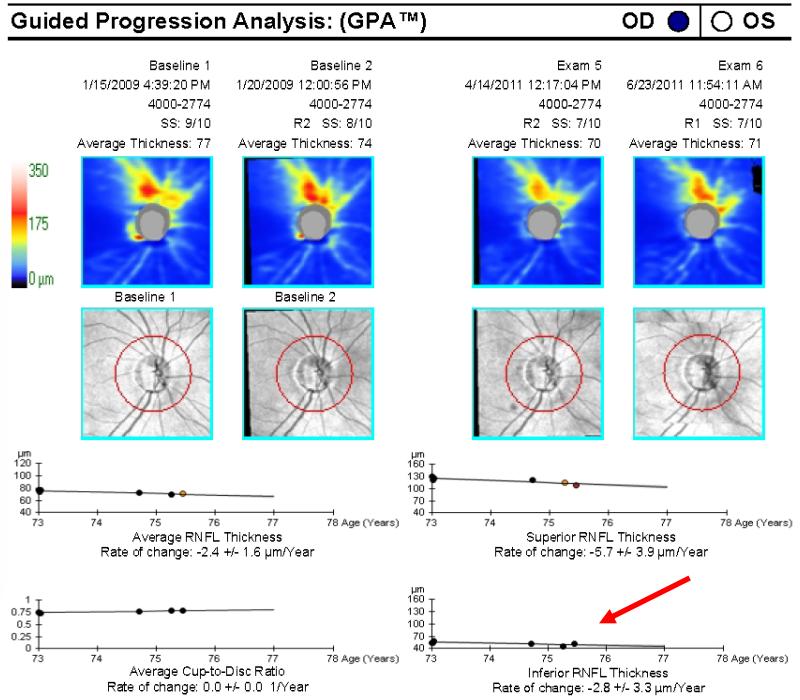
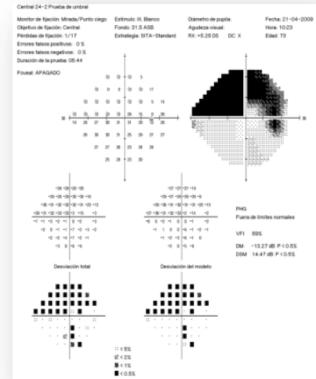
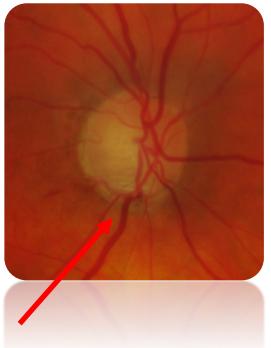
### Analisi cellula gangliare: Macular Cube 512x128

OD ● OS

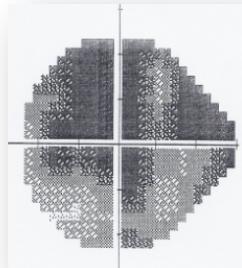
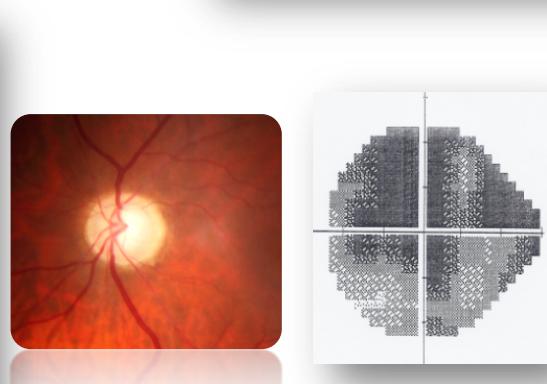
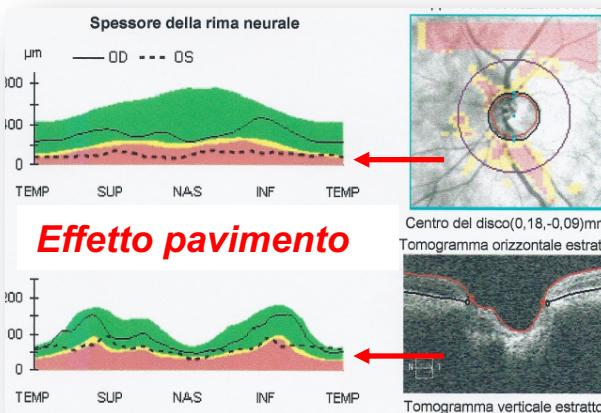


# LIMITI – 3. Glaucoma avanzato

- Effetto pavimento

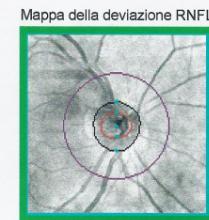
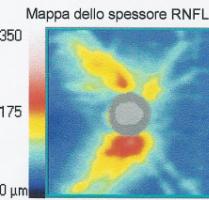
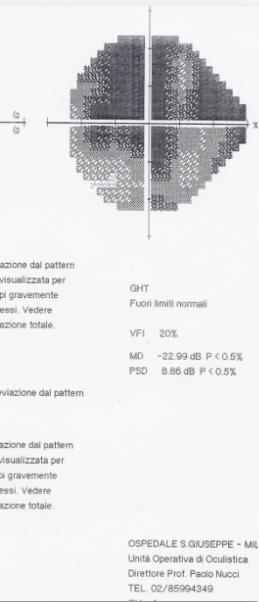
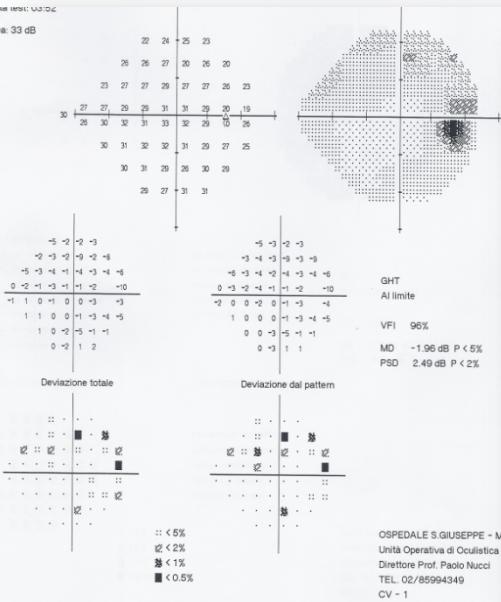


**Effetto pavimento**



***RNFL < 40 micron***

# LIMITI – 3. Glaucoma avanzato



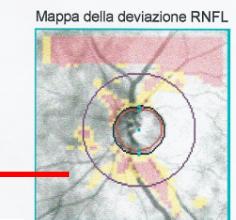
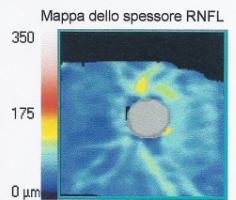
Centro del disco(-0,06,-0,03)mm

Tomogramma orizzontale estratto

Tomogramma verticale estratto

Tomogramma circolare RNFL

	OD	OS
Spessore RNFL medio	93 $\mu$ m	64 $\mu$ m
Simmetria RNFL	67%	
Area della rima	1.22 mm <sup>2</sup>	0.48 mm <sup>2</sup>
Area del disco	1.92 mm <sup>2</sup>	1.83 mm <sup>2</sup>
Rapporto C/D medio	0.80	0.86
Rapporto C/D verticale	0.49	0.82
Volume di escavazione	0.188 mm <sup>3</sup>	0.622 mm <sup>3</sup>

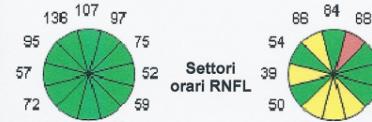
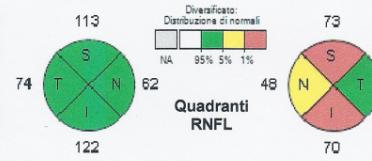
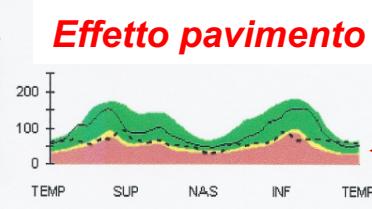
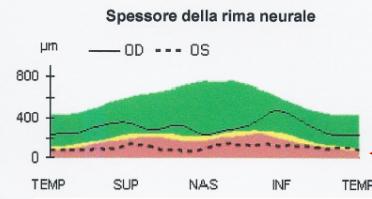


Centro del disco(0,18,-0,09)mm

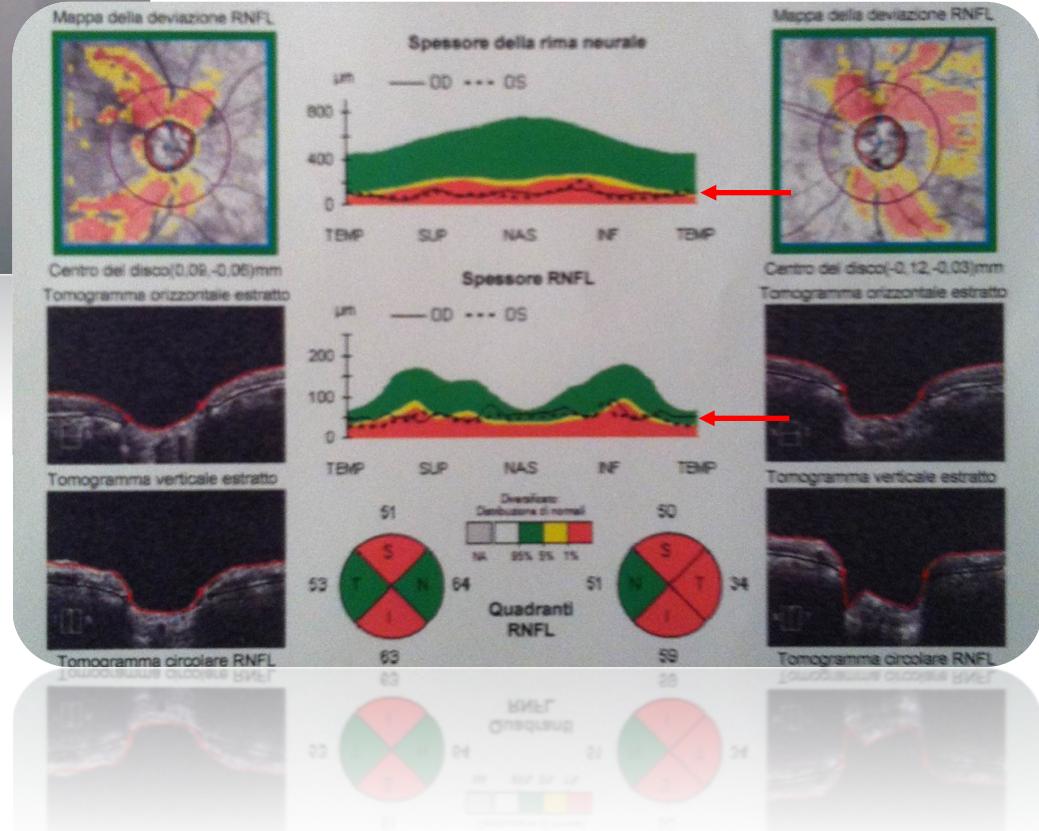
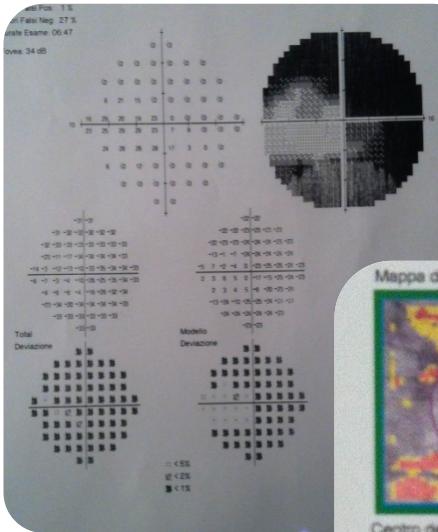
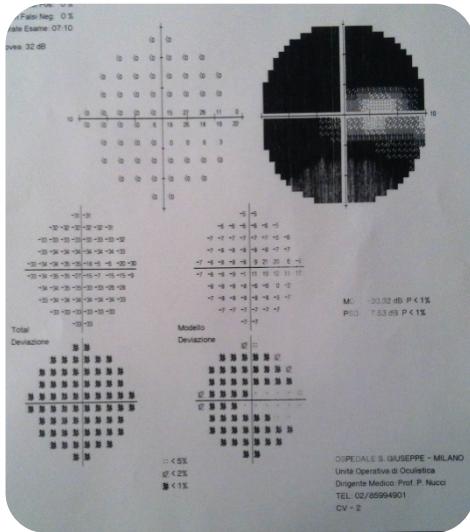
Tomogramma orizzontale estratto

Tomogramma verticale estratto

Tomogramma circolare RNFL



# LIMITI – 3. Glaucoma avanzato



## Glaucoma avanzato:

- OCT non utile nel follow-up
- Follow-up con campo visivo

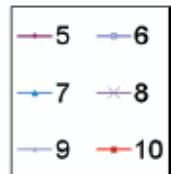
➤ Possibilità di monitorare  
progressione strutturale con analisi  
**COMPLESSO GANGLIONARE**

# ARTEFATTI – 4. Forza del segnale

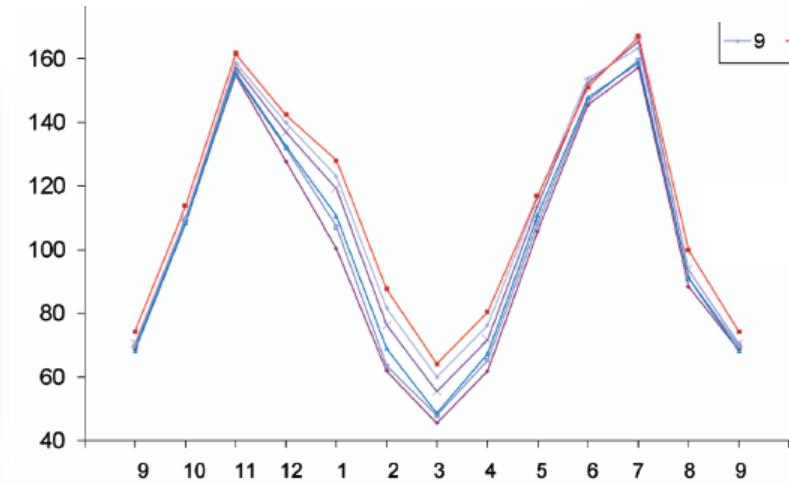
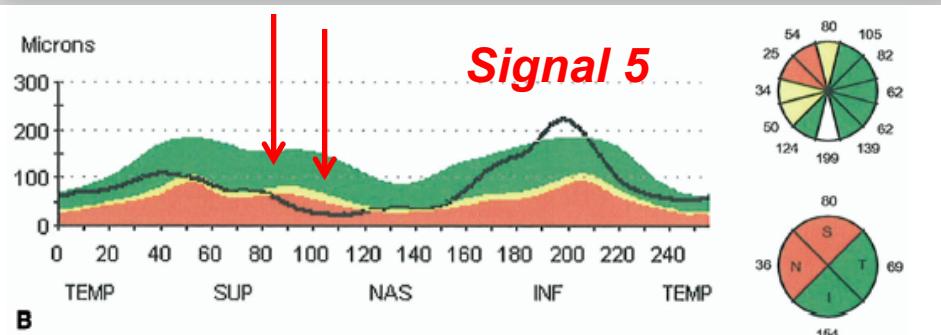
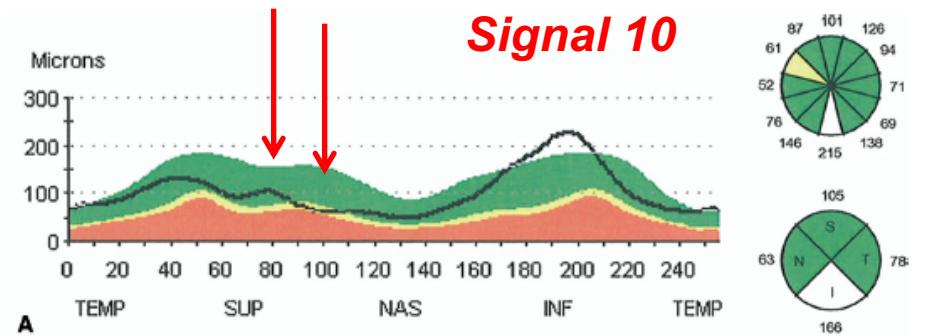
## Relationship between Retinal Nerve Fiber Layer Measurement and Signal Strength in Optical Coherence Tomography

Ophthalmology 2008;115:1347–1351

Carol Yim Lui Cheung, PhD,<sup>1</sup> Christopher Kai Shun Leung, MD, MB, ChB,<sup>1,2</sup> Dusheung Lin,<sup>1,3</sup> Chi-Pui Pang, DPhil,<sup>1</sup> Dennis Shun Chiu Lam, MD<sup>1</sup>



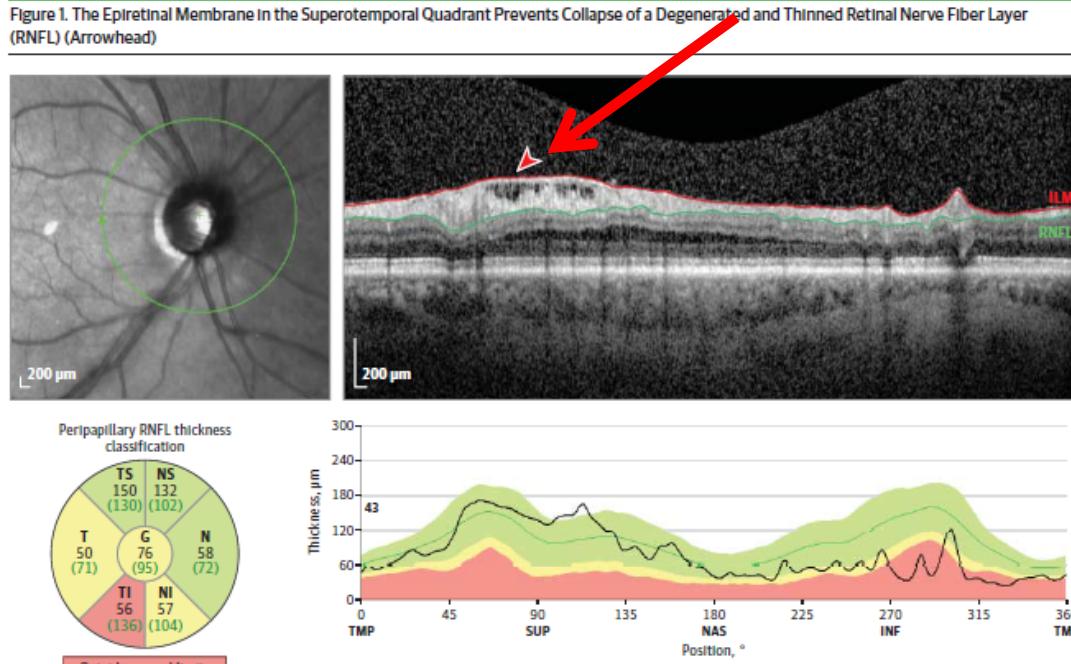
- Qualità dell'esame: forza del segnale  $\geq 7/10$



0715841 Data esame: 15/09/2016 15/09/2016 Univers  
8 Ora dell'esame: 08:44 08:44  
Numero di serie: 5000-2140 5000-2140  
rus Intensità segnale: 8/10 9/10

ONH OU:Optic Disc Cube 200x200

# ARTEFATTI– 5. Membrane epiretiniche



The spectral-domain optical coherence tomography software algorithm has misidentified the boundary of the epiretinal membrane as the upper edge of the RNFL, leading to an erroneously elevated measure of the RNFL in that region.

G indicates global mean thickness; ILM, internal limiting membrane; INF, inferior; NAS, nasal; NI, inferonasal; NS, supronasal; SUP, superior; T, temporal; TI, inferotemporal; TMP, temporal; and TS, superotemporal.

Asrani, et al, JAMA Ophthalmol 2014.

# ARTEFATTI– 6. Vitreous floaters

A & B: perdita di intensità del segnale (freccia bianca) associata a un corpo mobile del vitreo: spessore RNFL zero

Nota: anche un occhio cieco mostra uno spessore RNFL compreso tra 40-50 microns

C & D: una seconda scansione ripetuta pochi minuti dopo mostra una rappresentazione del RNFL fisiologica

prima scansione      seconda scansione

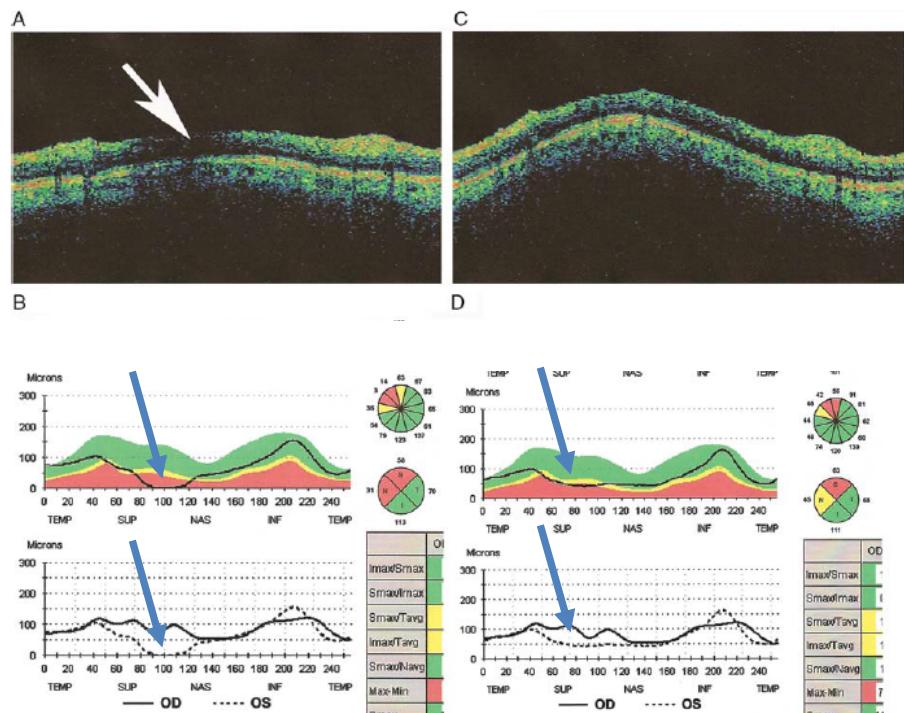
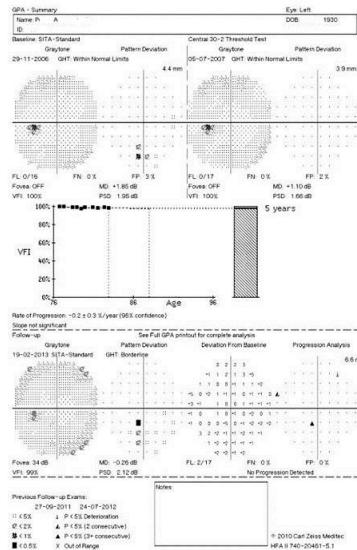
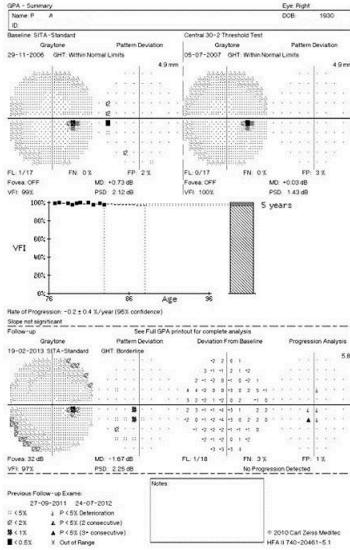


FIGURE 4. Optical coherence tomography errors in glaucoma: effect of media opacities. A (top left), Loss of signal intensity (white arrow) in the RNFL measurement of the left eye is noted. B (bottom left), An artificial and significant loss of RNFL measurement is seen in the numerical value display against the normative database. C (top right), Repeat measurement of the peripapillary RNFL a few minutes later resulted in better signal intensity. D (bottom right), Loss of RNFL thickness of a lesser magnitude is noted for the left eye against the normative database. This loss of signal intensity is possibly related to the presence of a Weiss ring or a large floater, which was avoided with repeat measurement. RNFL indicates retinal nerve fiber layer.

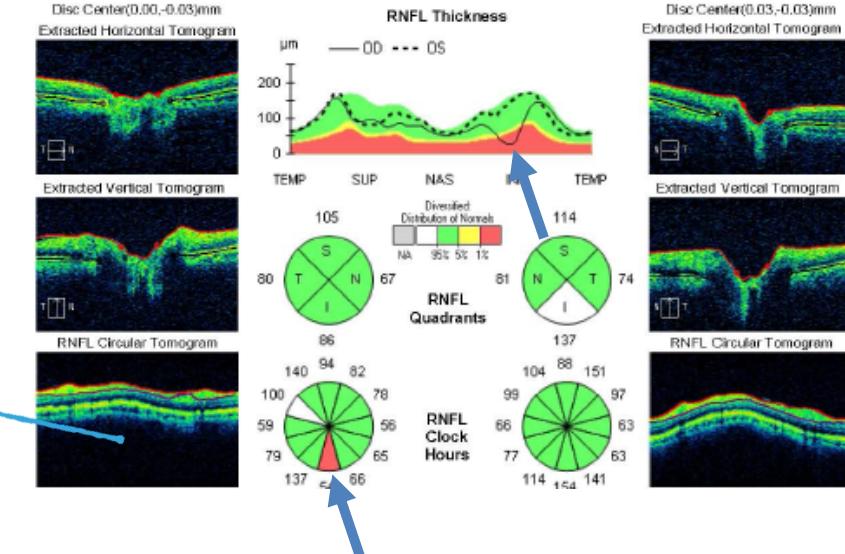
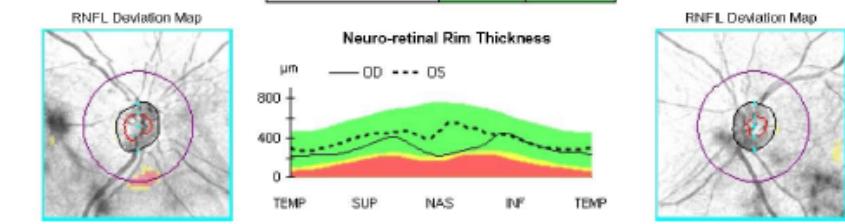
Asrani, et al. J Glaucoma 2010.

# ARTEFATTI - 7. Errore di segmentazione



Name: P - A  
ID: Exam Date: 24/07/2012 24/07/2012 CZMI  
DOB: Exam Time: 4:38 PM 4:39 PM  
Gender: Serial Number: 4000-1770 4000-1770  
Technician: Operator, Cirrus Signal Strength: 8/10 7/10

## ONH and RNFL OU Analysis: Optic Disc Cube 200x200 OD ● OS



ZEISS

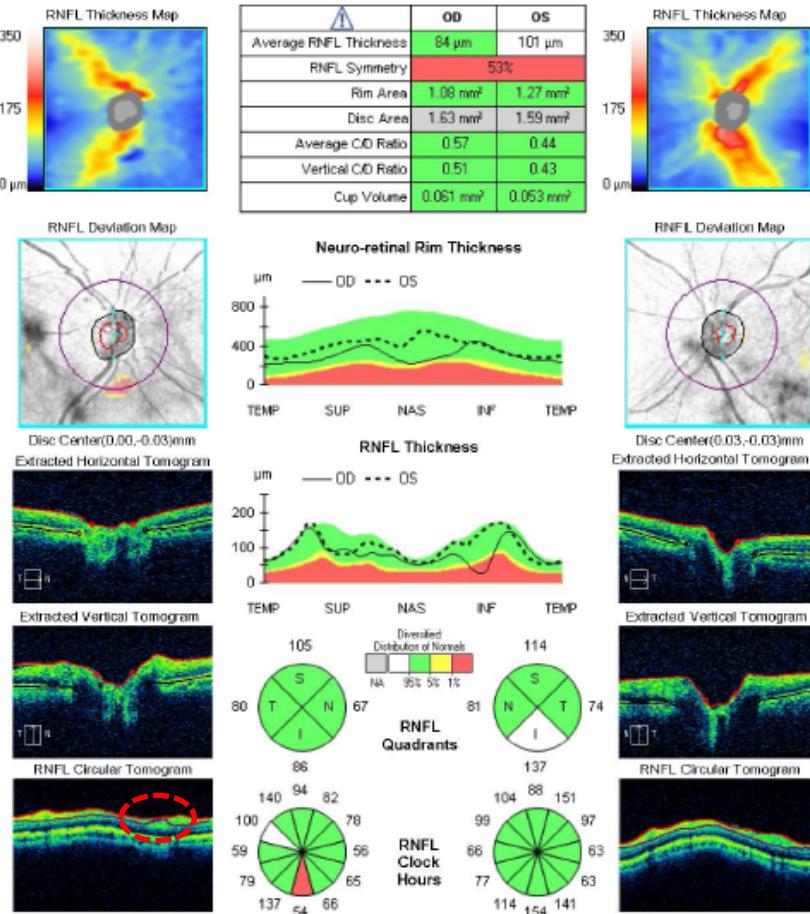
# ARTEFATTI– 7. Errore di segmentazione

2012

Name: P A  
 ID:  
 DOB:  
 Gender:  
 Technician: Operator, Cirrus  
 Exam Date: 24/07/2012 24/07/2012 CZMI  
 Exam Time: 4:38 PM 4:39 PM  
 Serial Number: 4000-1770 4000-1770  
 Signal Strength: 8/10 7/10



## ONH and RNFL OU Analysis:Optic Disc Cube 200x200 OD ● ● OS

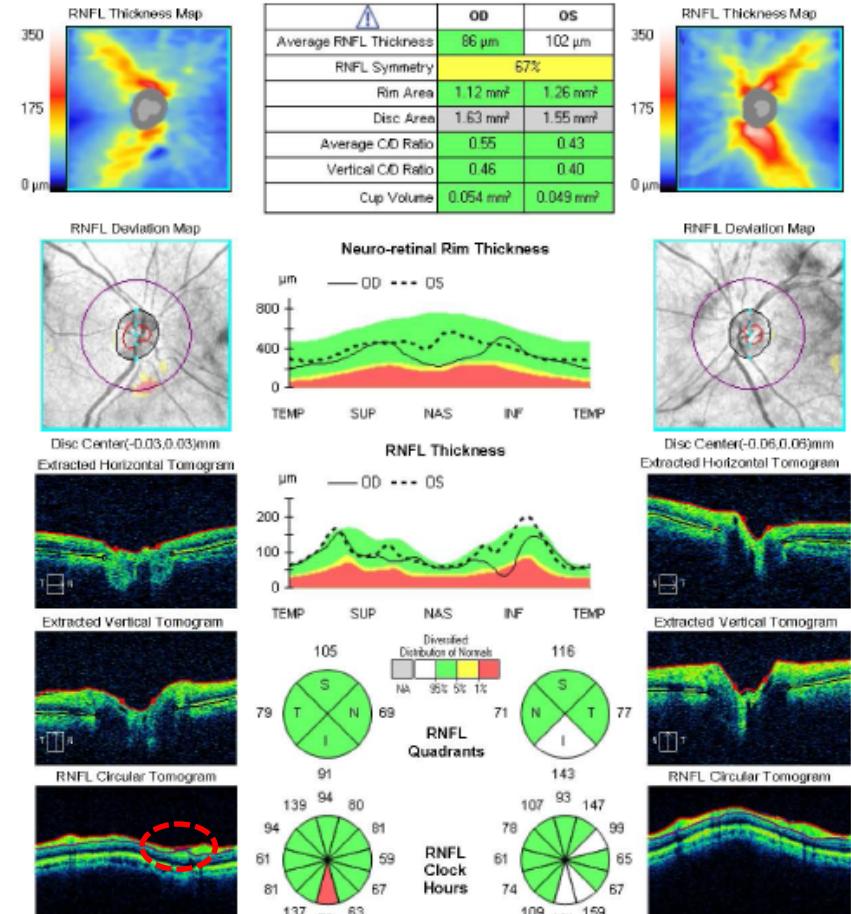


2013

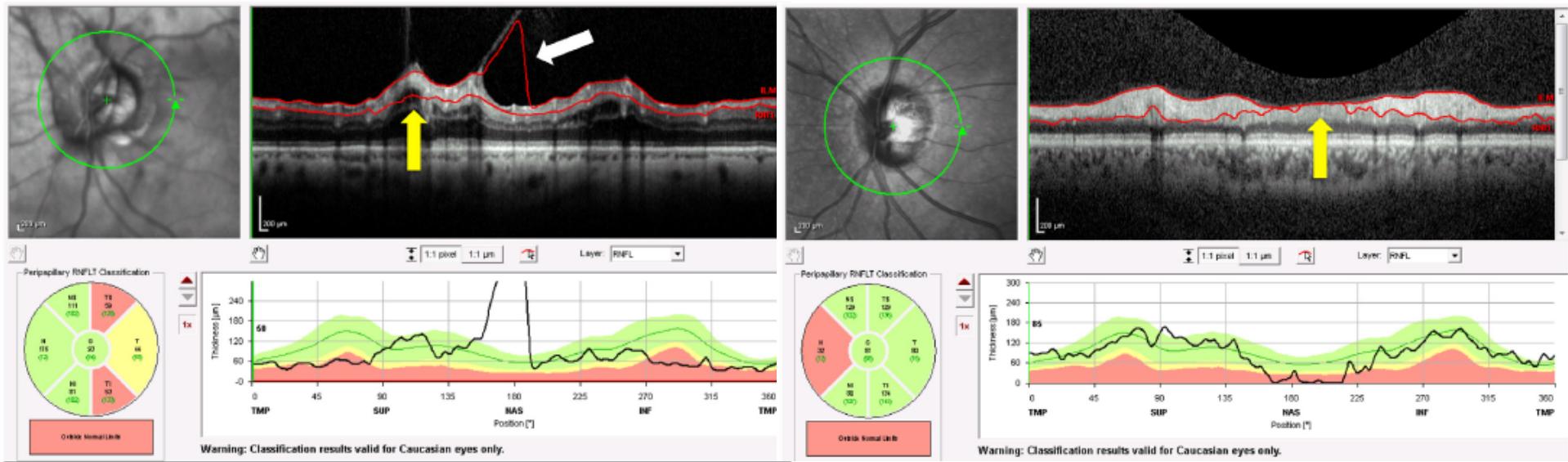
Name: P A  
 ID:  
 DOB:  
 Gender:  
 Technician: Operator, Cirrus  
 Exam Date: 19/02/2013 19/02/2013 CZMI  
 Exam Time: 3:02 PM 3:03 PM  
 Serial Number: 4000-1770 4000-1770  
 Signal Strength: 7/10 7/10



## ONH and RNFL OU Analysis:Optic Disc Cube 200x200 OD ● ● OS



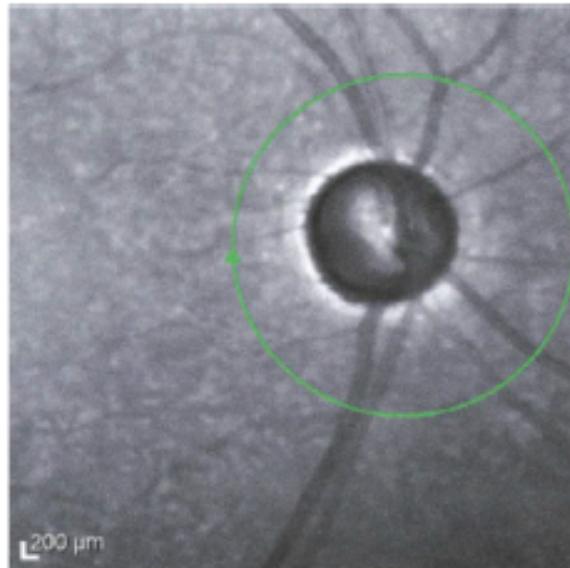
# ARTEFATTI– 7. Errore di segmentazione



# ARTEFATTI– 8. Operatore dipendenti

## Scansione centrata sul nervo ottico

Alcuni strumenti centratura automatica

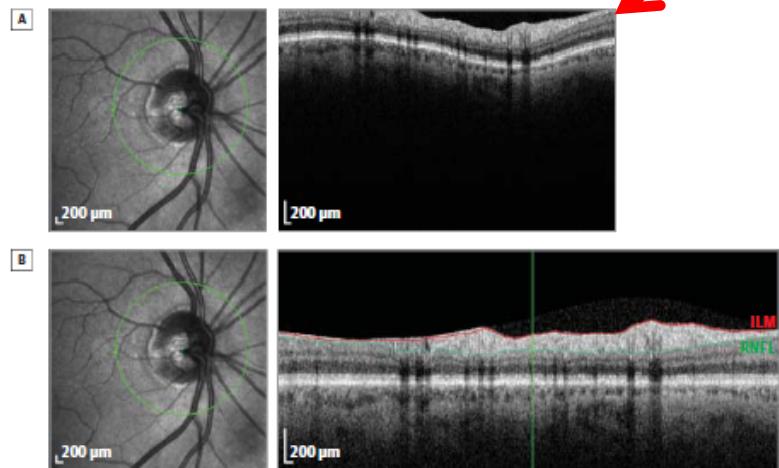


2 errori

- ✓ Scan non centrato sul nervo ottico
- ✓ Nervo ottico non centrato nello “scan box”

## Scansione all'esterno dello “scan box”

Figure 3. Operator-Dependent Artifacts Included Truncation of the Acquired Spectral-Domain Optical Coherence Tomography (SD-OCT) Image (ie, All Edges of the Image Were Not Within the Acquisition Window)



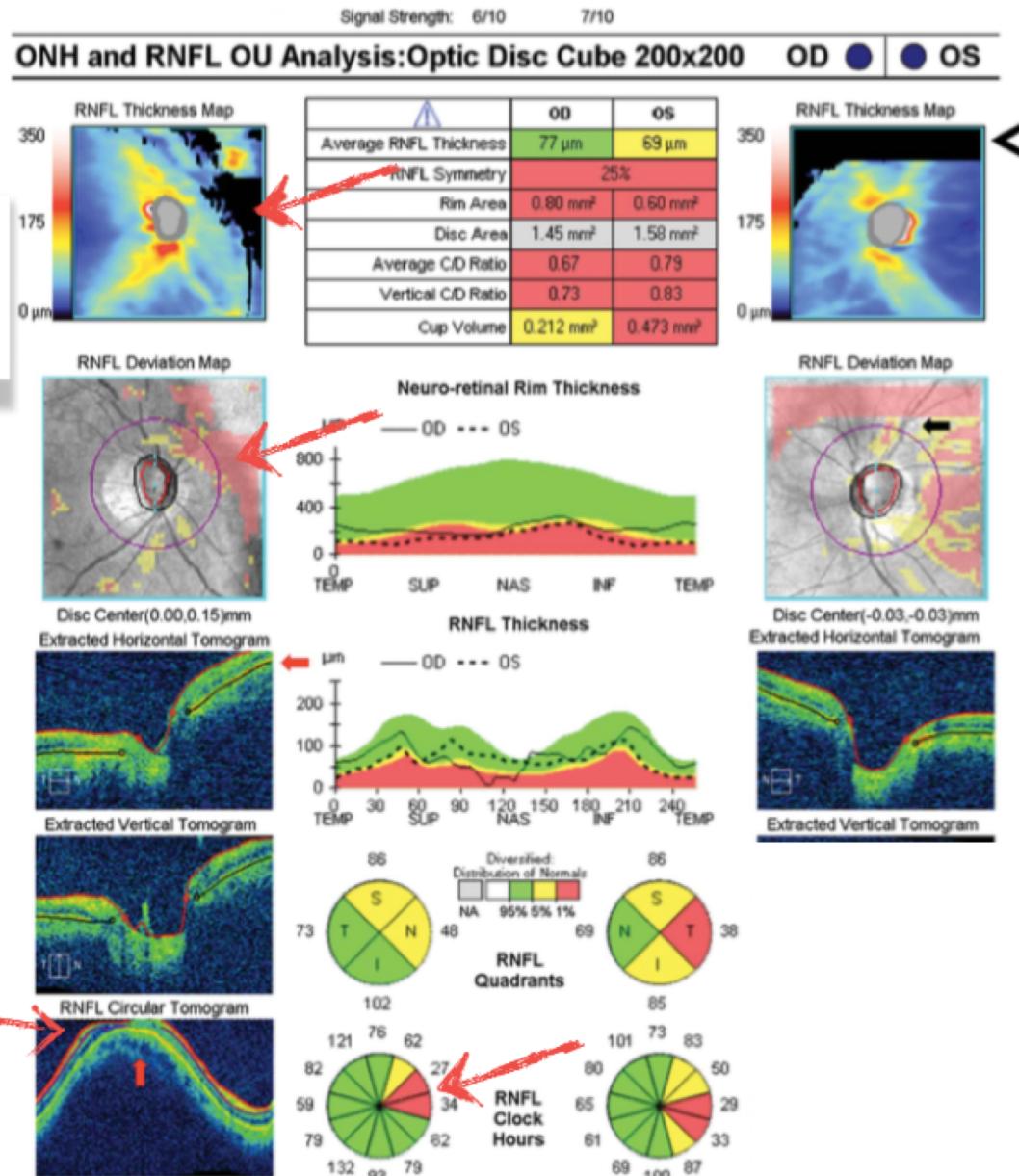
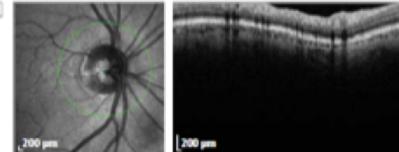
Asrani, et al, JAMA Ophthalmol 2014.

# ARTEFATTI– 8. Operatore dipendenti

Scansione decentrata

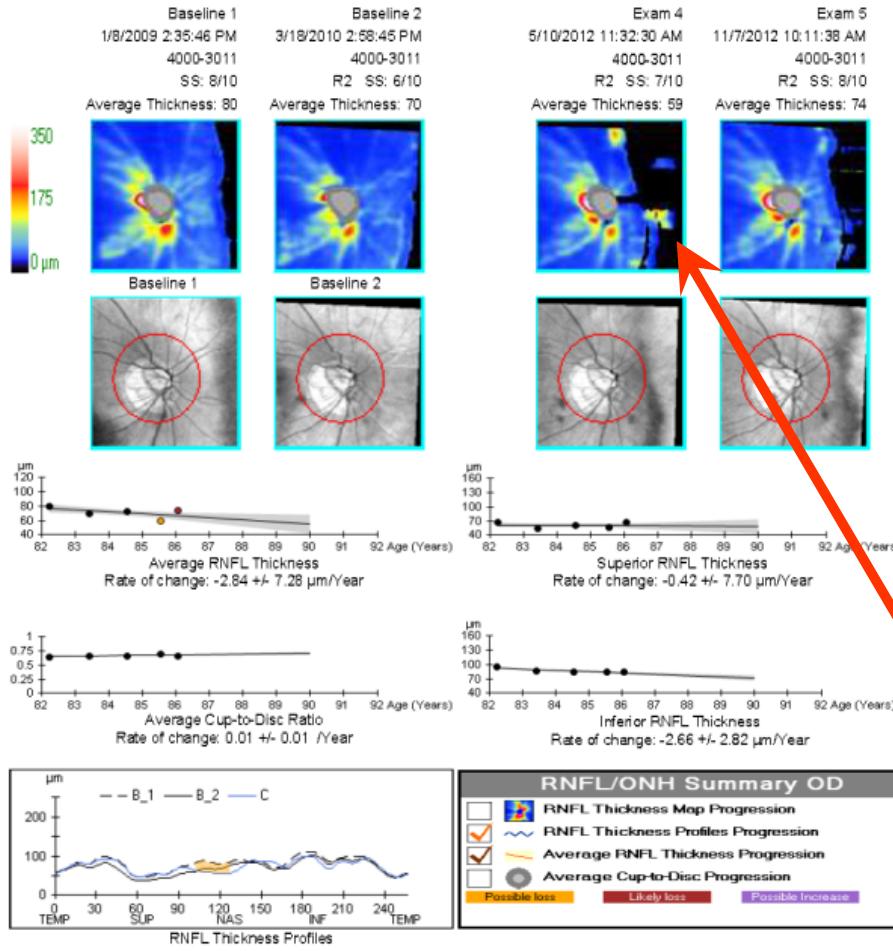
errore operatore  
dipendente

Figure 3. Operator-Dependent Artifacts Included Truncation of the Acquired Spectral-Domain Optical Coherence Tomography (SD-OCT) Image (ie, All Edges of the Image Were Not Within the Acquisition Window)

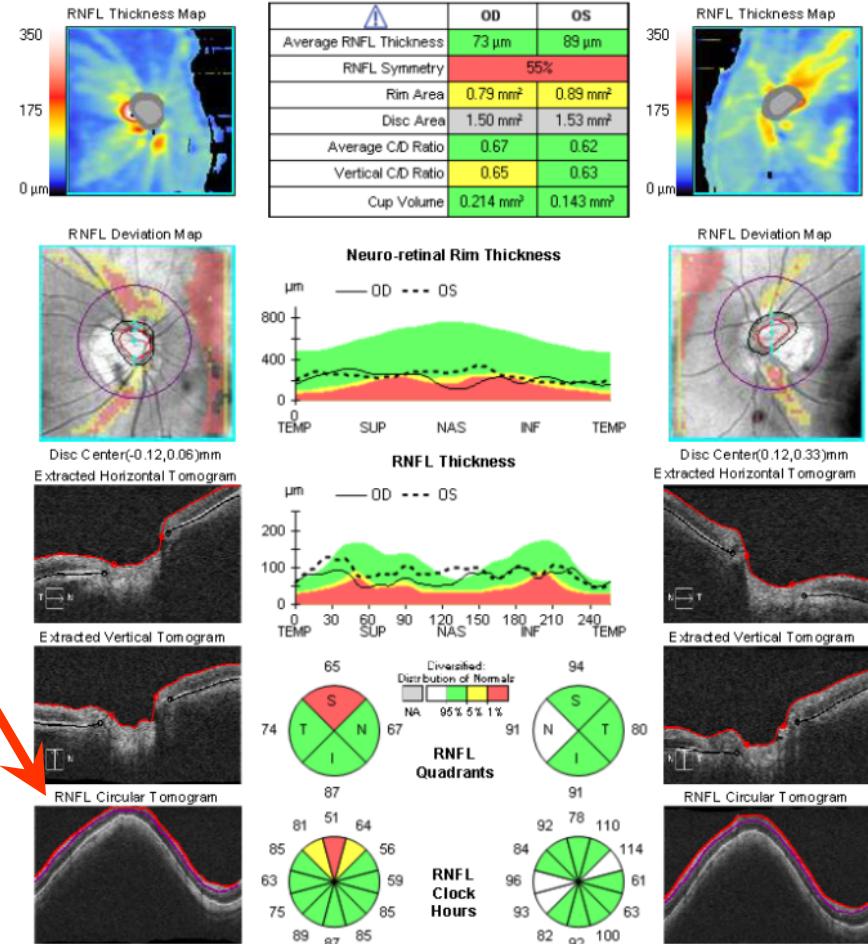


## Guided Progression Analysis: (GPA™)

OD ● ○ OS



## ONH and RNFL OU Analysis: Optic Disc Cube 200x200 OD ● OS

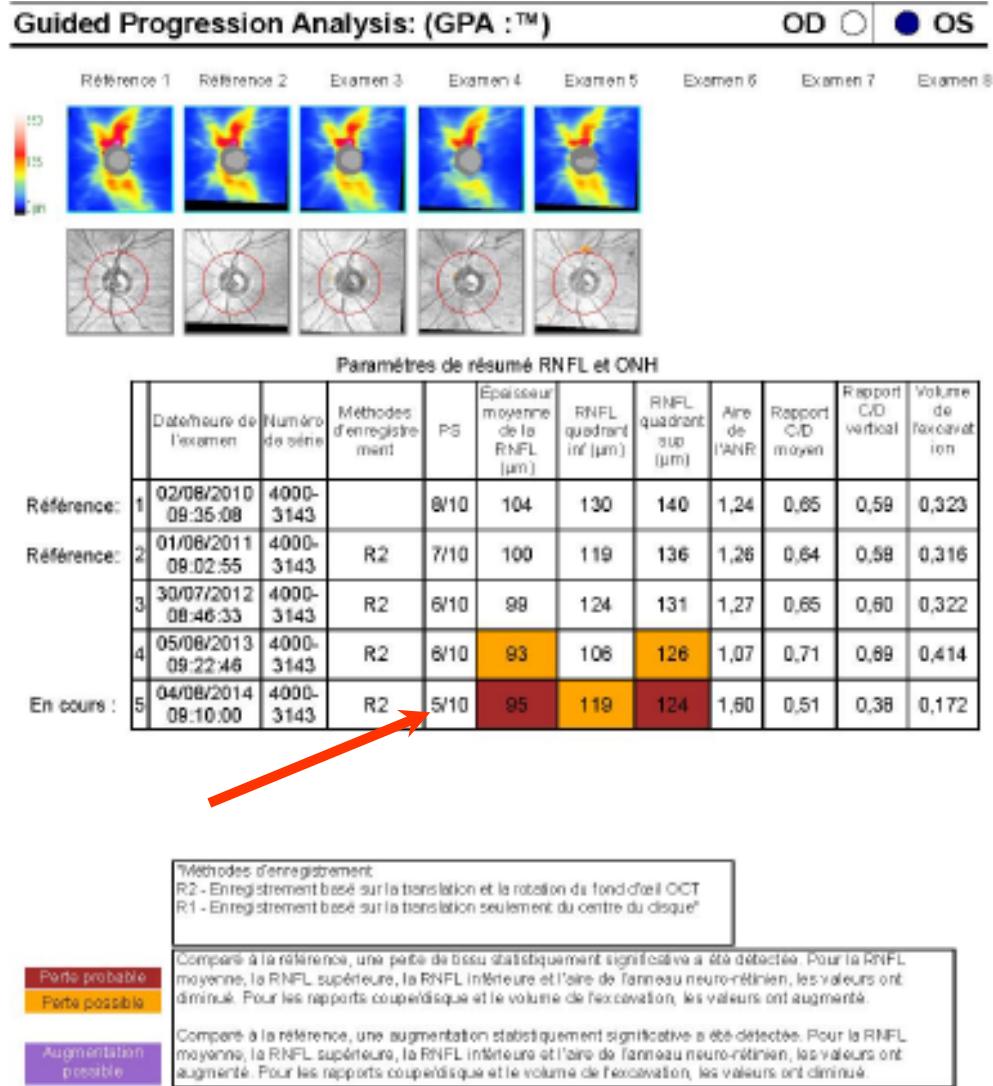


Significant change from baseline OS

However signal strength is 5 on most recent image

*Minimum recommended signal strength is 6*

Recommended action: *Repeat Scan*. Request service visit if scan strength is consistently low in patients in general



# **ARTEFATTI– considerare anche..**

- *1. trasparenza corneale (patologie, esiti chirurgia)*
- *2. cataratta*
- *3. movimenti paziente, ammiccamento*
- *4. obiettivo sporco (!!)*

Nome: Folino, Serena

ID: CZMI1333715841

#1 Data di nascita: 11/10/1978

Sesso: Donna

Tecnico: Operator, Cirrus

OD

OS

Data esame: 15/09/2016

15/09/2016

Ora dell'esame: 08:44

08:44

Numero di serie: 5000-2140

5000-2140

#2 Intensità segnale: 8/10

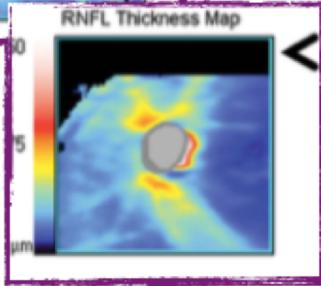
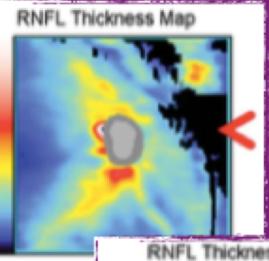
9/10

University Eye Clin

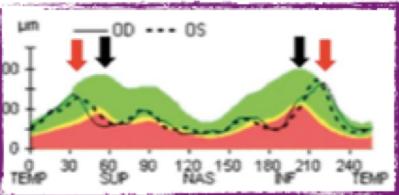
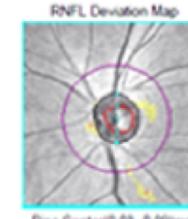
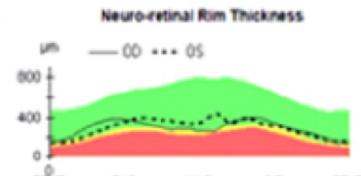
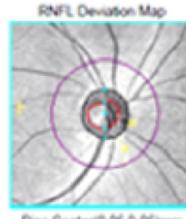
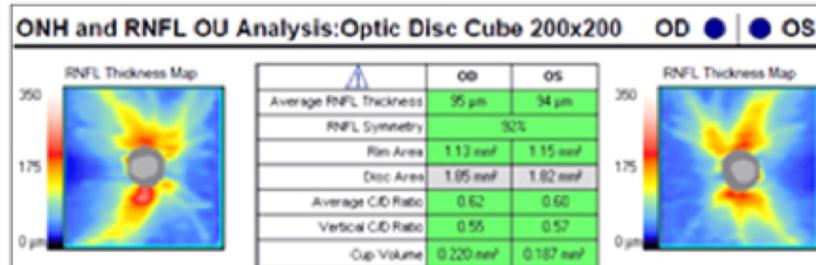
refrazione

(lunghezza assiale se PFK o post refrattiva)

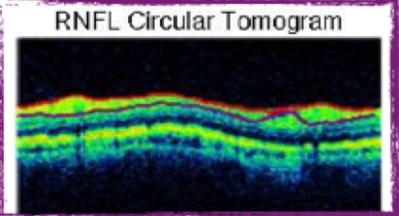
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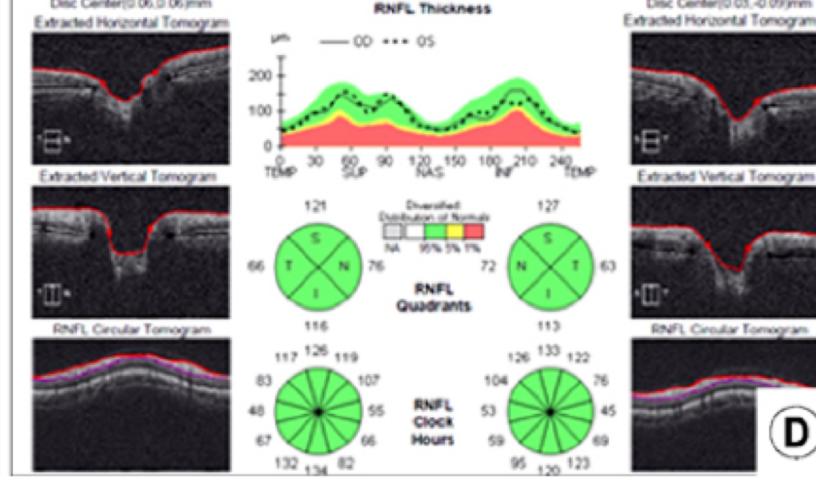
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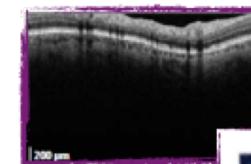
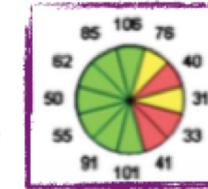
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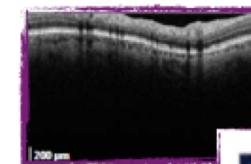
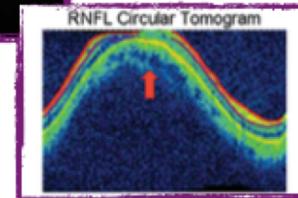
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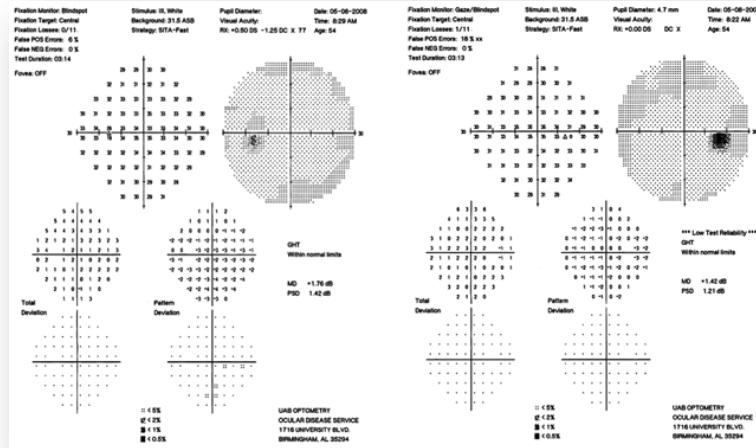
#6



#8



# Un OCT “red flag”..



- ✓ Paziente seguito per asimmetria dell'escavazione OS>OD
- ✓ Normoteso (14-18)

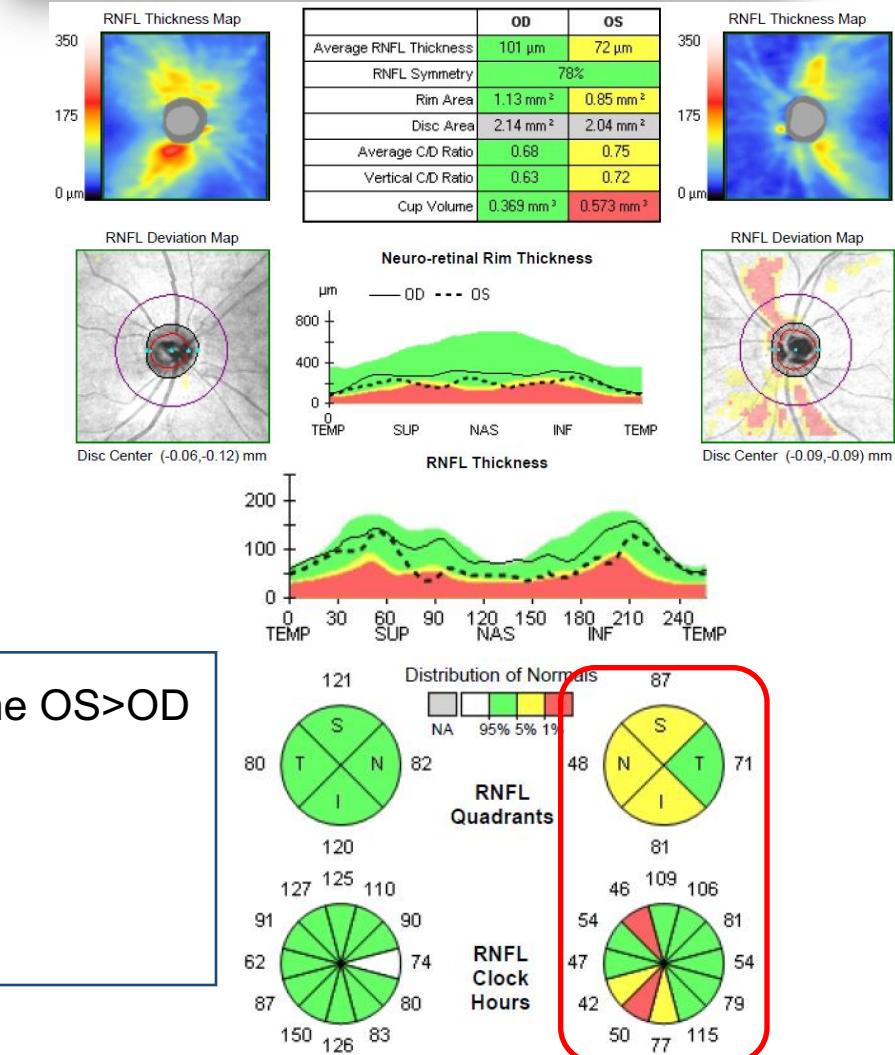
OD MD +1.75 PSD 1.42  
OS MD +1.42 PSD 1.21

## Special Commentary: Food and Drug Administration and American Glaucoma Society Co-sponsored Workshop

The Validity, Reliability, and Usability of Glaucoma Imaging Devices

Ophthalmology Volume 121, Number 11, November 2014

Kristen L. Meier, PhD,<sup>1</sup> David S. Greenfield, MD,<sup>2</sup> Gene Hilmantel, OD, MHS,<sup>3</sup> Malik Y. Kahook, MD,<sup>4</sup> Carol Lin, MD,<sup>5</sup> Eva M. Rorer, MD,<sup>3</sup> Kuldev Singh, MD, MPH,<sup>5</sup> Michelle E. Tarver, MD, PhD,<sup>3</sup> Robert N. Weinreb, MD,<sup>6</sup> Malvina B. Eydelman, MD,<sup>1</sup> Jeffrey M. Liebmann, MD<sup>7</sup>



# Un OCT “red flag”..

## Special Commentary: Food and Drug Administration and American Glaucoma Society Co-sponsored Workshop

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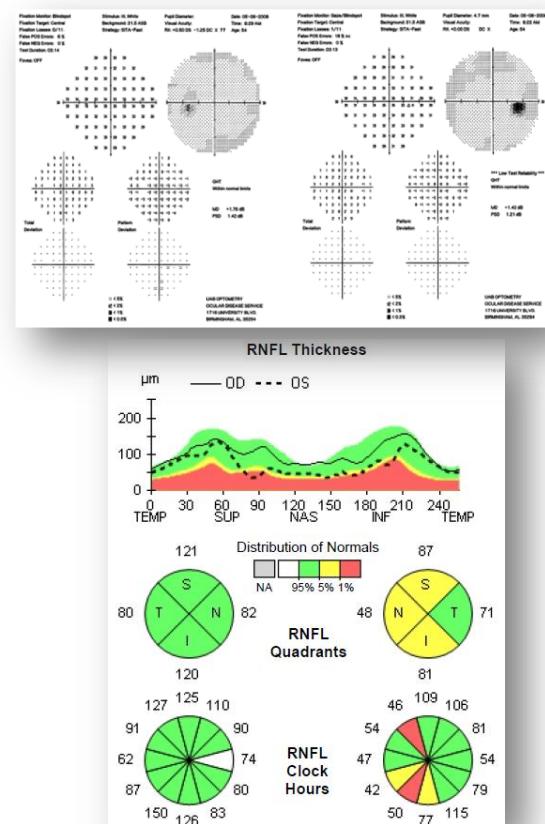
Kristen L. Meier, PhD,<sup>1</sup> David S. Greenfield, MD,<sup>2</sup> Gene Hilmantel, OD, MHS,<sup>3</sup> Malik Y. Kahook, MD,<sup>4</sup> Carol Lin, MD,<sup>5</sup> Eva M. Rorer, MD,<sup>3</sup> Kuldev Singh, MD, MPH,<sup>5</sup> Michelle E. Tarver, MD, PhD,<sup>3</sup> Robert N. Weinreb, MD,<sup>6</sup> Malvina B. Eydelman, MD,<sup>1</sup> Jeffrey M. Liebmann, MD<sup>7</sup>

- NON corrisponde a diagnosi di glaucoma

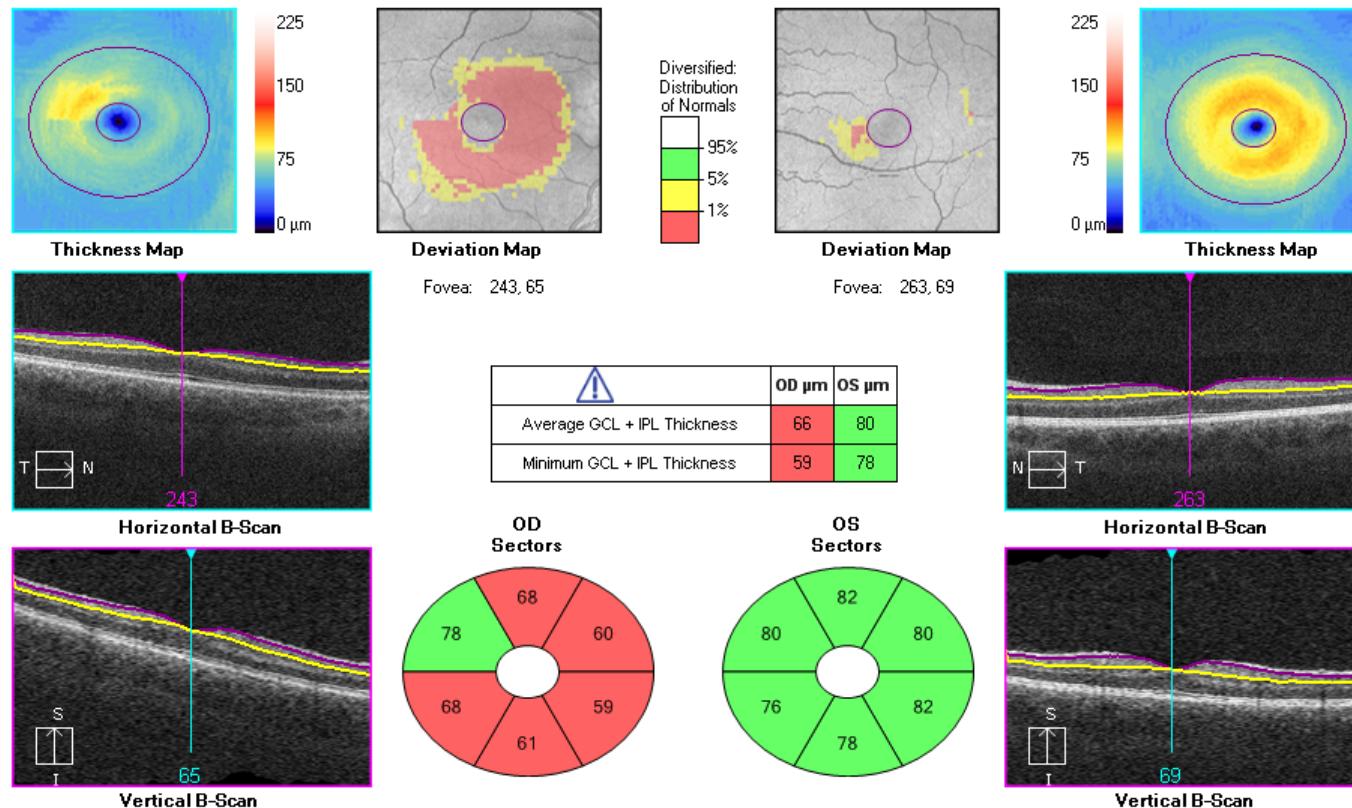
- ✓ Non tratto il paziente

- Può renderci più attenti nel follow-up:

- ✓ Aumentando la frequenza dei controlli

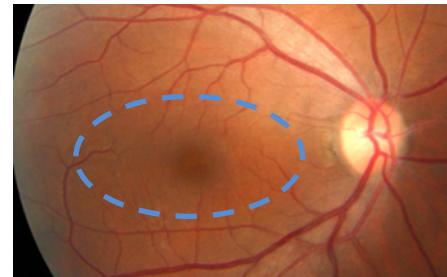
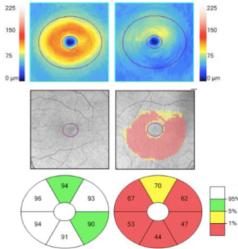


# Il complesso ganglionare



## Macula

### ganglion cell inner plexiform layer (GCIPL)



#### Analisi regione maculare

Minor variabilità

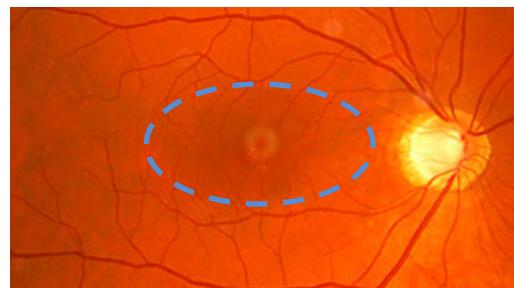
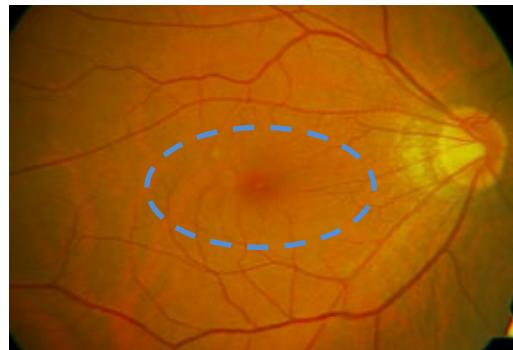
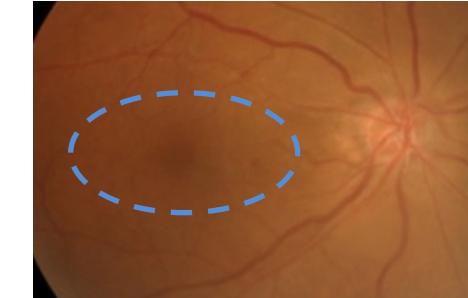
Comprende 50% *cellule ganglionari*

Non dipendente dalle caratteristiche della testa del nervo ottico

Corpo cellule ganglionari più grande degli asseni e più facilmente individuabile

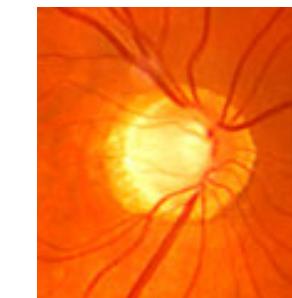
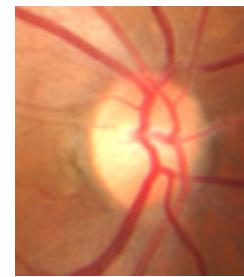
*Utile in occhi miopi*

No se patologie maculari



## Testa del nervo ottico

### RNFL



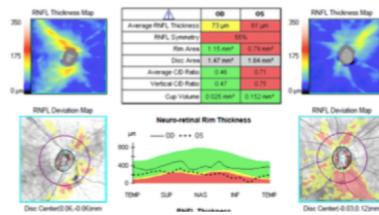
#### Analisi RNFL

Grande variabilità

Comprende gli *assoni* di tutte le cellule ganglionari

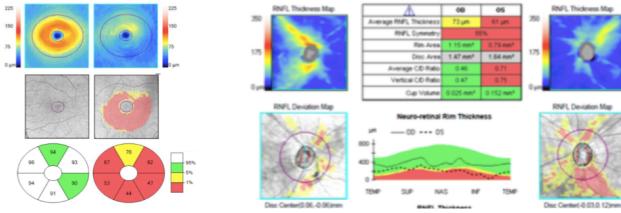
Alta variabilità in relazione a dimensioni e forma testa nervo ottico (atrofia, tilted disc)

*Non utile in occhi miopi*



# Il complesso ganglionare

Confronto tra **parametri maculari** (ganglion cell complex , GCC e ganglion cell inner plexiform layer, GCIPL) e **RNFL**



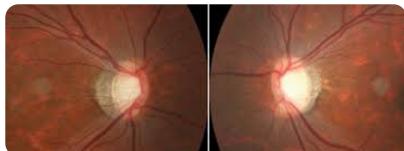
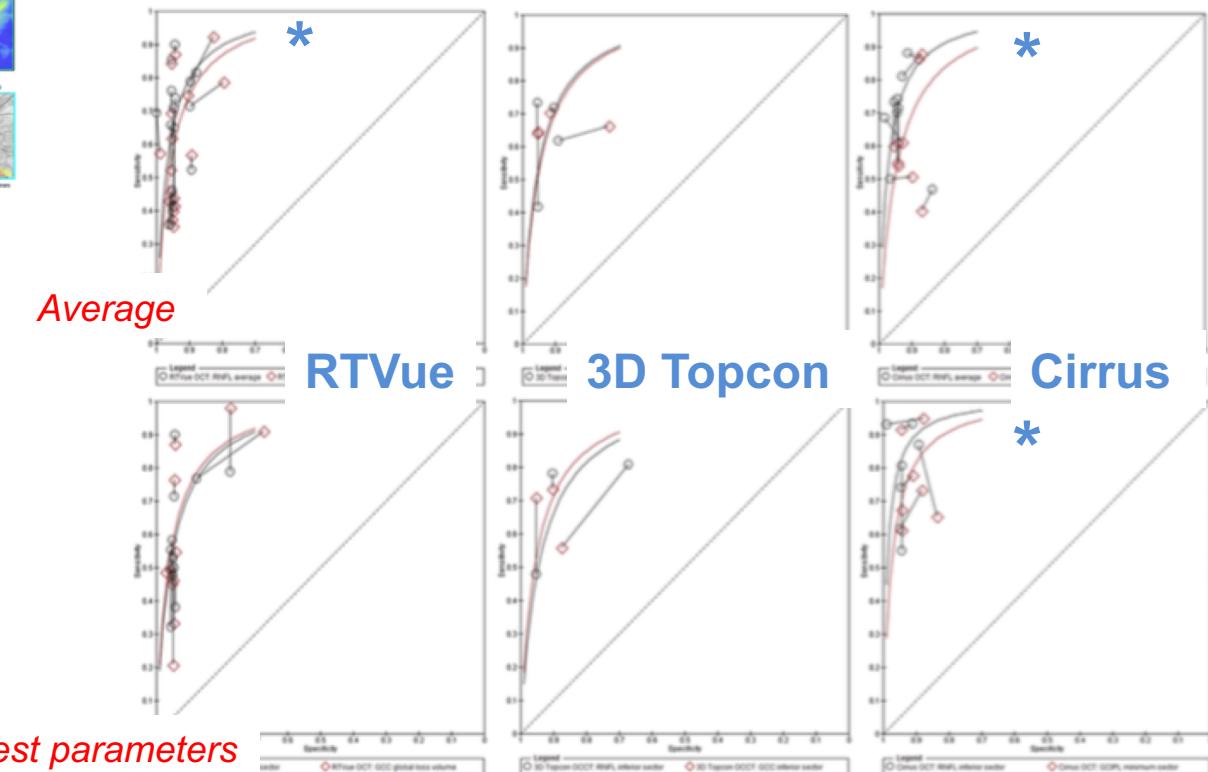
- *RNFL parameters are still preferable to macular parameters ..., but the differences are small.*
- Analisi **cellule ganglionari** (GCC) utile in **occhi miopi**

## Macular versus Retinal Nerve Fiber Layer Parameters for Diagnosing Manifest Glaucoma

A Systematic Review of Diagnostic Accuracy Studies

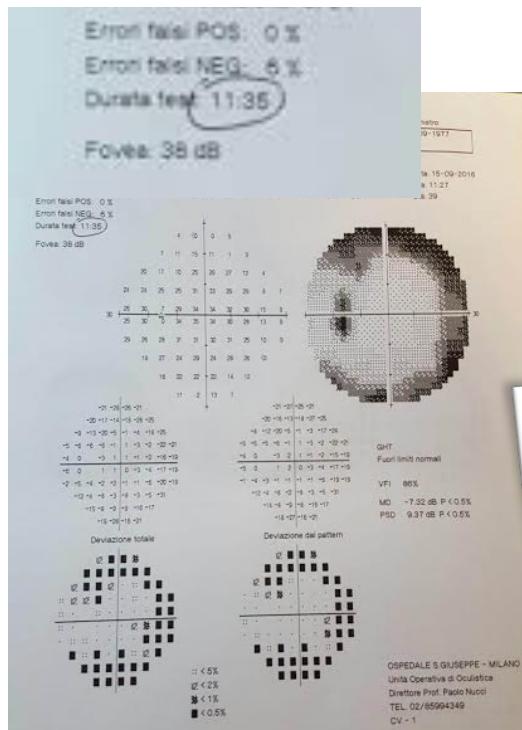
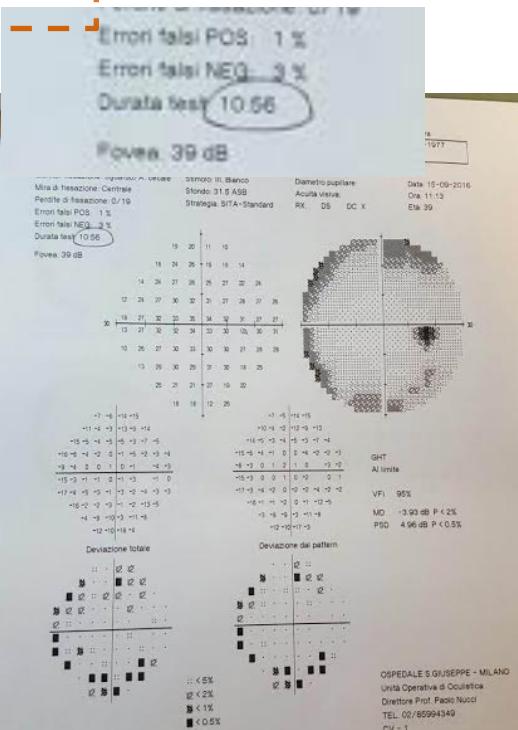
Francesco Oddone, MD,<sup>1</sup> Ersilia Lucenteforte, ScD, PhD,<sup>2</sup> Manuele Michelessi, MD,<sup>1</sup> Stanislao Rizzo, MD,<sup>3</sup> Simone Donati, MD,<sup>4</sup> Mariacristina Parravano, MD,<sup>1</sup> Gianni Virgili, MD<sup>3</sup>

Ophthalmology Volume 123, Number 5, May 2016

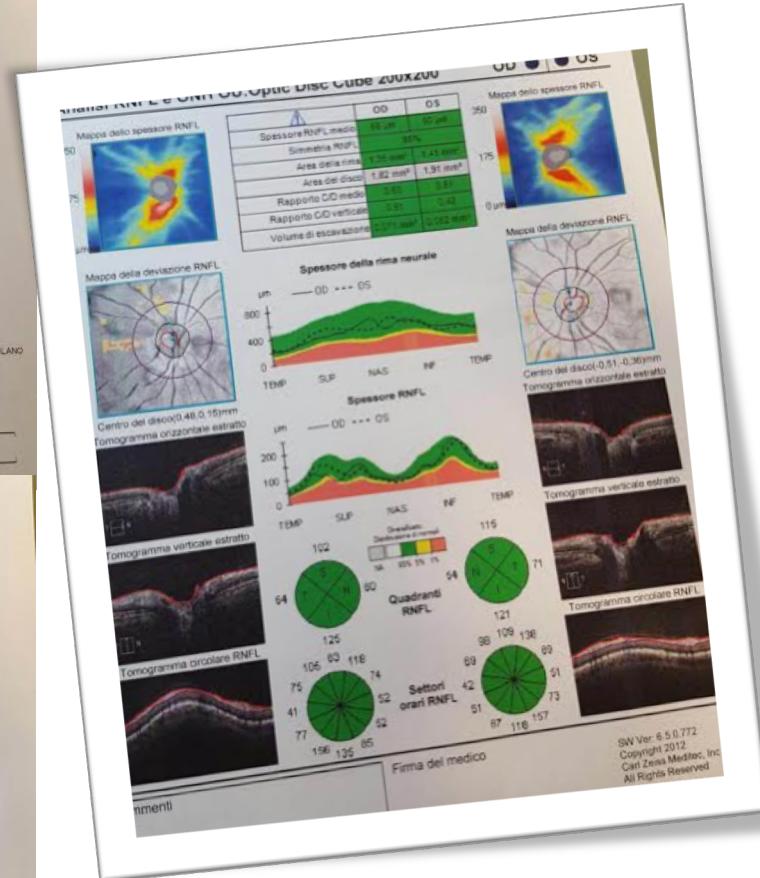


# Casi clinici

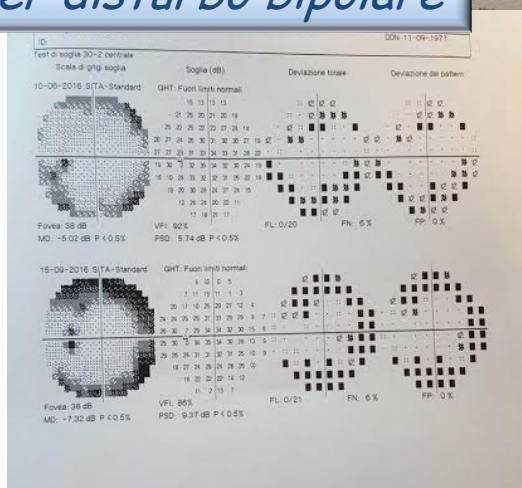
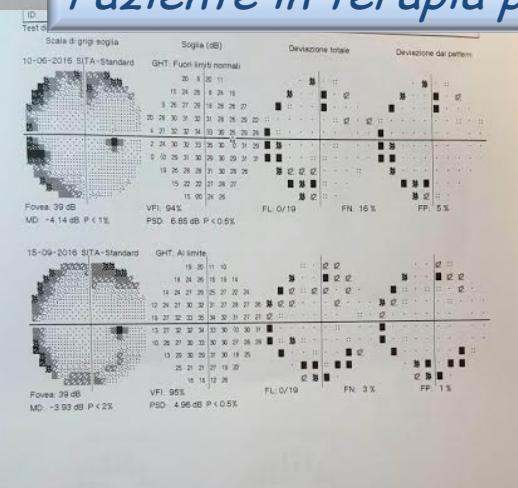
#1



Campo visivo non attendibile  
difetto concentrico  
tempo di esecuzione

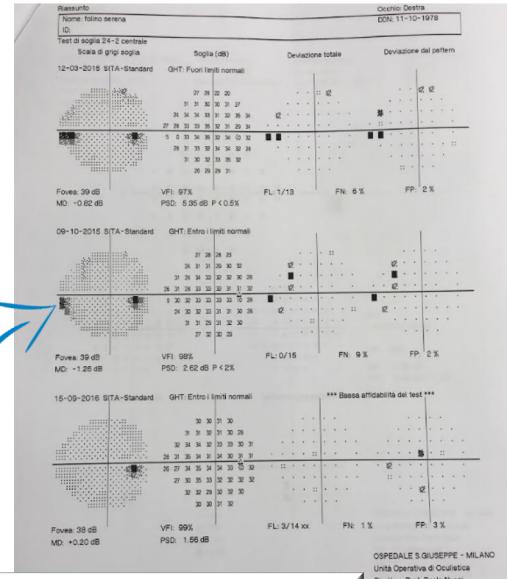
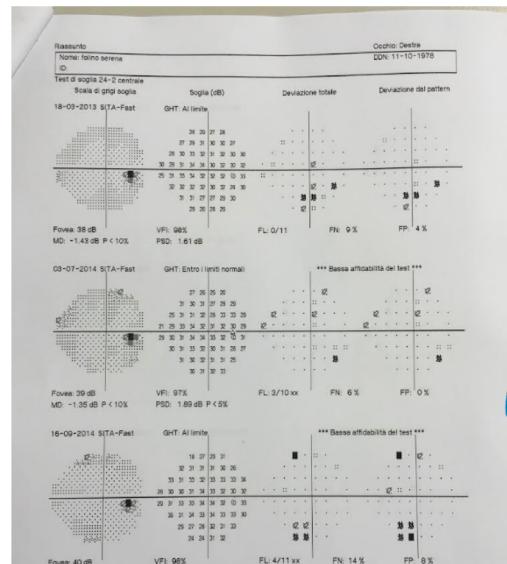
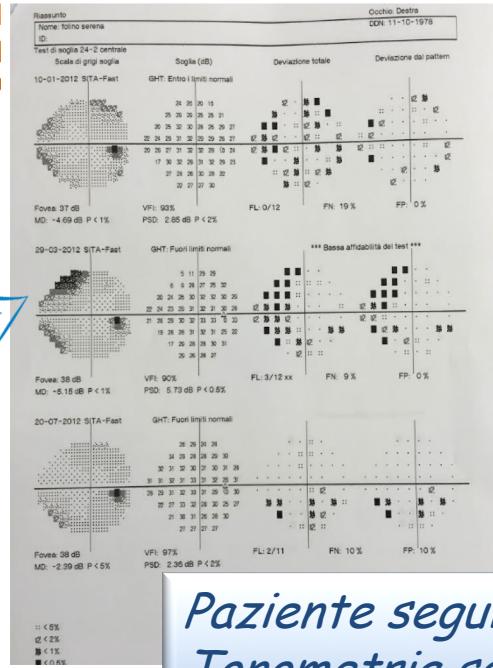


Paziente in terapia per disturbo bipolare

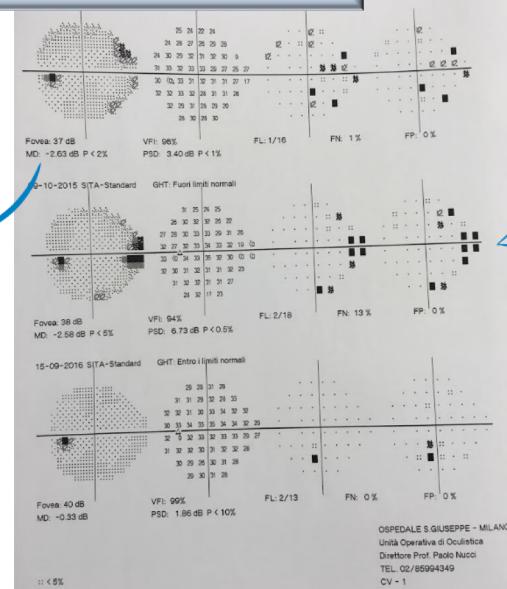
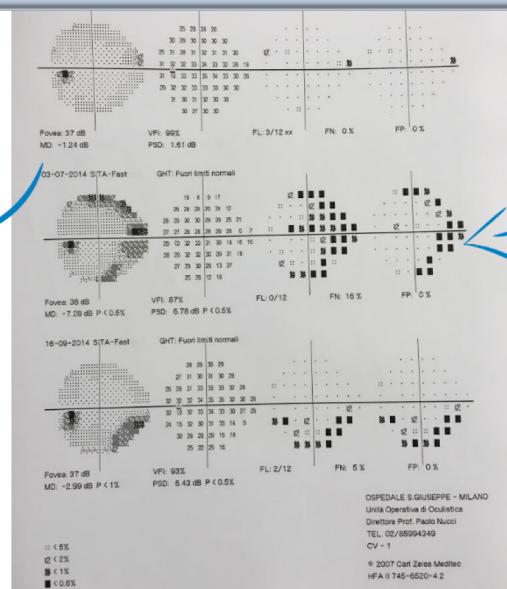
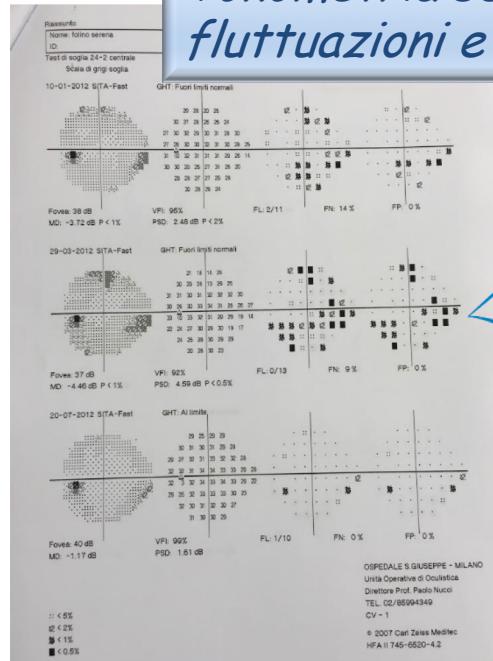


M. Sacchi – Ospedale San Giuseppe, Milano

#2

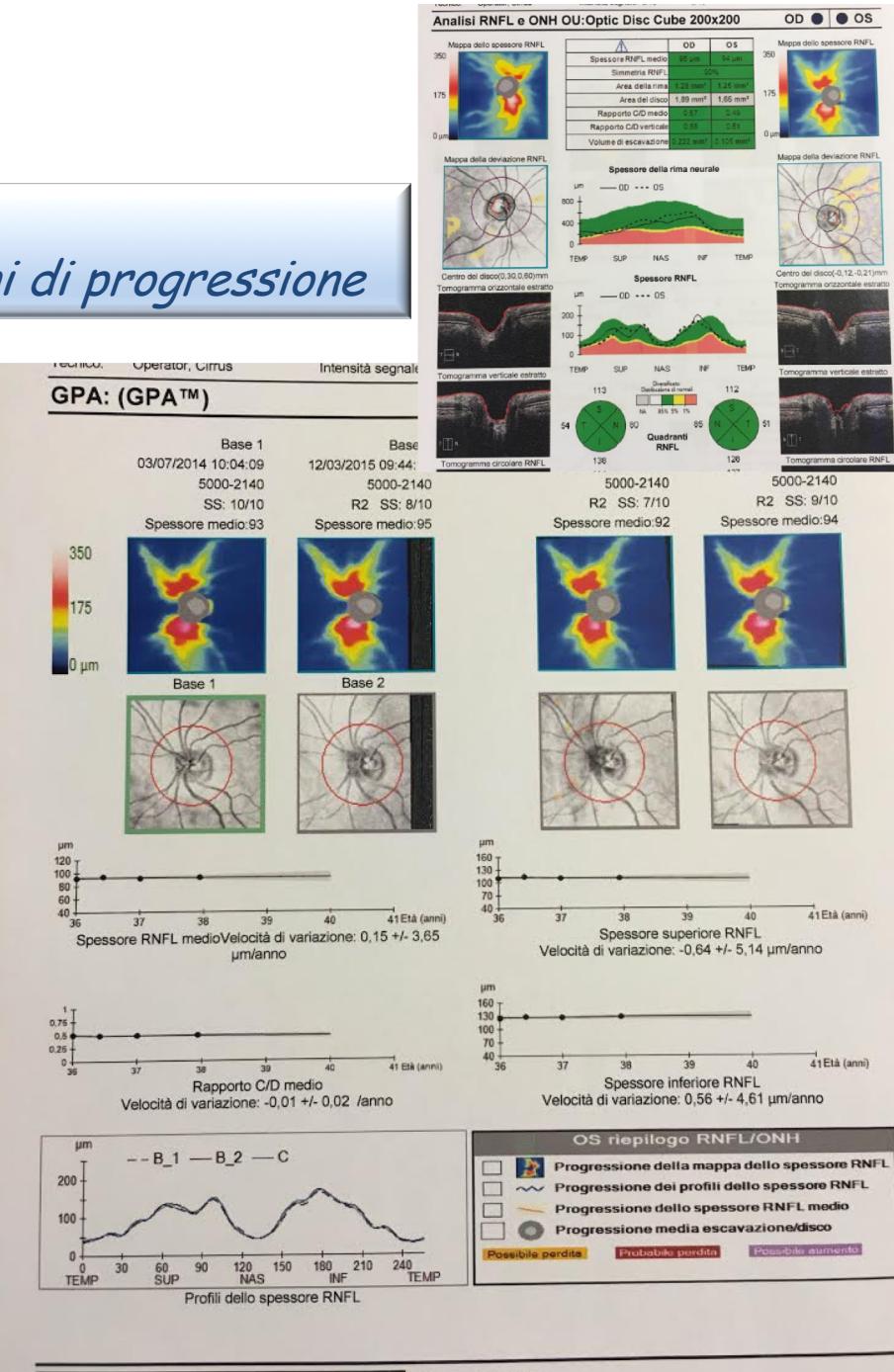
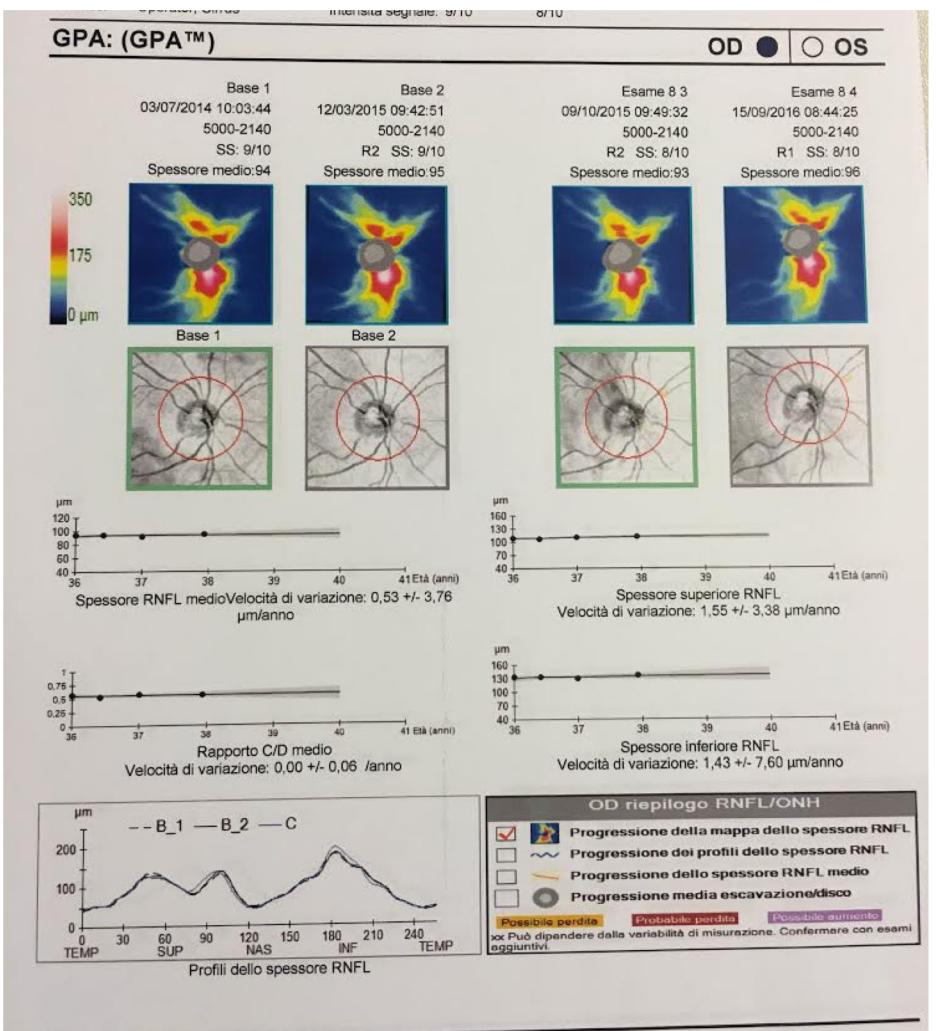


*Paziente seguita per sospetto glaucoma  
Tonometria sempre nella norma, campi visivo con ampie fluttuazioni e difetti aspecifici*



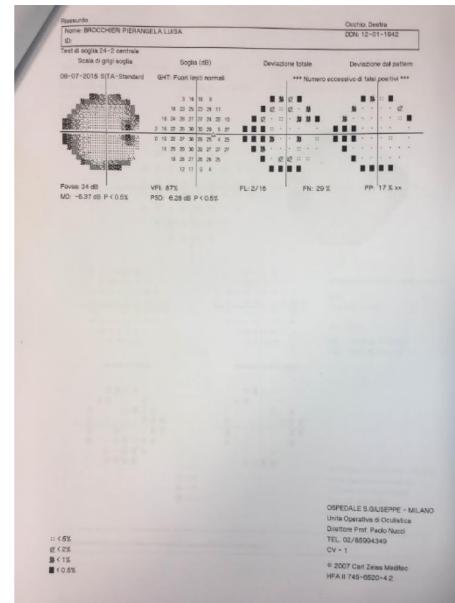
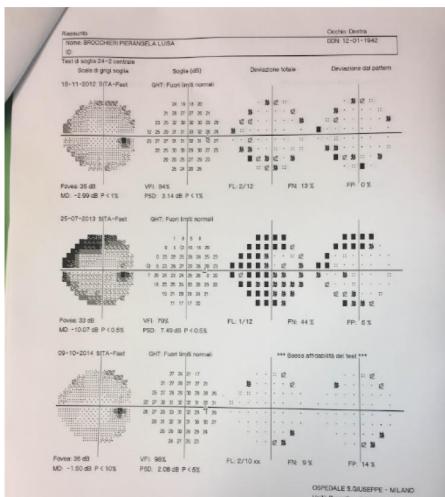
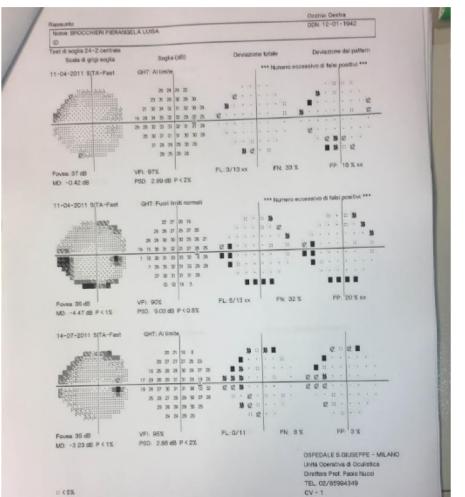
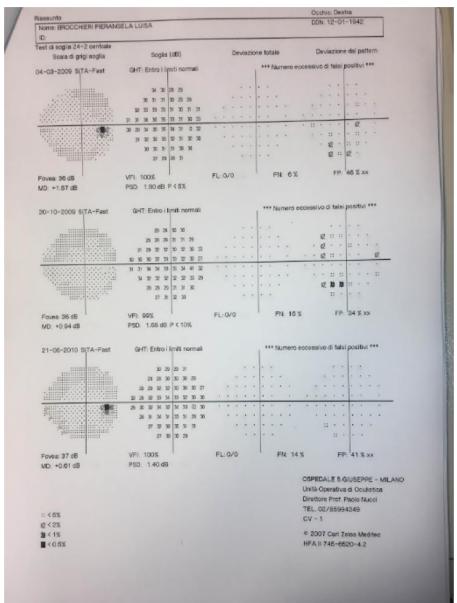
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OCT mostra quadro di normalità  
GPA mostra stabilità nel tempo senza segni di progressione

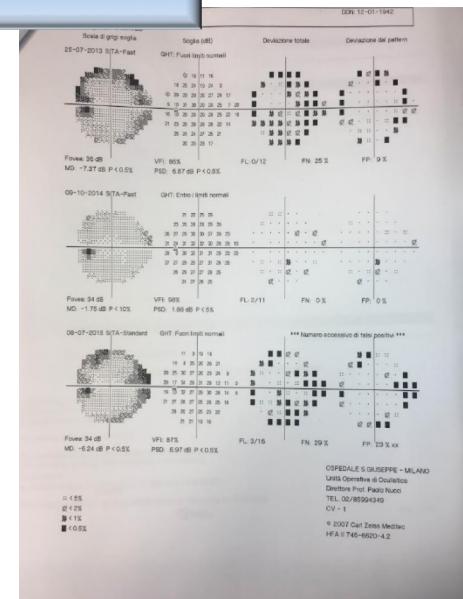
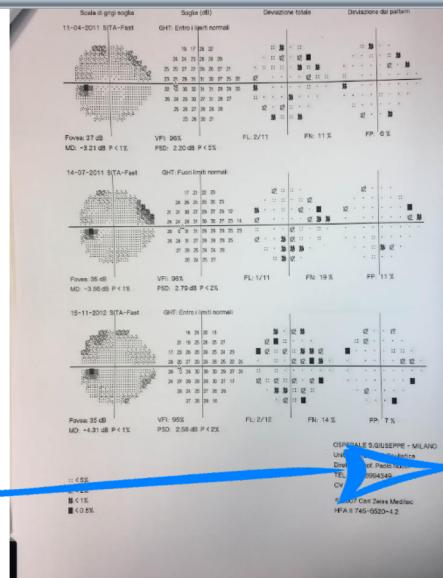
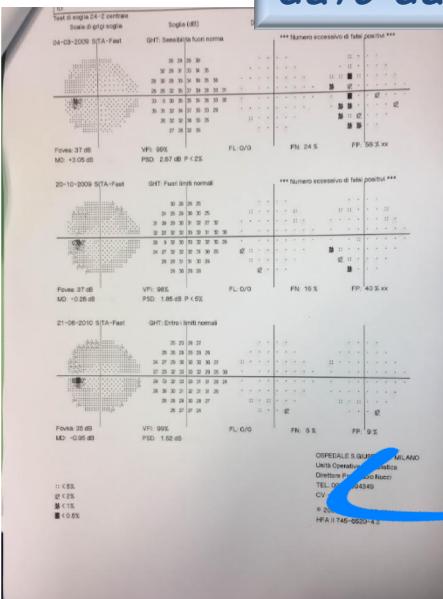


#3

# Paziente in terapia per morbo di Parkinson

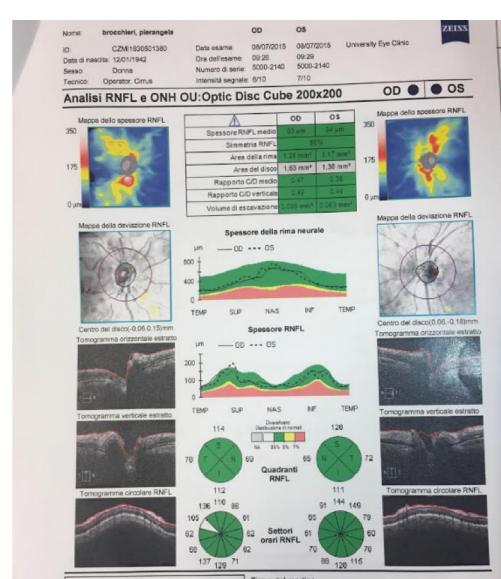
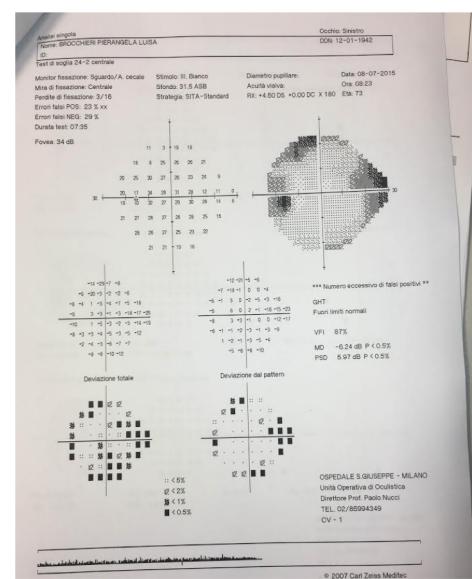
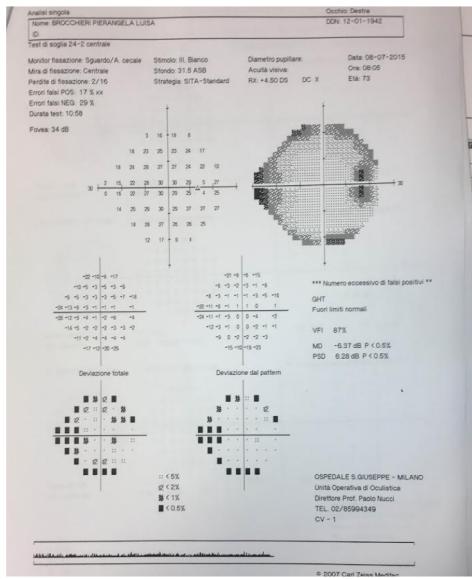


**Difficile valutare la progressione  
(ampie fluttuazioni, "rumore di fondo"  
dato da difetti aspecifici)**

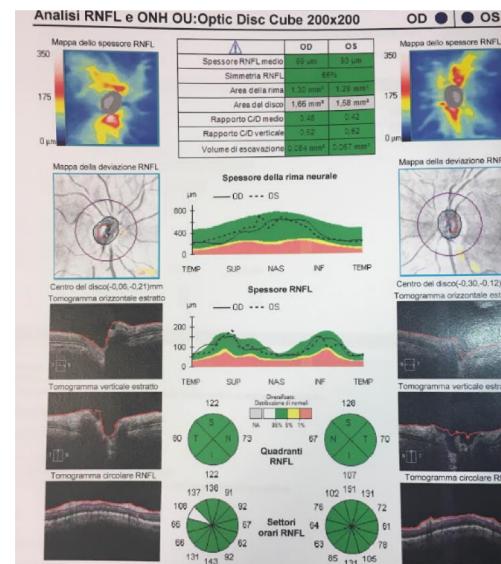
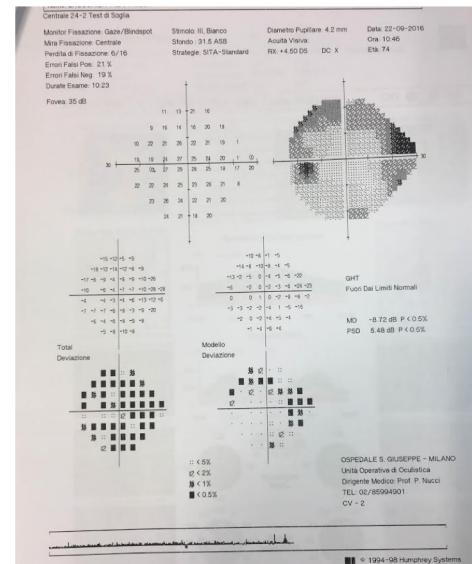
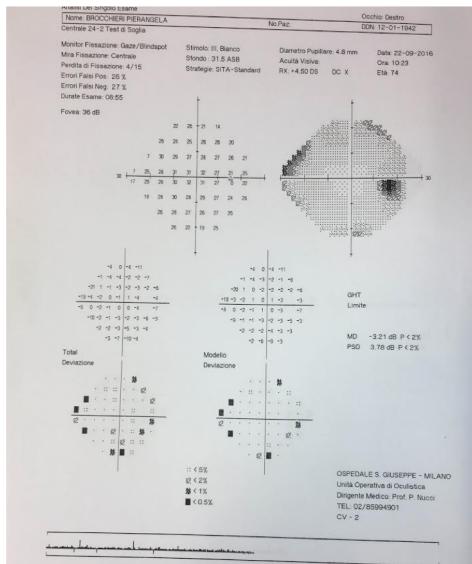


#3

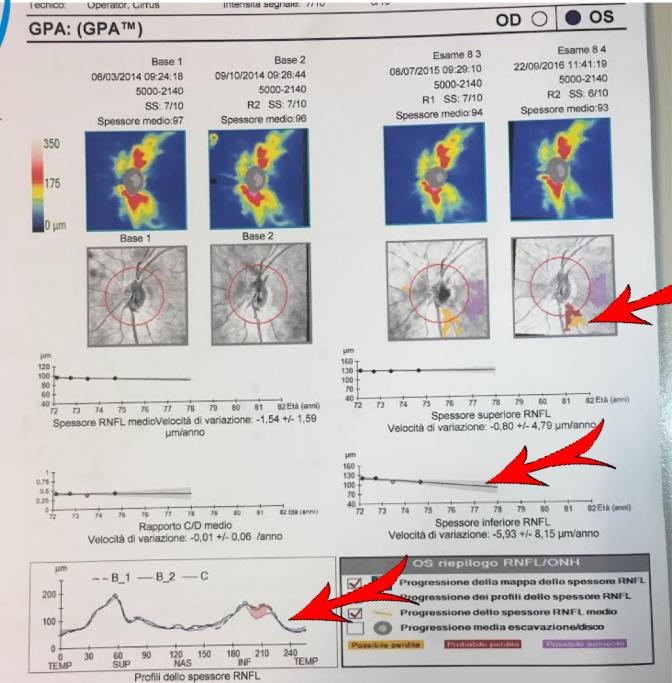
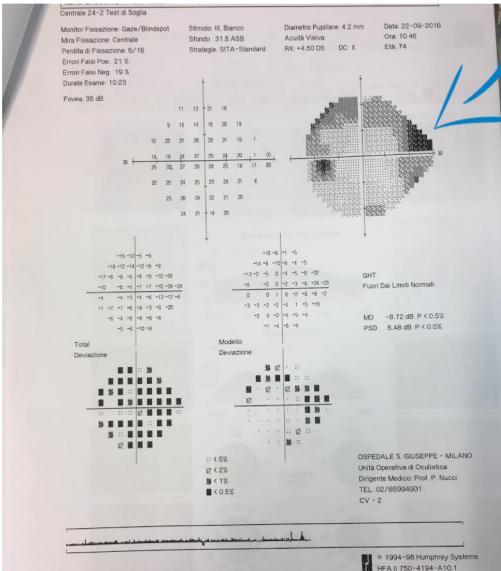
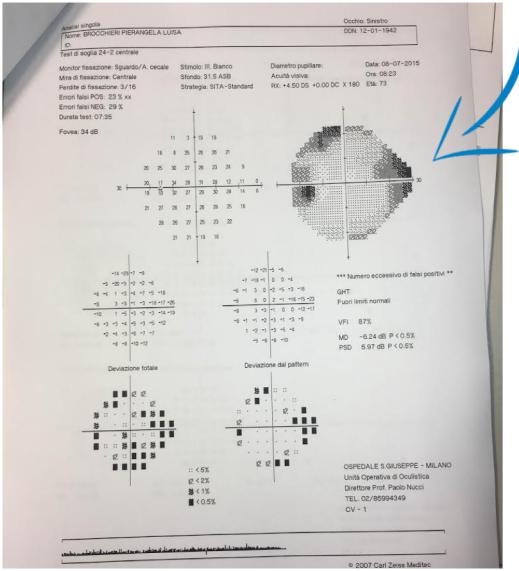
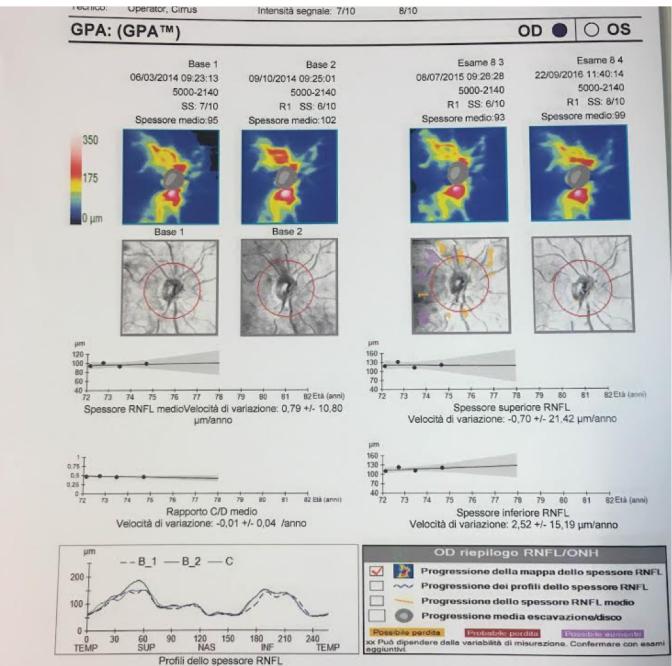
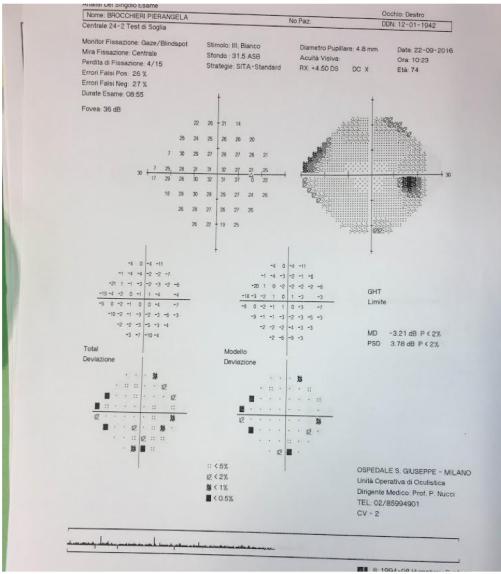
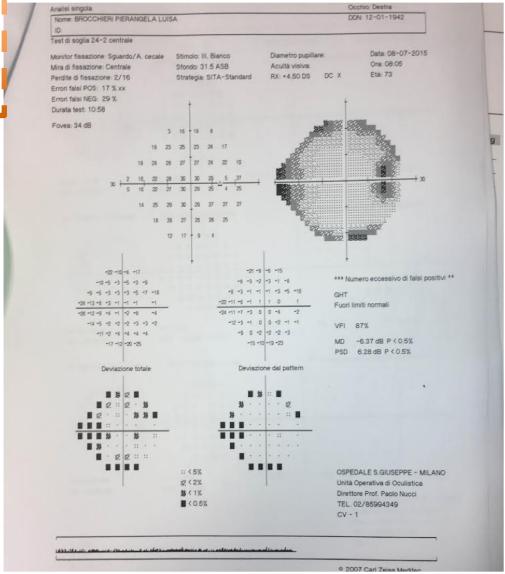
2015



## Paziente in terapia per morbo di Parkinson

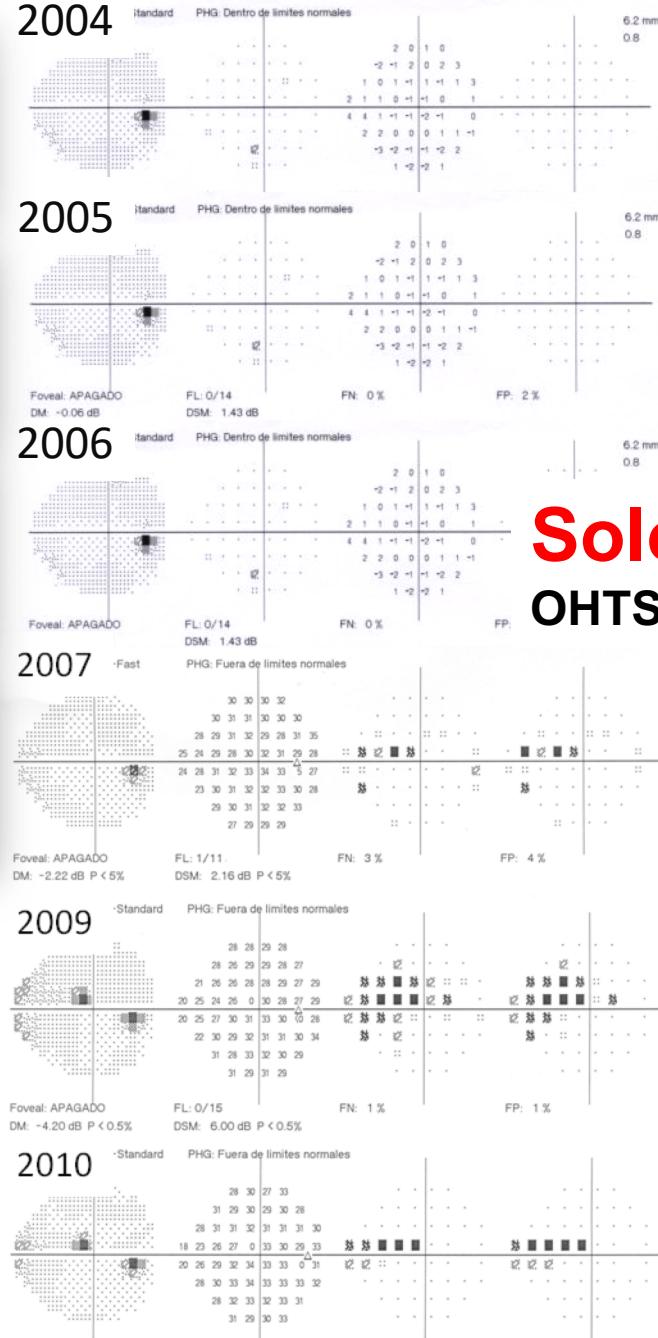


#3



**OCT individua una progressione (strutturale) difficilmente valutabile con la perimetria**

# Paziente iperteso oculare



**Scenario ideale**

**Imaging anticipa il difetto  
al campo visivo**

#5

Quale analisi è più efficace per fare  
diagnosi precoce?

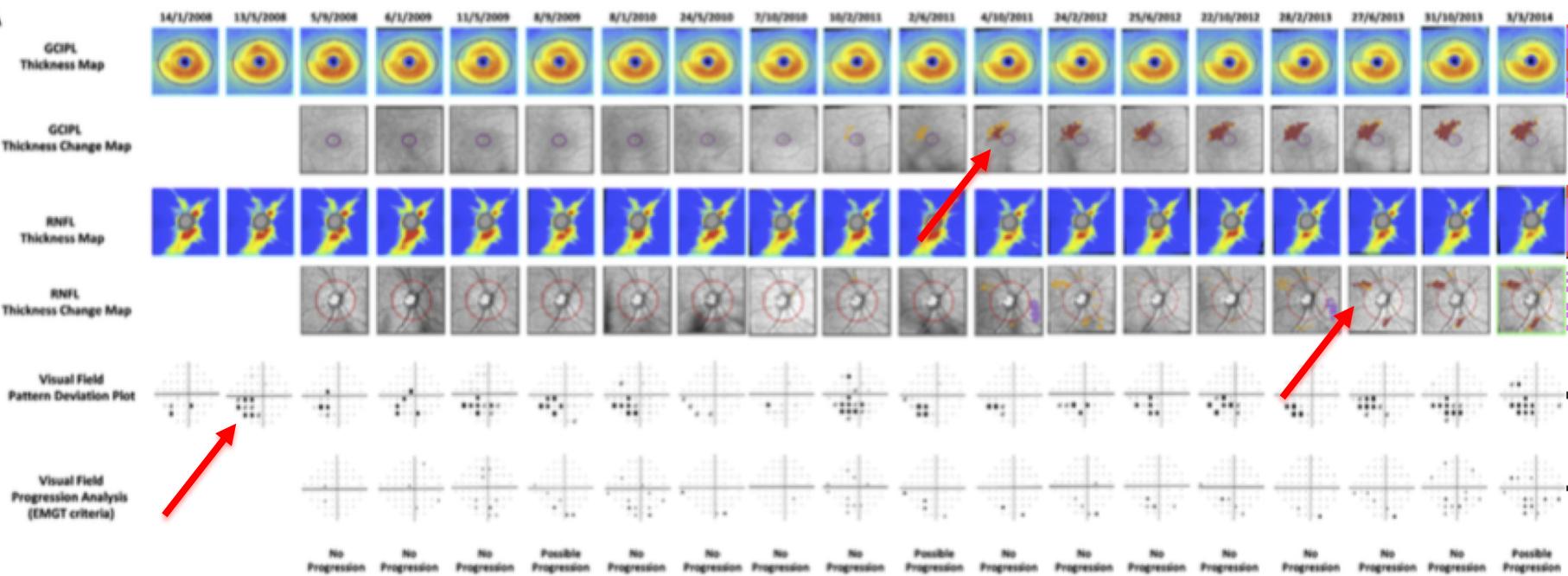
**Complesso ganglionare o RNFL?**

# Integrating Macular Ganglion Cell Inner Plexiform Layer and Parapapillary Retinal Nerve Fiber Layer Measurements to Detect Glaucoma Progression

Hei Wan Hou,\* Chen Lin, PhD,\* Christopher Kai-Shun Leung, MD, MBChB

Ophthalmology 2018

A



Complesso ganglionare precede RNFL

MA..

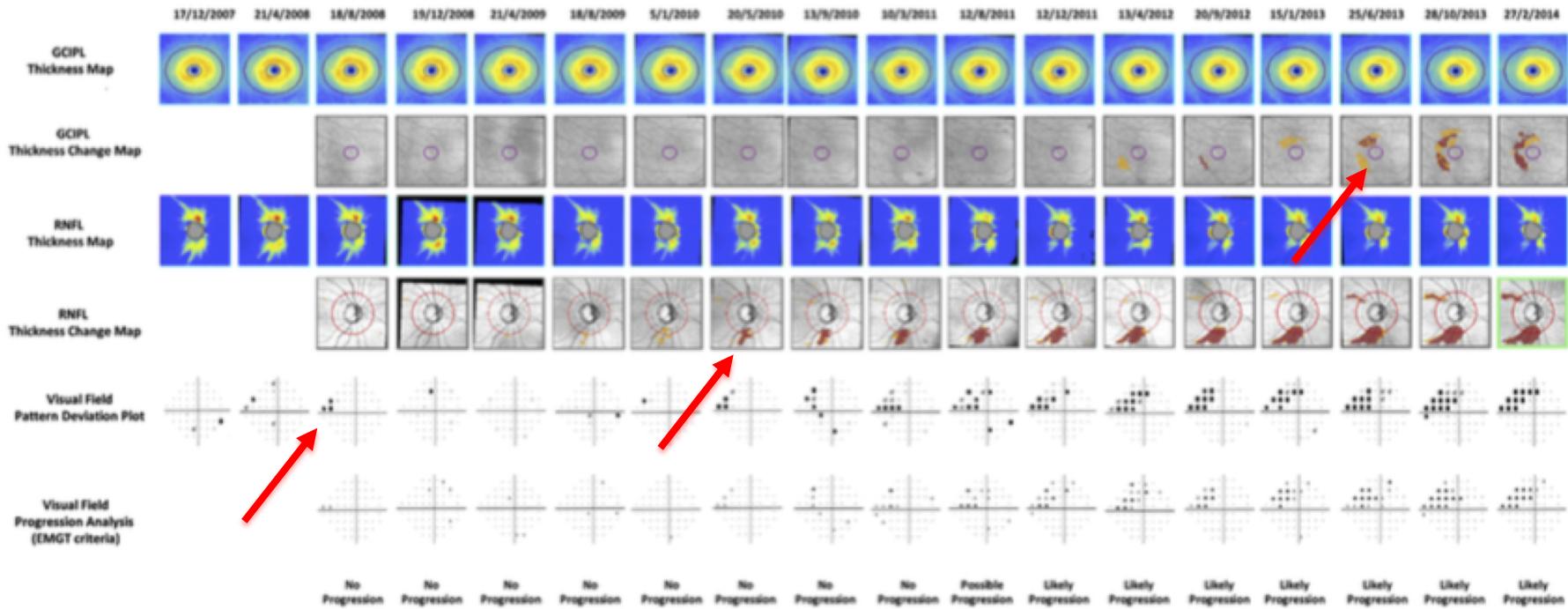
Difetto perimetrico precede danno strutturale!!

# Integrating Macular Ganglion Cell Inner Plexiform Layer and Parapapillary Retinal Nerve Fiber Layer Measurements to Detect Glaucoma Progression

Hei Wan Hou,\* Chen Lin, PhD,\* Christopher Kai-Shun Leung, MD, MBChB

Ophthalmology 2018

B



**RNFL precede Complesso ganglionare**

MA..

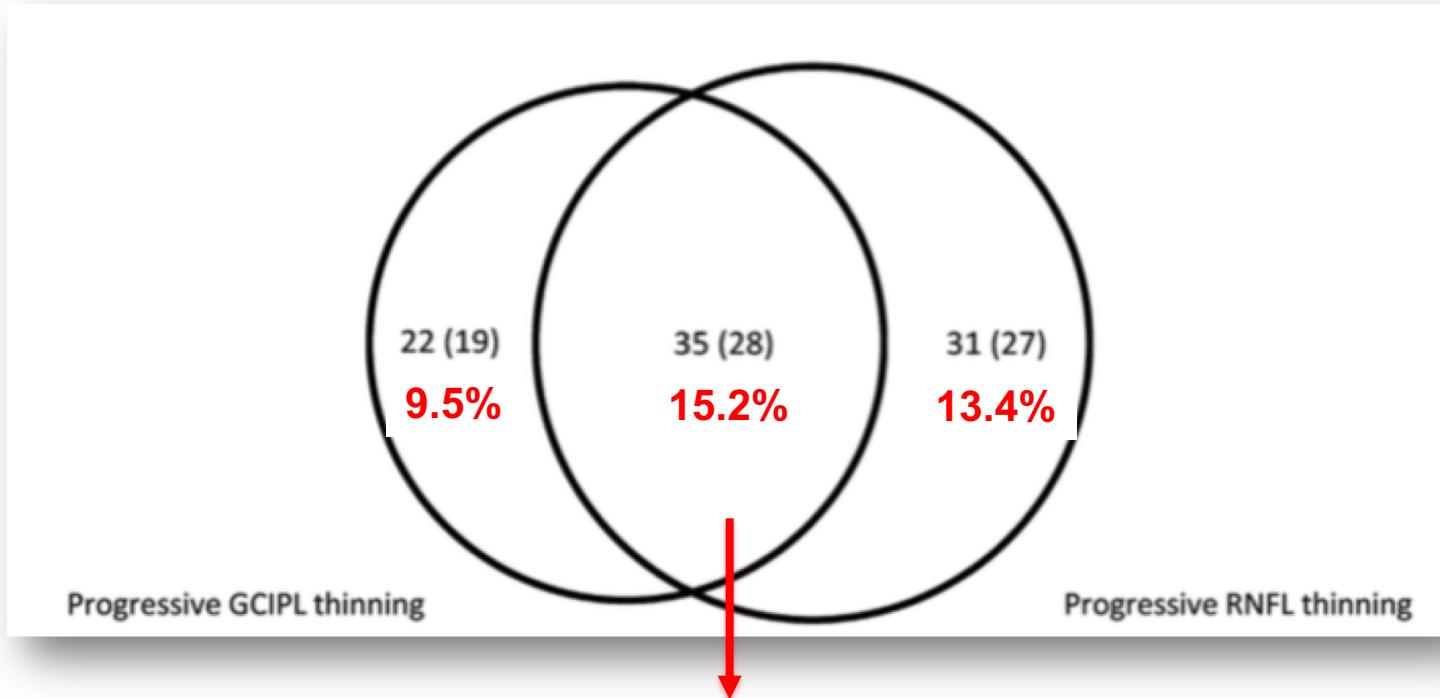
**Difetto perimetrico precede danno strutturale!!**

# Integrating Macular Ganglion Cell Inner Plexiform Layer and Parapapillary Retinal Nerve Fiber Layer Measurements to Detect Glaucoma Progression

Hei Wan Hou,\* Chen Lin, PhD,\* Christopher Kai-Shun Leung, MD, MBChB

Ophthalmology 2018

57 occhi (24.7%) progressione con GCIPL  
66 occhi (28.6%) progressione con RNFL



13 RNFL before  
19 GCIPL before  
3 simultaneously

# **Integrating Macular Ganglion Cell Inner Plexiform Layer and Parapapillary Retinal Nerve Fiber Layer Measurements to Detect Glaucoma Progression**

Hei Wan Hou,\* Chen Lin, PhD,\* Christopher Kai-Shun Leung, MD, MBChB

Ophthalmology 2018

The temporal sequence of axonal and dendritic degeneration in glaucomatous RGC degeneration is largely unclear

Quale analisi è più efficace per fare diagnosi precoce?

**Complesso ganglionare o RNFL?**

It remains obscure why some eyes exhibited progressive RNFL thinning before progressive GCIPL thinning and vice versa in others

# **Macular imaging by optical coherence tomography in the diagnosis and management of glaucoma**

Ko Eun Kim,<sup>1</sup> Ki Ho Park<sup>2</sup>

**BJO 2017**

It still is not fully understood whether damage to the RGC body and RGC axonal loss occurs simultaneously or sequentially

# Funzione vs struttura

## The Ocular Hypertension Treatment Study ARCHIVES EXPRESS

A Randomized Trial Determines That Topical Ocular Hypotensive Medication Delays or Prevents the Onset of Primary Open-Angle Glaucoma

Michael A. Kass, MD; Dale K. Heuer, MD; Eve J. Higginbotham, MD; Chris A. Johnson, PhD; John L. Keltner, MD; J. Philip Miller, AB; Richard K. Parrish II, MD; M. Roy Wilson, MD; Mae O. Gordon, PhD; for the Ocular Hypertension Treatment Study Group

Arch Ophthalmol. 2002;120:701-713

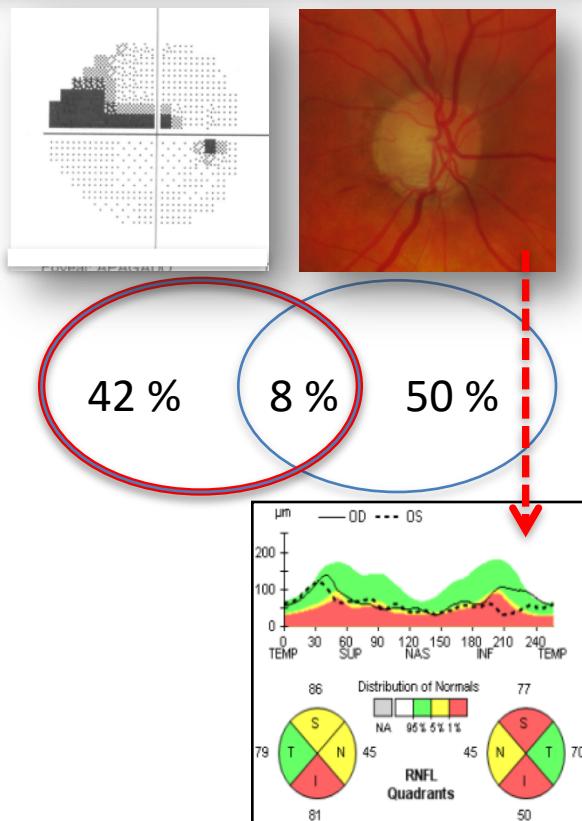


Table 4. First POAG Endpoint for Each Participant\*

	Medication Group, No. (%)	Observation Group, No. (%)
Visual field	15 (41.7)	29 (32.6)
Optic disc	18 (50.0)	51 (57.3)
Concurrent visual field and optic disc	3 (8.3)	9 (10.1)
Total	36 (100.0)	89 (100.0)

## OCT non sostituisce campo visivo

Pazienti ipertesi/sospetti andrebbero seguiti con:

**campo visivo + esame strutturale**

# Conclusioni

- La diagnosi di glaucoma è **perimetrica**. Un'alterazione all'OCT non consente di fare **diagnosi di glaucoma** (considerarla come fattore di rischio, aumentare controlli)
- OCT utile per individuare **alterazioni precoci**, “preperimetriche” (iperteso oculare), POCO UTILE nel GLAUCOMA AVANZATO (programmi per la progressione strutturale complesso ganglionare)
- Utile in pazienti con **difficoltà nell'eseguire campo visivo** (stati d'ansia, terapie neurolettiche)
- Se **atrofia peripapillare**, papille **miopiche**, **tiltate**, **dismorfiche** RNFL non utile, considerare lo studio del **complesso ganglionare**
- Possibilità di utilizzare **GPA** per la **progressione strutturale**

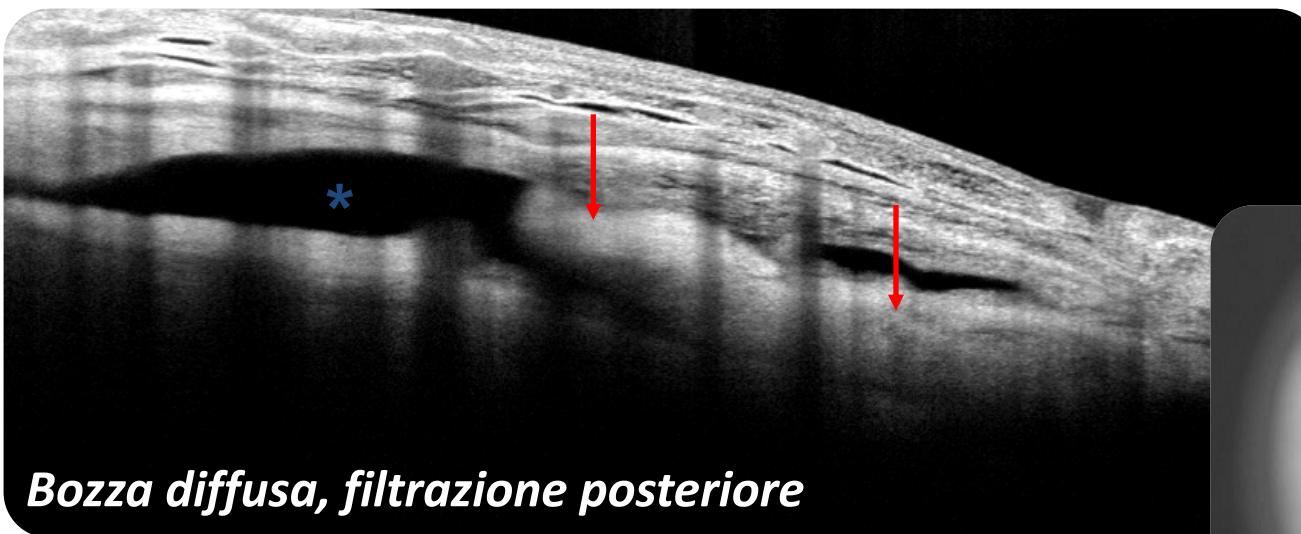
# Expanding indications studio dell'angolo irido-corneale

*Angolo stretto, iride a plateau*

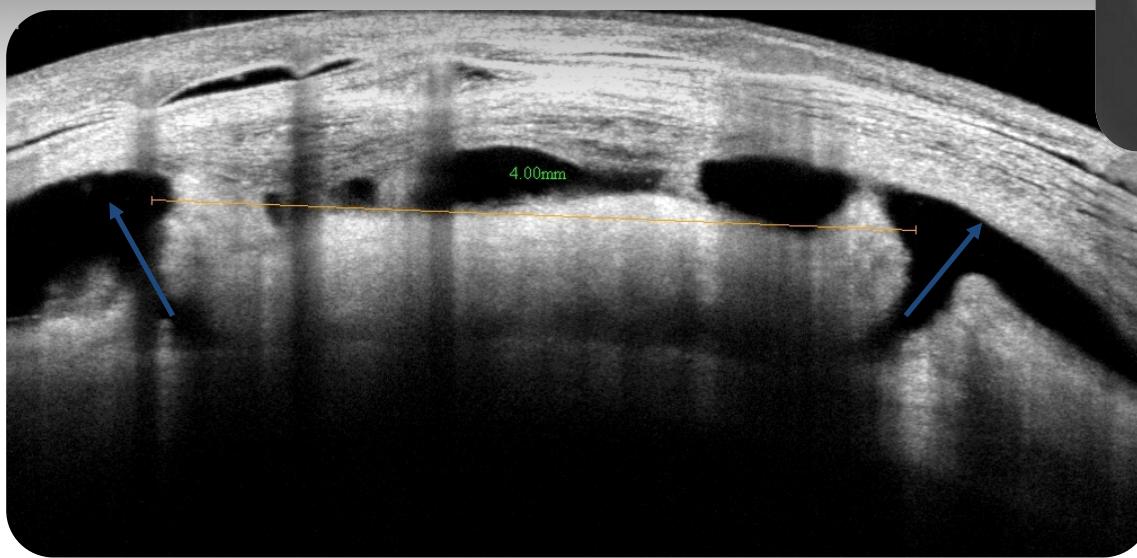
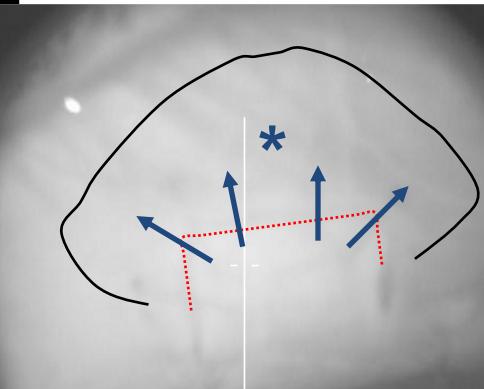


*Scansione 30' dopo istillazione  
pilocarpina 2%*

# Expanding indications studio della bozza congiuntivale

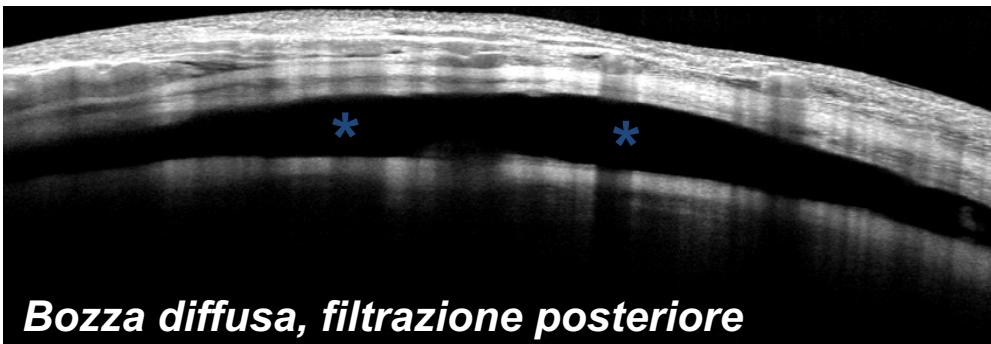


*Trabeculectomia con MMC*

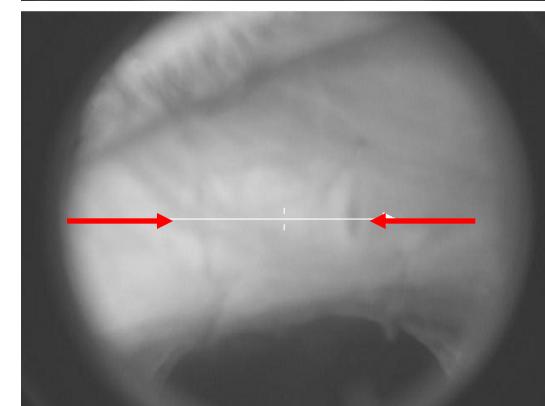
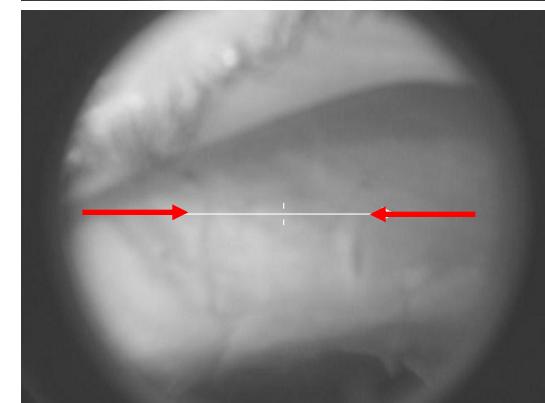
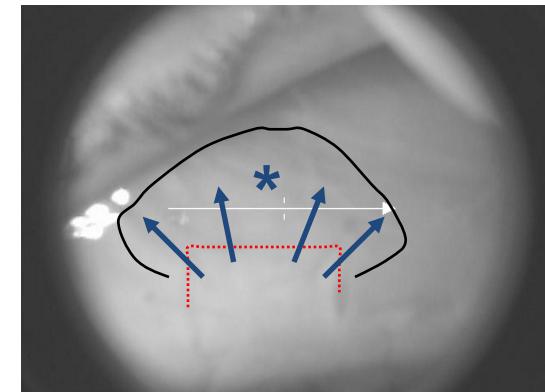
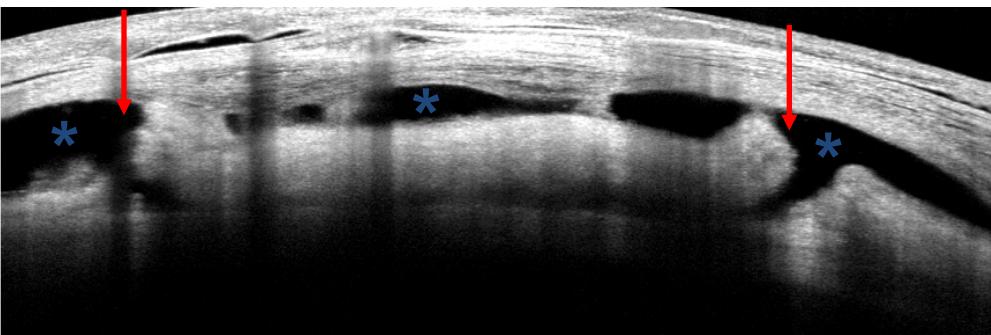
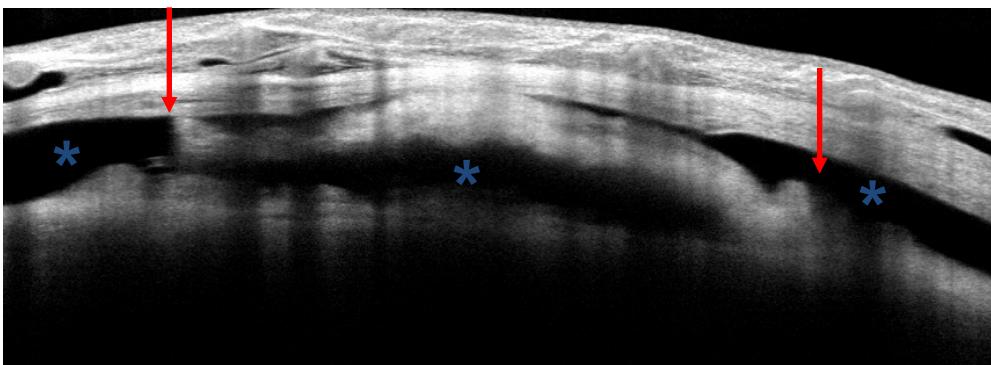


# Expanding indications Studio della bozza congiuntivale

Trabeculectomia con MMC



**Bozza diffusa, filtrazione posteriore**

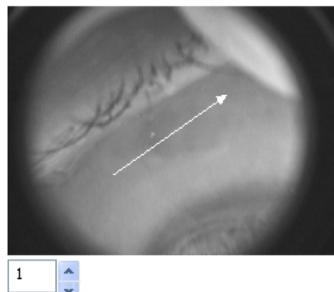


# Expanding indications studio della bozza congenitale

05 03/23/2017 09:39:22

CL - Line SSI = 50.2

6.0 *Impianto di XEN*

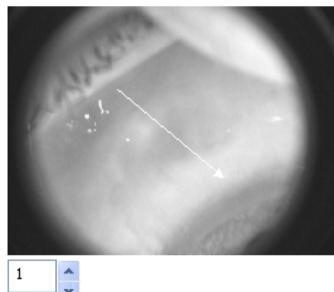


250 µm

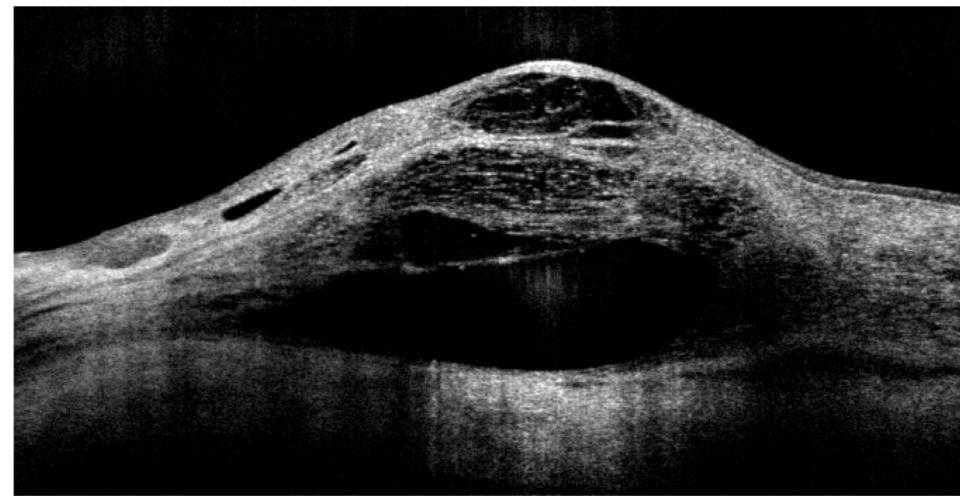


05 03/23/2017 09:40:48

6.00 Scan Size (mm)



250 µm



# Expanding indications studio della bozza congiuntivale

*Impianto di XEN*

OS 03/08/2017 09:55:56

CL - Line SSI = 63.7

6.00 Scan Size (mm)

*Xen, passaggio intrasclerale*

1 ▲ ▼

250 µm

—→ —←

OS 03/08/2017 09:59:58

6.00 Scan Size (mm)

*Xen, bozza ampia diffusa*

1 ▲ ▼

250 µm

OS

CL - Line SSI = 25.5

6.00mm Scan Length

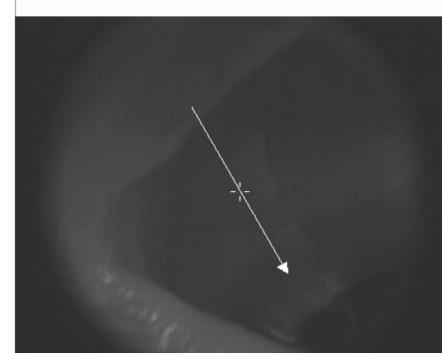
*Xen, bozza ampia diffusa*

—→ —←

# of Averages:

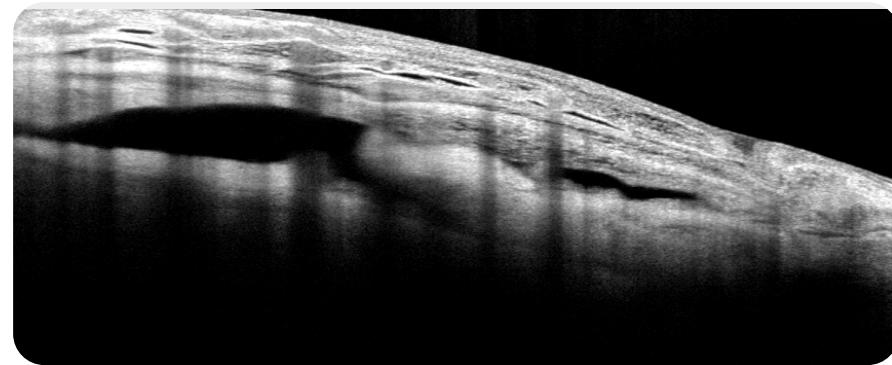
Average

No Average



# Expanding indications studio della bozza congenitale

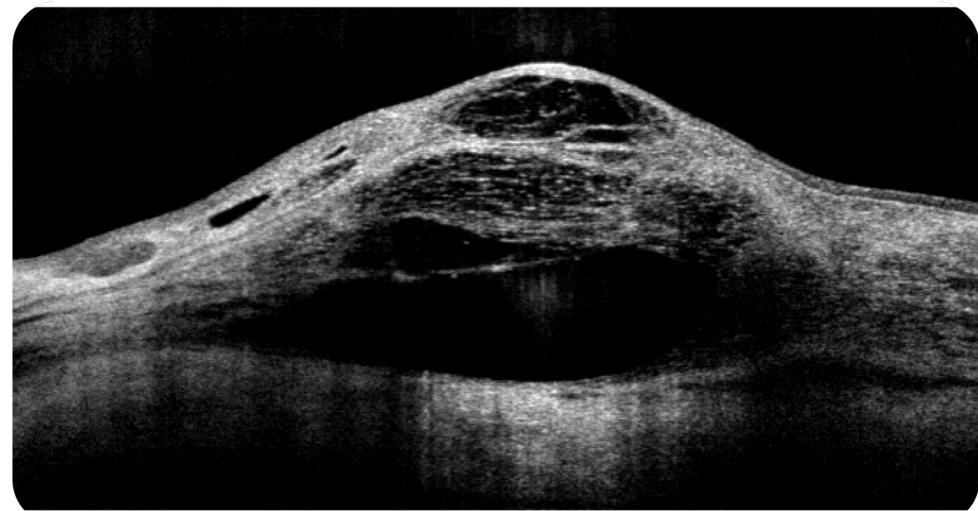
Trabe



ODT 14

Follow-up 2.5 anni  
(dic 2014)

Impianto di XEN



ODT 9

Follow-up 6 mesi  
(sett 2016)

# Expanding indications studio della bozza congiuntivale

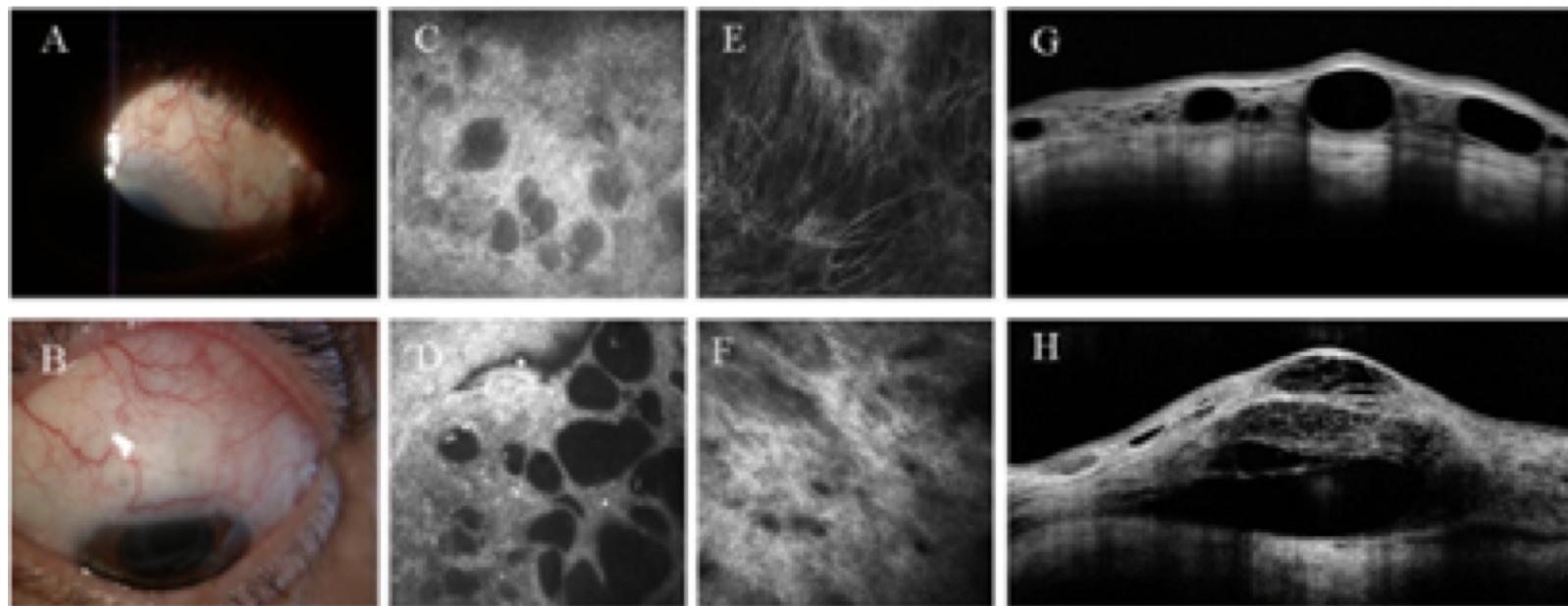
Graefe's Archive for Clinical and Experimental Ophthalmology (2020) 258:1763–1770  
<https://doi.org/10.1007/s00417-020-04671-2>

GLAUCOMA



## Structural imaging of conjunctival filtering blebs in XEN gel implantation and trabeculectomy: a confocal and anterior segment optical coherence tomography study

Matteo Sacchi<sup>1</sup> · Luca Agnifili<sup>2</sup> · Lorenza Brescia<sup>3</sup> · Francesco Oddone<sup>3</sup> · Edoardo Villani<sup>1</sup> · Paolo Nucci<sup>1</sup> · Leonardo Mastropasqua<sup>2</sup>





**Ragazzo 29 anni  
Dall'età di 16 anni diagnosi di  
glaucoma e terapia ipotonizzante  
con latanoprost generico**

**IOP max 14/14**

**IOP in terapia 11/11**

**Motivo dell'Accesso e Anamnesi Patologica Prossima**  
In terapia ipotonizzante dall'età di 16 anni  
Noto per aumento dell'escavazione papillare, dato basale ottobre 2004 (14 mmHg)  
tp con lopizze da 13 anni. [REDACTED]

**Valutazione Clinica ed Esame Obiettivo**

ODV:10/10 csl  
OSV:10/10 csl

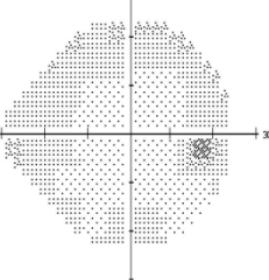
SAOO:nella norma

OOT:11/11 mmHg

OOF:papilla tiltata con accentuata escavazione fisiologica papillare, polo posteriore nella norma

Durée du test: 09:46

Fovéa: 39 dB



-1 -2	-2 -4
-2 -2 -3	-2 0 -2
-2 -2 -1	0 2 1 -1 -3
0 -3 1 0	0 1 1 -3
-3 -2 1 -1	0 0 1 0
-1 1 -1 -1	1 -1 1 -1
-1 0 -1	-1 1 2
1 0	1 2

-2 -3 -3 -5  
-3 -3 -4 -3 1 -3  
-3 -3 1 -1 1 1 -2 -4  
-1 -4 -2 -1 -1 0 0 -4  
-4 -3 -2 -2 -1 0 0 -1  
-2 0 -2 -2 0 -2 0 -2  
-2 -1 -2 -2 0 1  
0 -1 -2 1

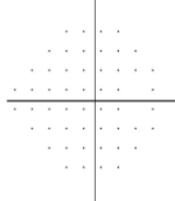
THG  
Dans les limites normales

VFI 100%

MD -0.56 dB  
PSD 1.43 dB

Déviation Totale

Déviation individuelle

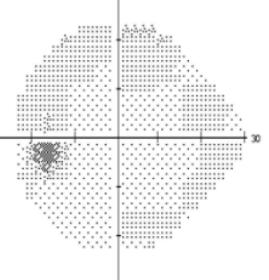
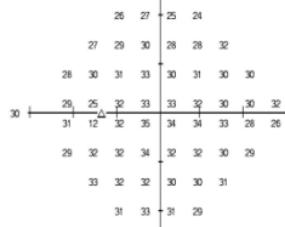


• < 5%  
◎ < 2%  
■ < 1%  
■ < 0.5%

L'œil droit (R) - 7 A

Durée du test: 05:00

Fovéa: 37 dB

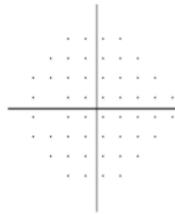


0 0 -2 -3
-1 0 0 -2 -2 3
-1 0 0 1 -1 0 0 1
0 0 1 1 0 -1 0 5
1 0 2 2 1 1 -2 -1
-1 1 0 2 0 0 -1 0
3 1 0 -1 -1 1
1 3 1 0

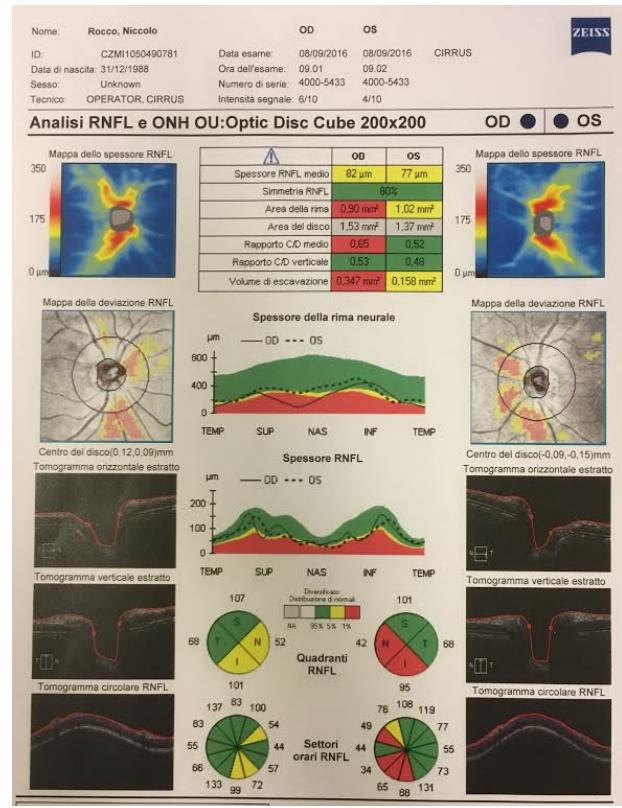
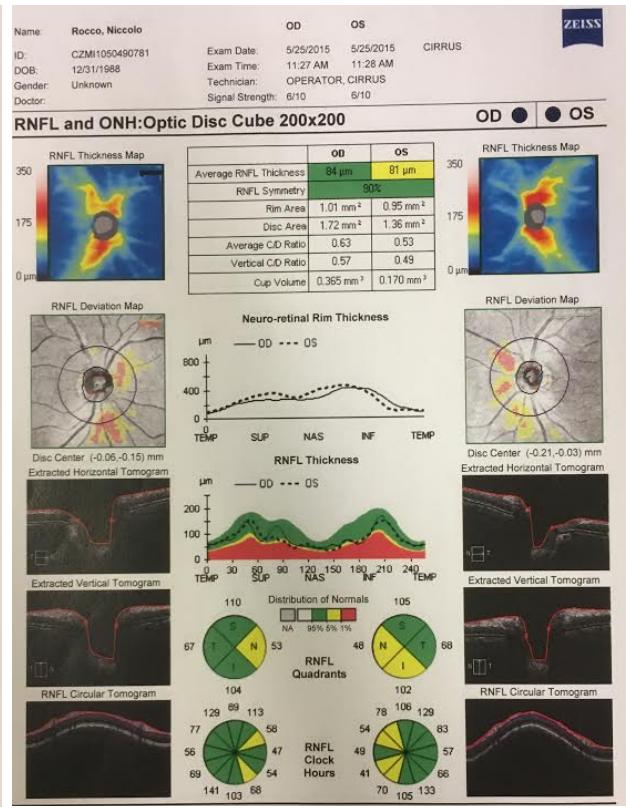
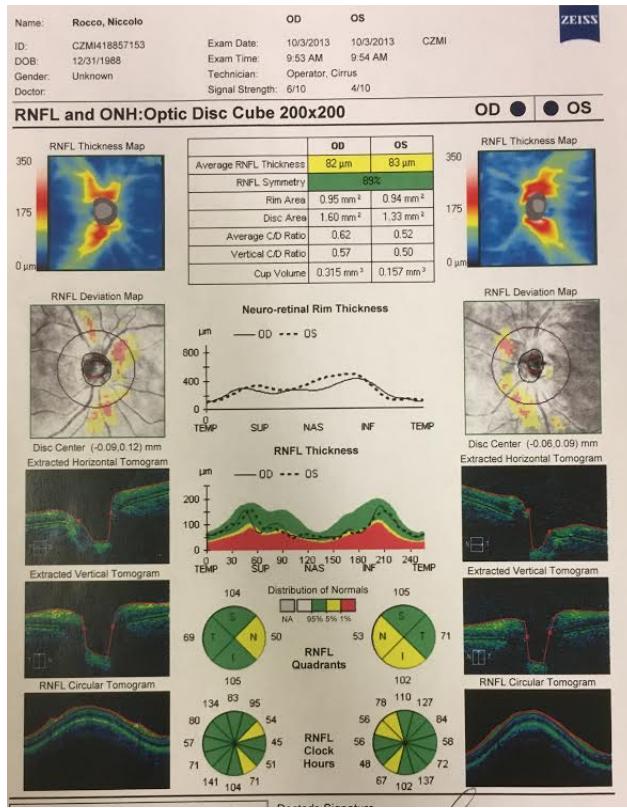
-2 -2 -3 -4
-2 -1 -1 -8 -3 1
-3 -1 -1 0 -3 -1 -2 0
-2 -1 0 -1 -2 -2 -1 3
-1 -1 1 0 0 0 -3 -3
-2 -1 -1 0 -2 -2 -2
1 0 -1 -2 -2 0
0 2 0 -2

Déviation Totale

Déviation individuelle

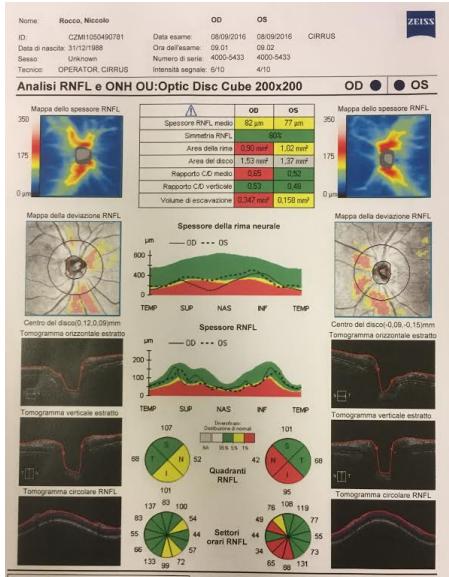
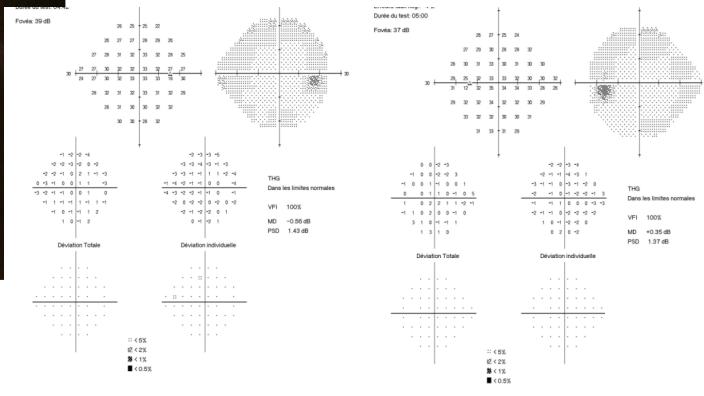
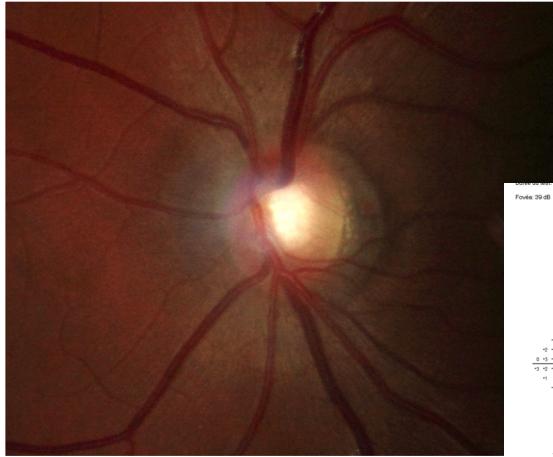


• < 5%  
◎ < 2%  
■ < 1%  
■ < 0.5%



*Interpretazione OCT: glaucoma in peggioramento*

*Aggiunta citalicina*



## Diagnosi di glaucoma (all'età di 16 anni)

**Papilla: dubbia (tiltata, atrofia peripapillare)**  
**Campo visivo: normale**  
**IOP basale: 14/14**  
**OCT alterato**

**Siete d'accordo?**

#6

**Esiste il glaucoma a bassa tensione nella popolazione pediatrica-giovanile?**



**Ragazzo 29 anni  
Glaucoma giovanile**

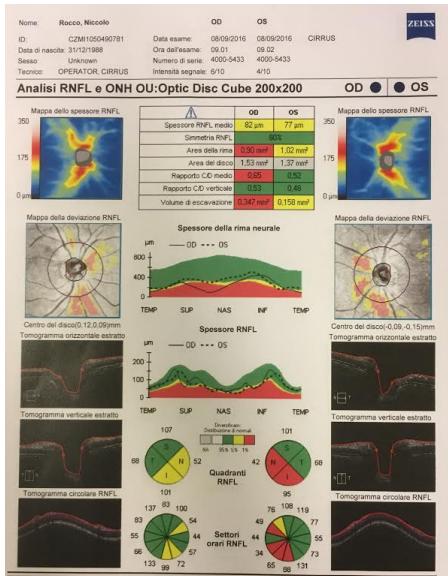
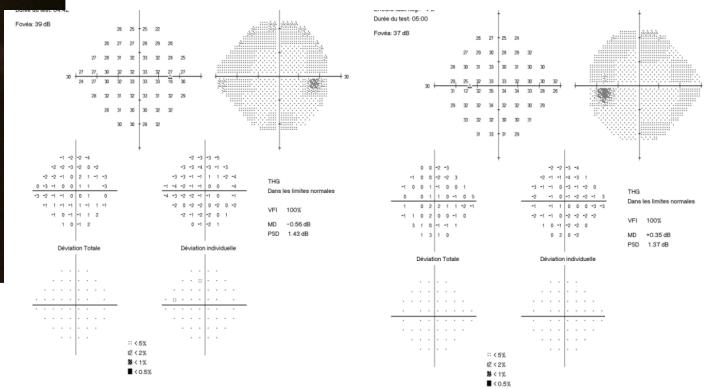
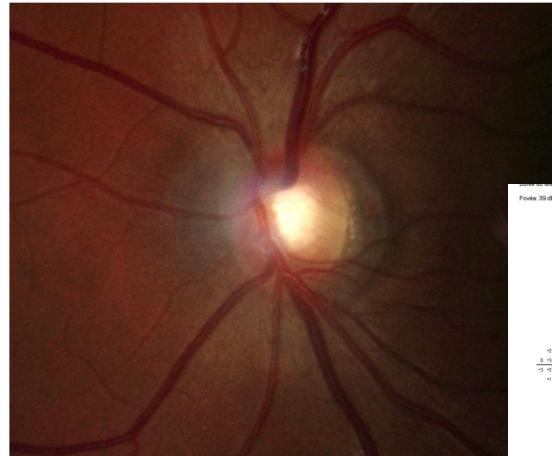
**Sempre iperbarico**

**Alterazioni campo visivo**

**Nostro caso**

**Normotono (IOP max 14/14)**

**Campo visivo nella norma**



➤ *OCT non utile perchè papilla tiltata, atrofia peripapillare*

➤ *Nostro paziente NON ha glaucoma*

➤ *Papilla tiltata, dismorfica, fisiologica*

➤ *Sospesa terapia con latanoprost  
Ricontrollata IOP: 12/12*

➤ *Resta senza terapia*

- Back-up slides

## Optical Coherence Tomography Angiography in Glaucoma

Harsha L. Rao, MD, PhD,\* Zia S. Pradhan, FRCOphth,† Min Hee Suh, MD,‡  
Sasan Moghimi, MD,§ Kaweh Mansouri, MD,|| and Robert N. Weinreb, MD§

in glaucomatous eyes.<sup>36</sup> Another important point to note is that segmentation errors are possible in the setting of normal anatomic variation or pathologic changes in the retinal layers due to the fact that fixed boundaries are assigned for the slabs; hence each OCTA B-scan should be reviewed before interpretation of the quantitative analysis.

found that intravisit coefficient of variation (CV) of OCTA peripapillary vessel density measurements (global and sectoral) ranged from 2.5% to 6.6% and that of superficial

than that of OCTA measurements implying that the OCTA measurements were less reproducible than the OCT measurements.<sup>57</sup> The intravisit and intervisit CVs of average RNFL and GCC thickness, for example, were around 1.5%, whereas that of average peripapillary and parafoveal vessel density was close to 4.0% ( $P < 0.001$ ).<sup>57</sup> This is an important

# Optical Coherence Tomography Angiography in Glaucoma

Harsha L. Rao, MD, PhD,\* Zia S. Pradhan, FRCOphth,† Min Hee Suh, MD,‡  
Sasan Moghimi, MD,§ Kaweh Mansouri, MD,|| and Robert N. Weinreb, MD§

- (1) **Demographics:** Most studies have reported older age to be associated with lower macular and peripapillary vessel density measurements.<sup>23,36,68,85,97–99</sup> In studies with a mixture of patients of African and European descent, the vessel density measurements were found to be lower in the glaucomatous eyes of patients with European compared with African descent.<sup>77,85</sup>
- (2) **Diurnal change:** Studies have reported that the diurnal changes in OCTA vessel densities were small and clinically insignificant.<sup>100,101</sup>
- (3) **Exercise:** In a small cohort of 13 healthy people before and after exercise, it was found that increased physical activity-induced significant reduction in OCTA vessel densities.<sup>102</sup>
- (4) **Systemic conditions:** In hypertensive individuals (with no retinopathy), the peripapillary vessel densities were lower, while the macular vessel densities were higher. The vessel densities also were lower in subjects with diabetes (with no retinopathy)<sup>103</sup> and the reduction in vessel density was associated with the duration of diabetes.<sup>99</sup> Another study evaluating the diurnal changes in OCTA measurements found a negative correlation of superficial macular and peripapillary vessel densities with heart rate and a positive correlation of superficial vessel density with mean arterial pressure.<sup>101</sup>
- (5) **Medication:** The effect of medications on OCTA measurements has not been studied well. Topical β-blocker administration has been reported to lead to 3.3% lower superficial macular vessel density compared with prostaglandin analogs, alpha agonists and carbonic anhydrase inhibitors, after adjusting for macular GCC thickness.<sup>36</sup>

# Optical Coherence Tomography Angiography in Glaucoma

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Sasan Moghimi, MD,§ Kaweh Mansouri, MD,|| and Robert N. Weinreb, MD§

## LIMITATIONS AND RECENT ADVANCES IN OCTA

Motion artifacts are common with OCTA imaging due to the prolonged time required to acquire the scans despite methods available to account for the artifacts (Fig. 5). Multiple studies have also reported a high number of poor quality images with OCTA.<sup>56,58,92,129</sup> Two significant improvements incorporated recently to overcome the issue of poor quality scans are (i) real-time eye-tracking technology, for controlling the motion artifacts more effectively<sup>130</sup> and, (ii) high-density scanning mode, for improving the resolution of the scans. A recent study has reported that the number of poor quality scans significantly decreased with the incorporation of these improvements.<sup>131</sup> Future advances in technology should aim at reducing the acquisition time to obtain more precise measurements.

Media opacities, especially vitreous opacities, can significantly affect the quality of OCTA scans and the quantification of vessel densities (Fig. 6). Pupillary size also affects the quality of OCTA scans and dilation of the pupil is necessary for good quality scans.

# Optical Coherence Tomography Angiography in Glaucoma

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## Glaucoma Progression and its Risk Assessment Using OCTA

As OCTA is a recently developed technique, there are no long-term studies evaluating its ability to detect progression. However, a few cases reports<sup>85,98</sup> and case series<sup>23,112</sup> have shown that OCTA is capable of detecting a progressive decrease in superficial vessel densities in glaucomatous eyes even when monitored over short periods of time. It is important to note that vessel density is more variable than RNFL thickness and may reflect IOP changes, the status of systemic perfusion, glaucomatous vascular dysregulation, retinal oxygenation, and hypercapnia at the time of measurements.<sup>97,100,102,103,108</sup> A recent study by Kim et al<sup>113</sup> also showed that the increase in MvD area could be detected using serial OCTA scans. Future studies are needed to compare the progression detection ability of OCTA parameters with VF and OCT measurements.

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relation better than linear fits.<sup>60,62</sup> In addition, in glaucoma eyes with high myopia<sup>70</sup> and in eyes with advanced glaucoma,<sup>71,72</sup> the association of VF parameters seemed to be stronger with OCTA compared with OCT thickness measurements. Furthermore, a recent study also found that the measurement floor, the value beyond which further change in the measurement becomes undetectable, was at a lower level for OCTA compared with OCT measurements.<sup>73</sup> In fact, no detectable measurement floor was found for macular vessel density measurements and this showed that OCTA is a promising tool for monitoring progression in advanced disease.<sup>73</sup>

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was not available in the past. Currently, researchers are still understanding the full potential of OCTA in clinical practice and hence, ophthalmologists need to be conservative in the application of this technology in treatment decisions. However, since OCTA is a safe, noninvasive test, it can be performed at the same time as OCT and can provide information that complements VF and OCT examinations for early diagnosis of glaucoma, detection of progression and its risk assessment. Future longitudinal studies should evaluate if OCTA can detect vascular changes earlier than RNFL thinning in glaucoma. If this were shown to be the

## Key points

- La diagnosi e la gestione del glaucoma è fondamentalmente “LOW TECH”
  - Clinica, esame obiettivo, tonometria, campo visivo
- Conoscere i limiti delle tecnologie “HIGH TECH” per
  - ridurre esami inutili
  - avere cautela prima di confermare una diagnosi
  - ottimizzare la selezionare il paziente