Il Glaucoma OLTRE...!

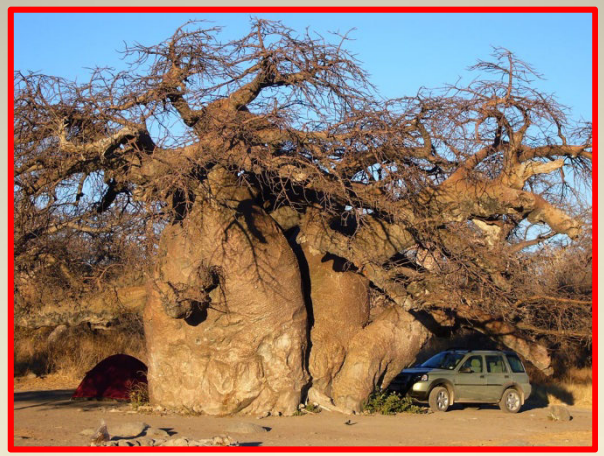
Glaucoma tra struttura e funzione: la risposta degli HD-OCT

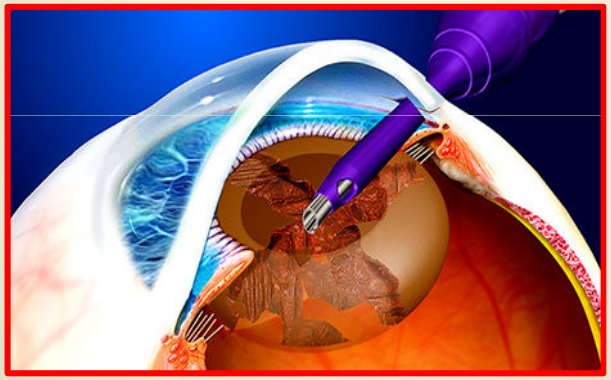
Studio Oculistico
dott. A. Lucente
In oculis salus

Tricase 16/05/14

The author declares no competing financial interests

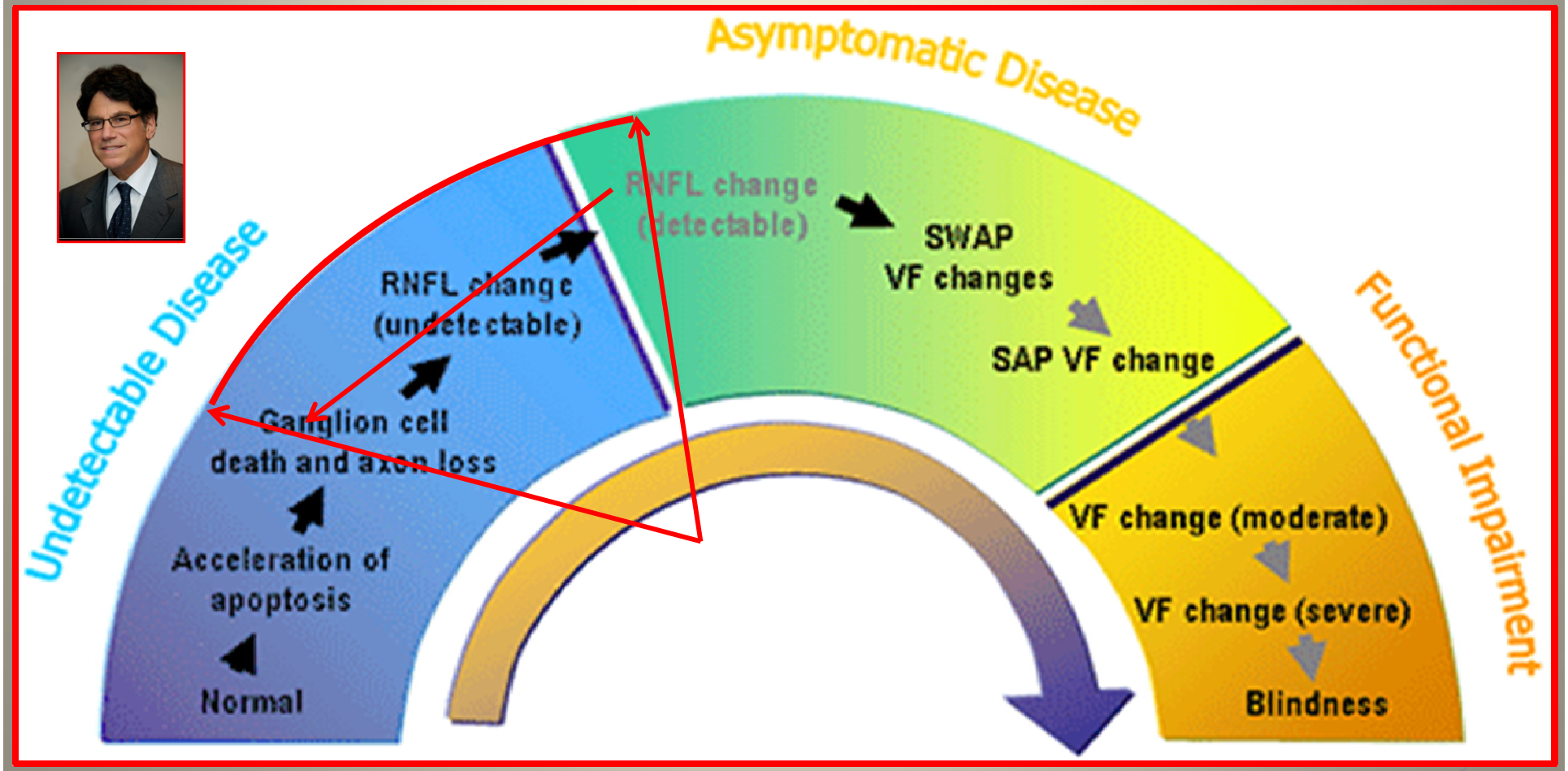
Structure and function: not only glaucoma



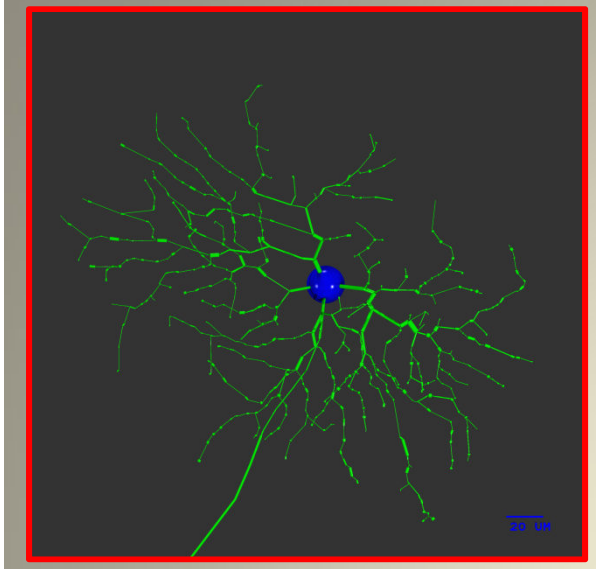


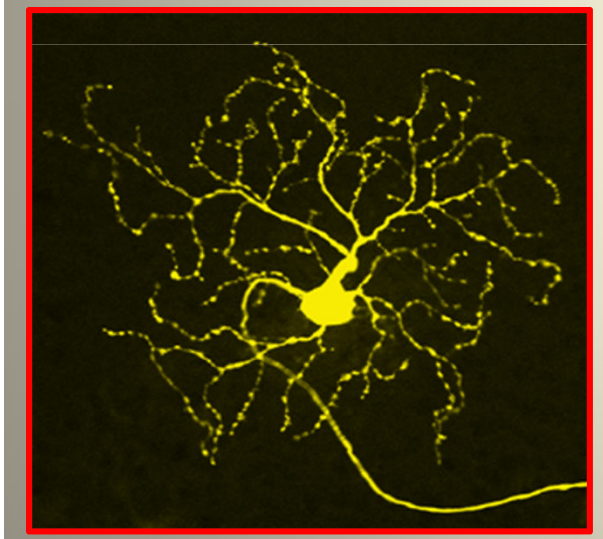
Glaucoma Continuum by R. Weinreb

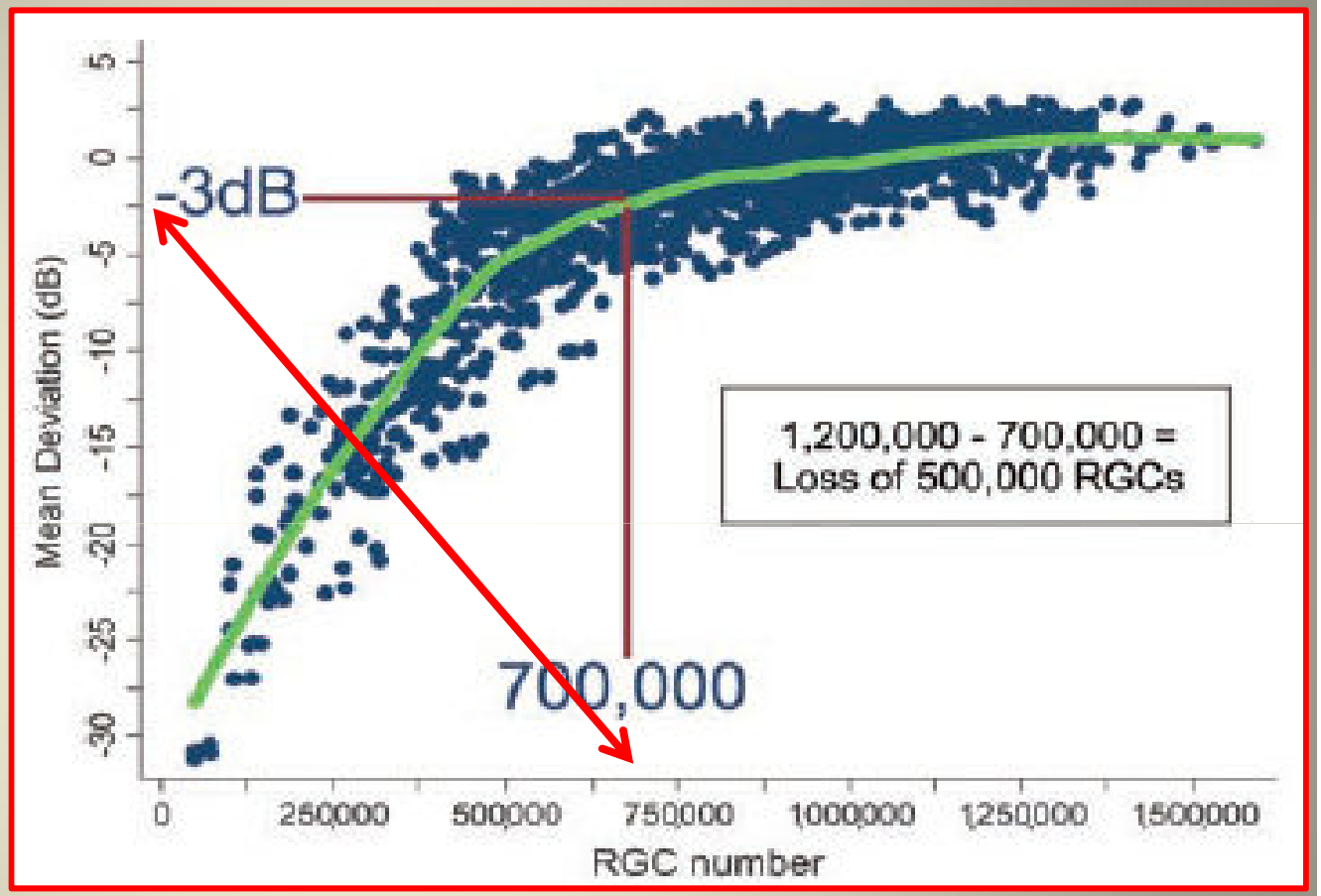
R. Weinreb et al. A. J. Ophthalmol 2004; 138; 458-467



RGCs & MD CV HFA







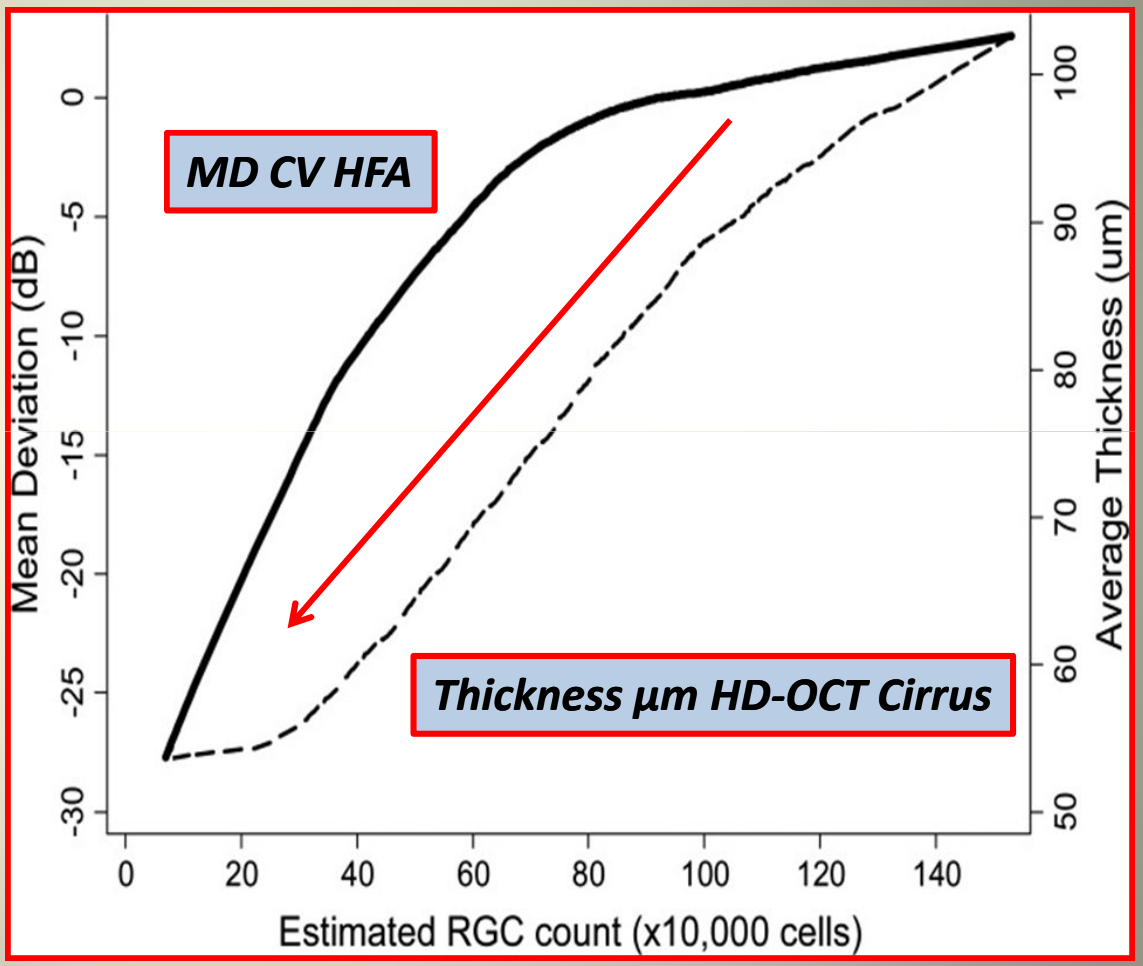
5000/9000 Retinal Ganglion Cells/Year

Adapted from Medeiros FA, Lisboa R, Weinreb RN, et al. A combined index of structure and function for staging glaucomatous damage. Arch Ophthalmol. 2012; 130 (5)

- At ***early stages*** of damage ***(high RGC counts),*** changes in estimated ***RGC*** counts correspond to relatively ***smaller changes in MD*** *(continuous line)* and relatively ***larger changes in average RNFL*** thickness *(dashed line).*

- At ***advanced stages*** of damage ***(low RGC counts),*** changes in estimated ***RGC*** counts correspond to relatively ***large changes in MD***, but only ***small changes in average RNFL*** thickness.

Estimated RCGs count (x10.000 cells)
RNFL Average Thickness (µm)
MD Mean Deviation CV (dB)



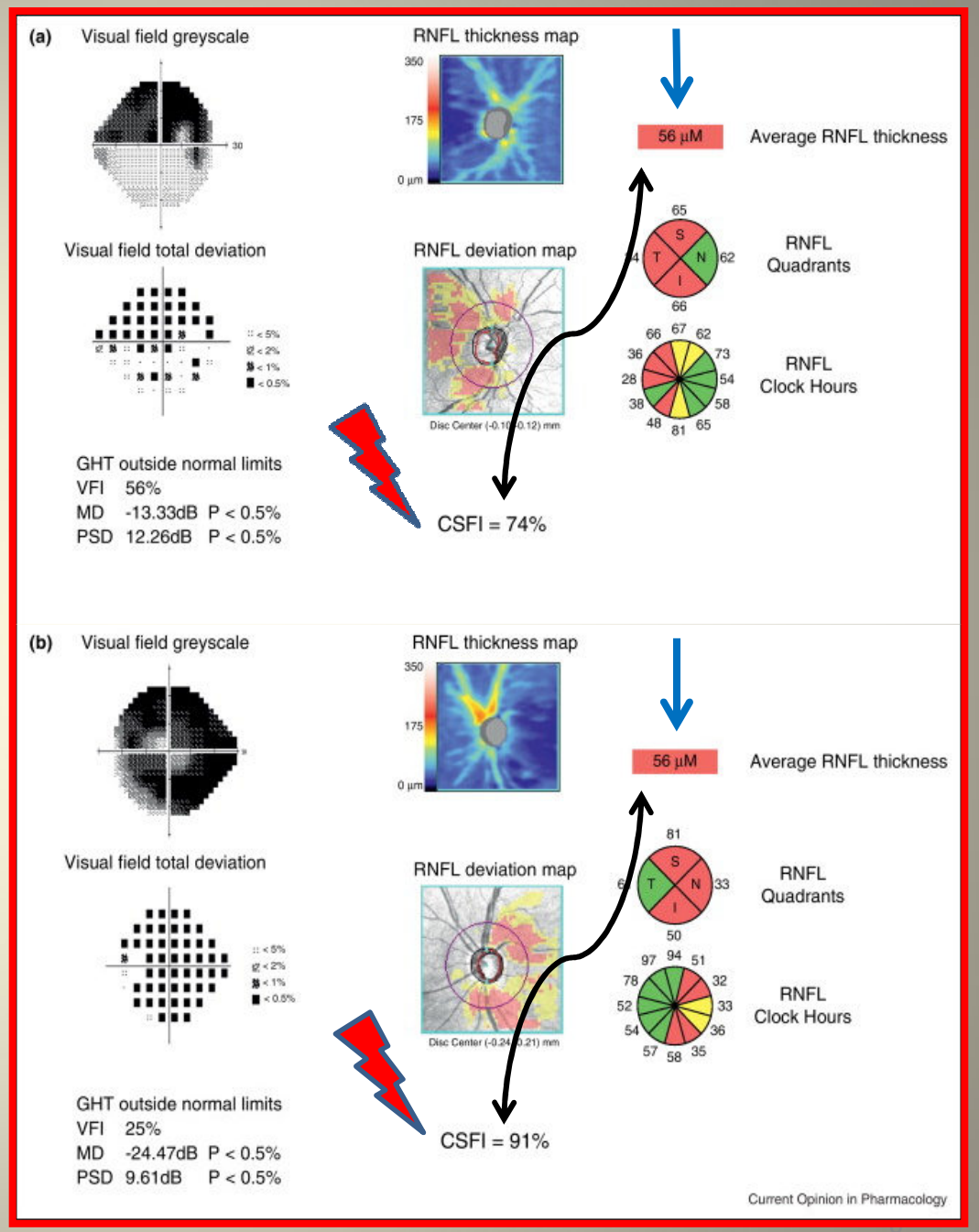
Felipe A. Medeiros, Linda M. Zangwill, Christopher Bowd, Kaweh Mansouri, and Robert N. Weinreb
Investigative Ophthalmology & Visual Science, October 2012, Vol. 53, No. 11

CSFI

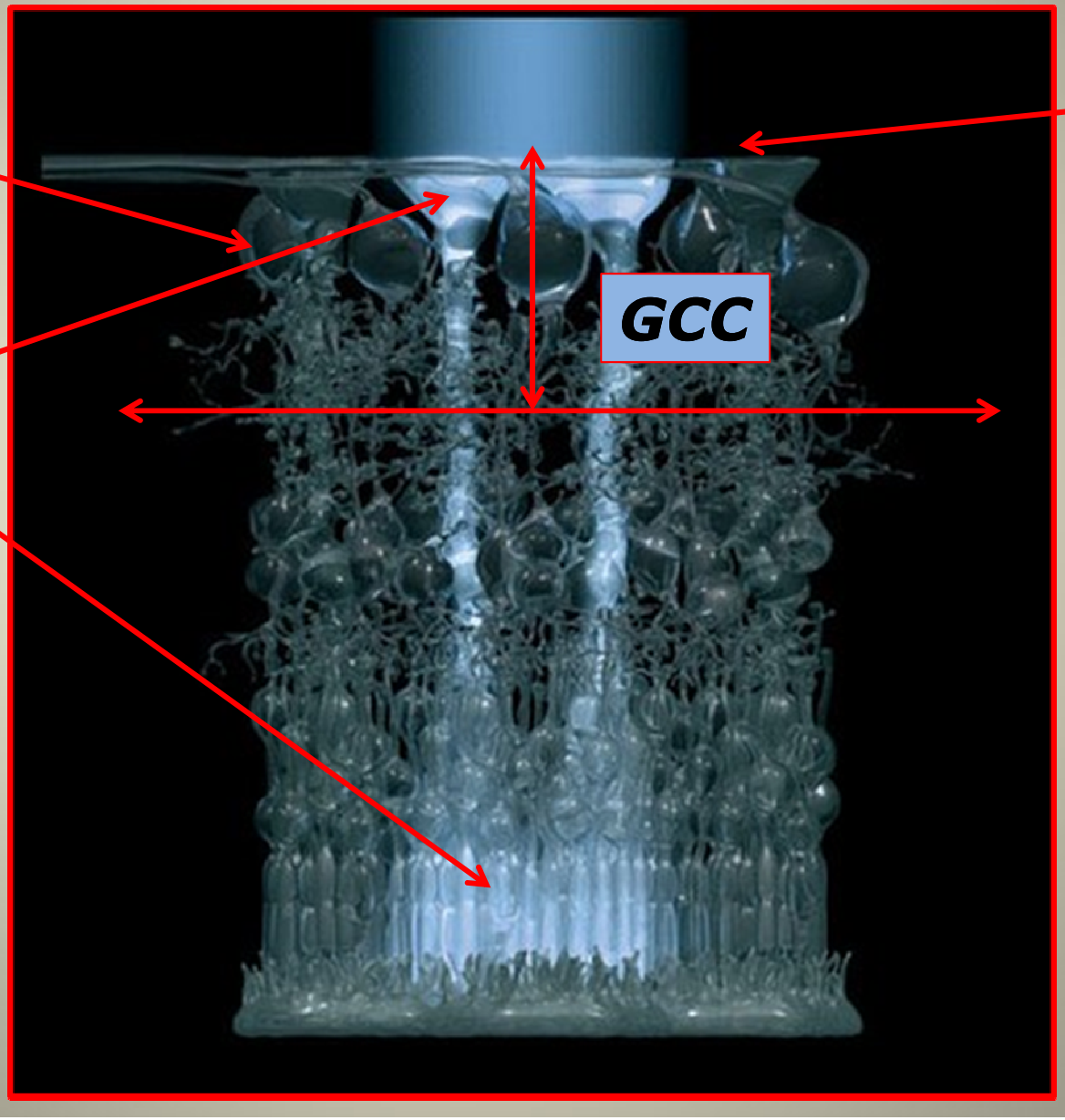
Combined Structure Function Index

Felipe A. Medeiros
Renato Lisboa
Robert N. Weinreb
Christopher A. Girkin
Jeffrey M. Liebmann
Linda M. Zangwill
Arch Ophthalmol. 2012

Douglas GR, Drance SM, Schulzer M. A correlation of fields and discs in open angle glaucoma. ***Can J. O. 1974***



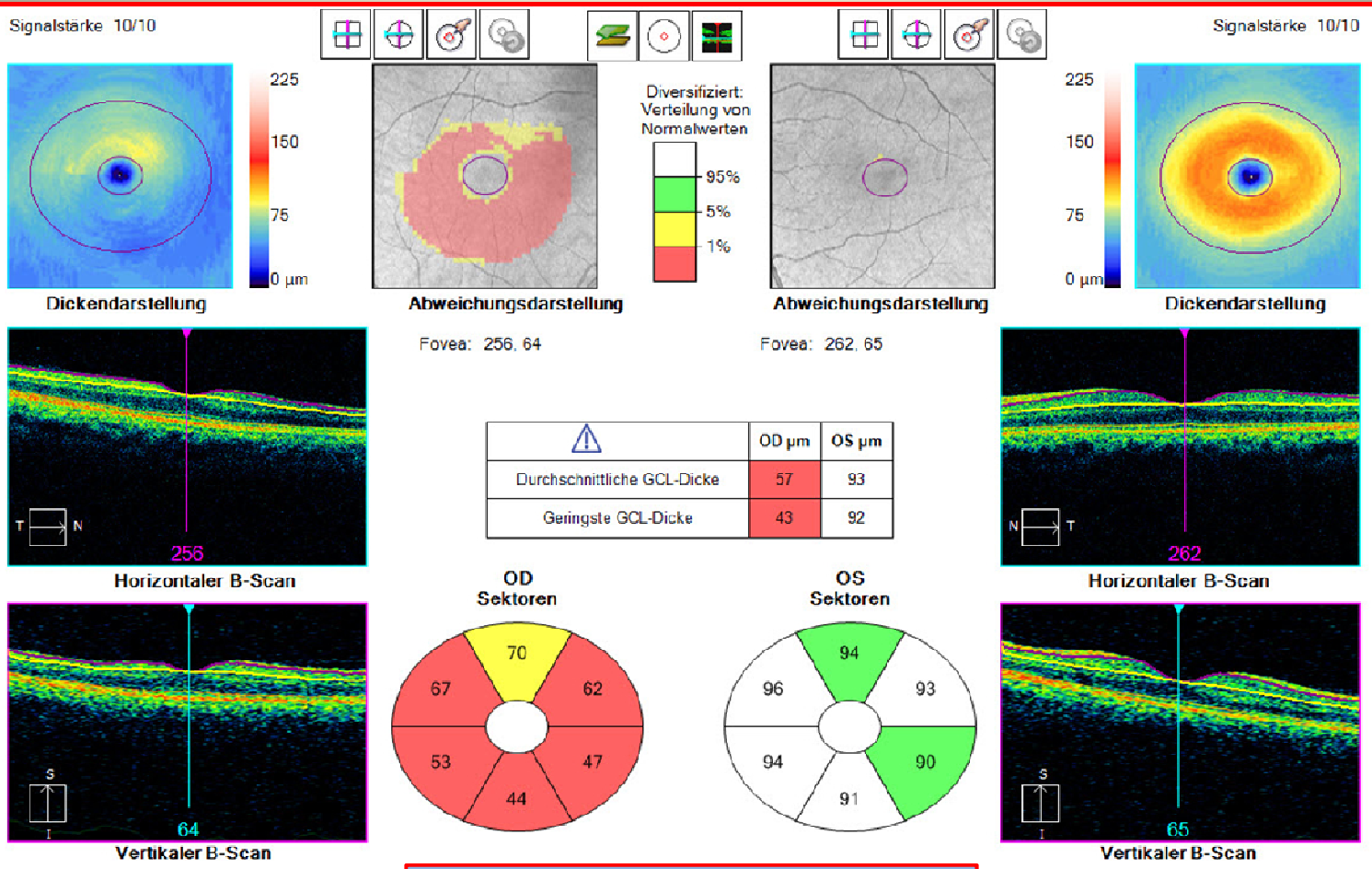
Inner and outer retina



Ganglion Cell Analysis Report for Cirrus

6 quadranti

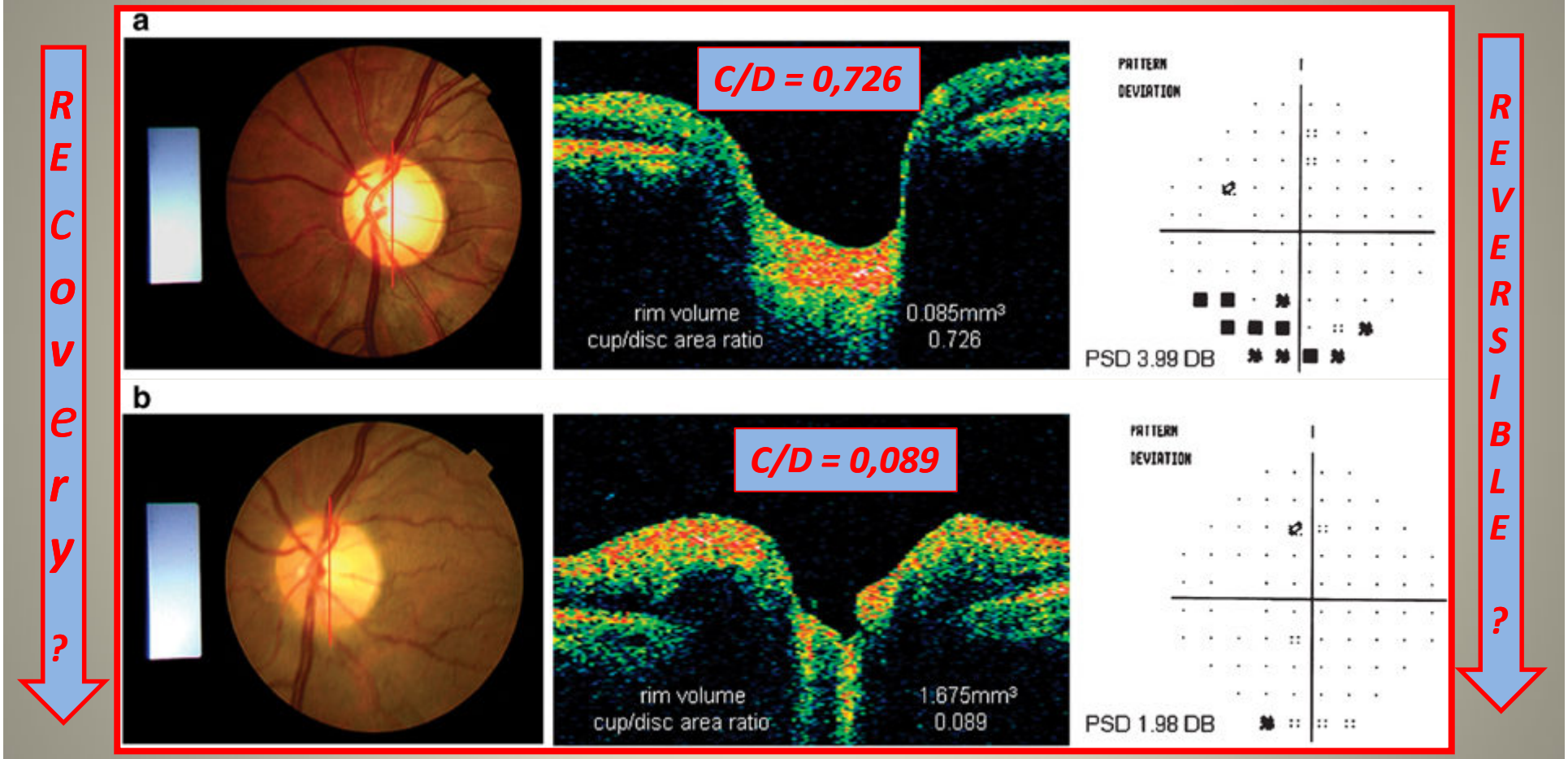
90% RCG parve 50% in macula



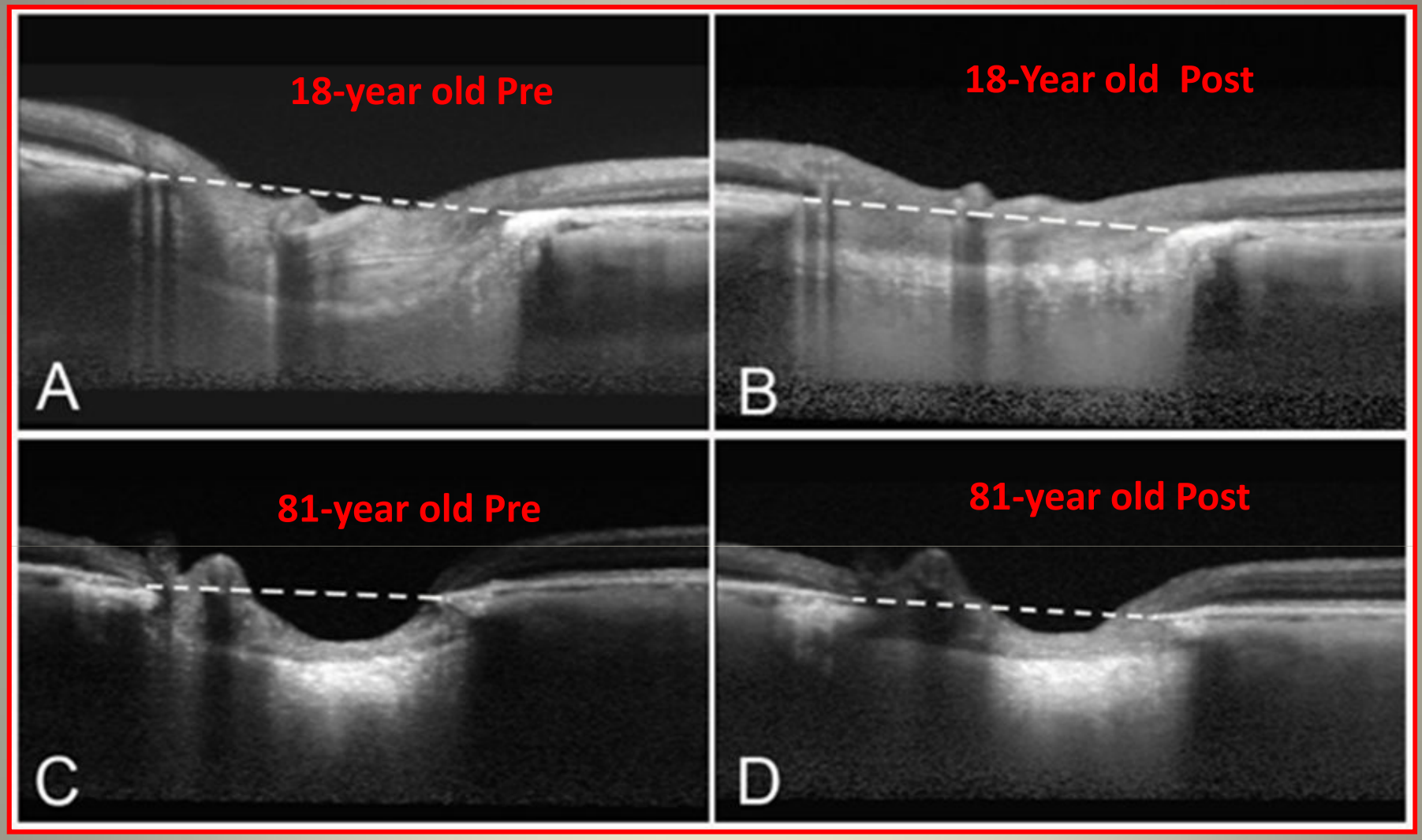
	OD µm	OS µm
Durchschnittliche GCL-Dicke	57	93
Geringste GCL-Dicke	43	92

5000/9000 RCG/Year

Structural and functional recovery in juvenile open angle glaucoma after trabeculectomy C K S Leung, J Woo, M K Tsang and K K Tse



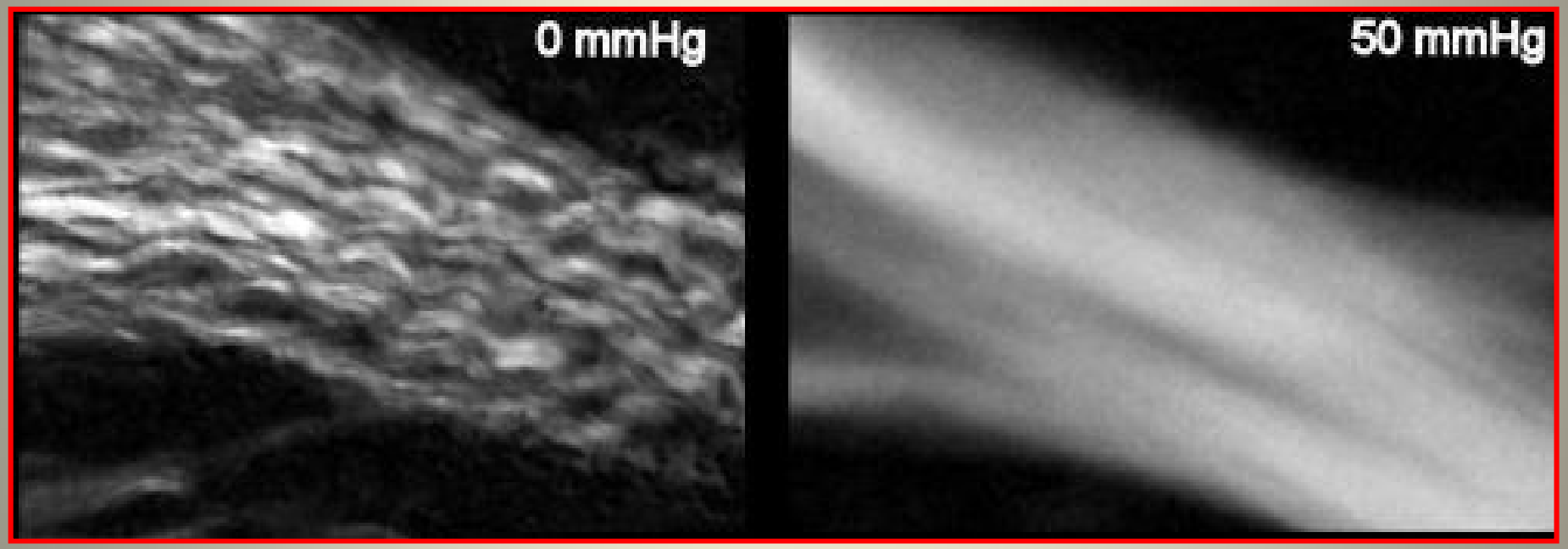
Fundus photographs, OCT optic nerve head scans (vertical cut) and Humphrey visual field pattern deviation plots of the left eye *obtained the day before trabeculectomy (a) and 1 week postoperatively (b).* The red lines on the fundus photographs indicate the location of the OCT scans in the middle panel. *Eye (Lond). 2006 Jan;20(1):132-4*



Preoperative and postoperative optic nerve images of the left eye of a **18-year old (A, B)** and an **81-year old** woman (C, D), where the IOPs were lowered from **25 to 6 mmHg** and from **20 to 7 mmHg,** respectively**.** The reversal of the backward bowing of the lamina cribrosa is clearly noticeable. Images were taken by enhanced depth imaging SD-OCT. **Dashed lines** indicate the plane of **Bruch's membrane opening BMO**. **(da Weinreb et al. 2012)**

IOP Elevation Reduces the Waviness of the Load Bearing Collagen Fibers in the Lamina Cribrosa

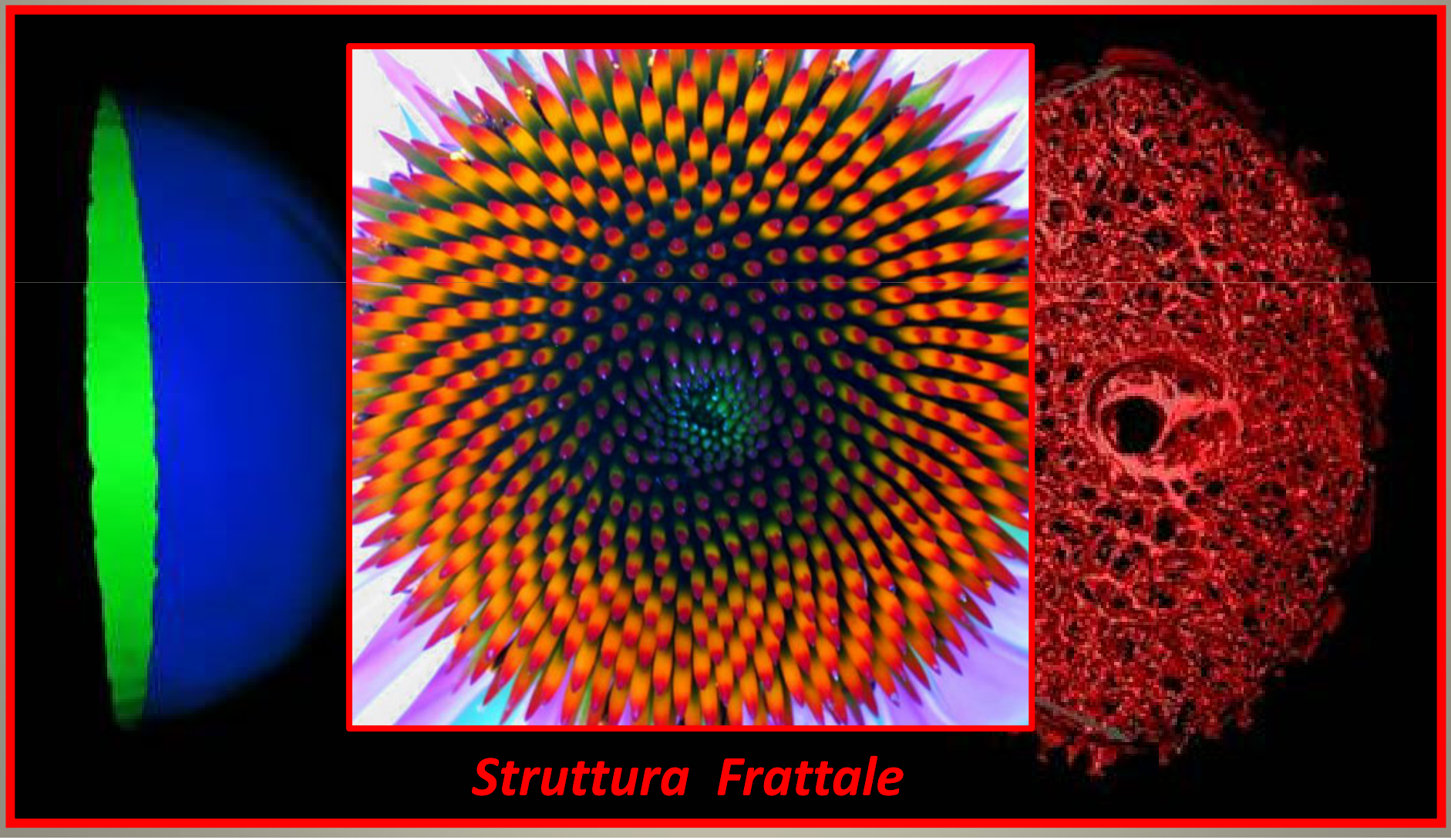
Ian A. Sigal et al. ARVO 2013 Annual Meeting Abstracts



Collagen fibers with and without crimp

Finite Element Modeling of the Lamina Cribrosa of the Optic Nerve Head in Glaucoma

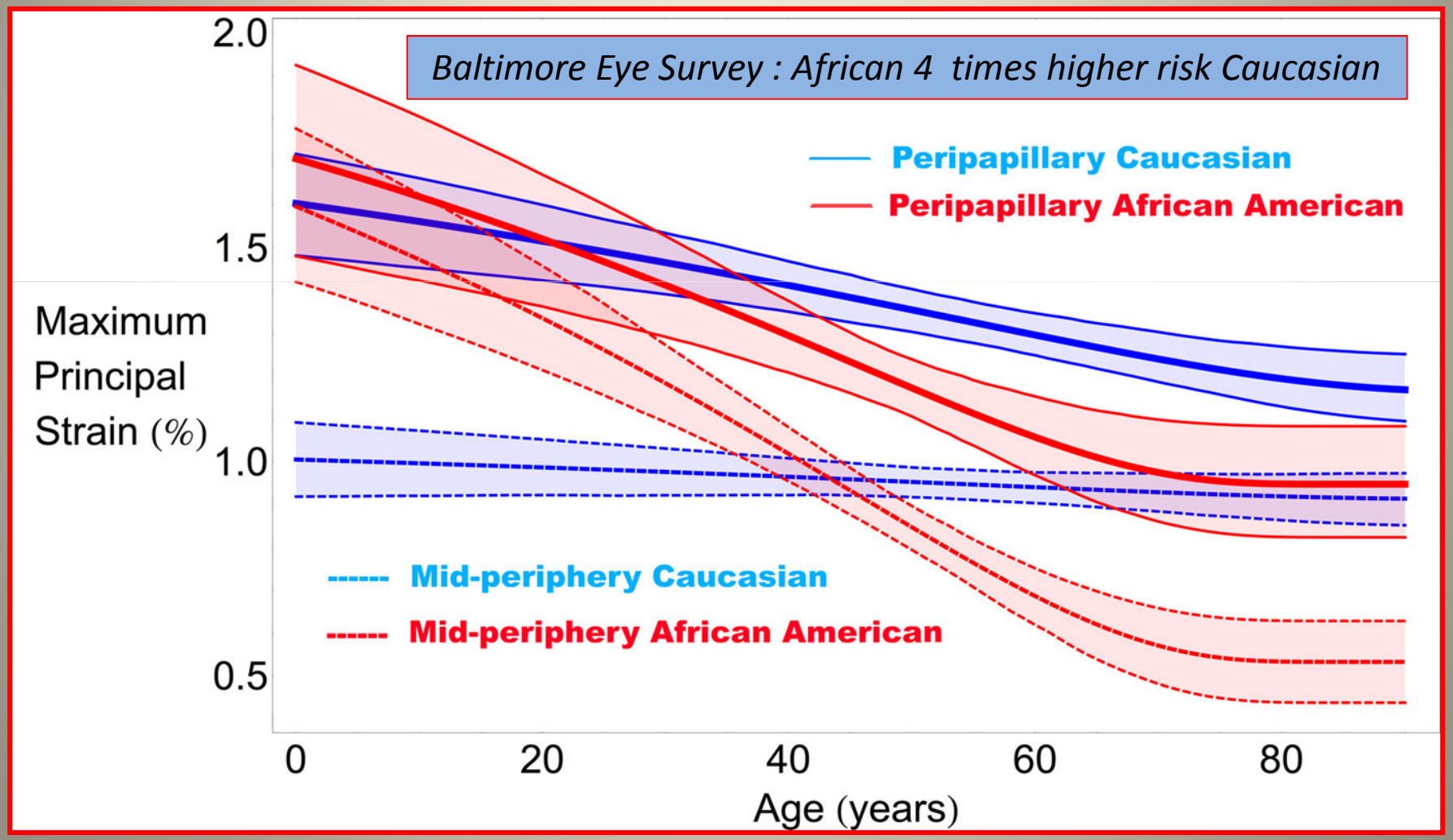
Devers Eye Institute / National Institute of Health Optic Nerve Head Research Laboratory
directed by dr. Claude Burgoyne (Portland Oregon)



Racial Differences in Mechanical Strain in the Posterior Human Sclera

M. A. Fazio 1-2, R. Grytz 1, L. Bruno 2, J. S. Morris 3, C. A. Girkin 2, J. Crawford C. Downs 2.
1 Ophthalmology, The University of Alabama in Birmingham, Birmingham, AL;
2 Mechanical Engineering, University of Calabria, Cosenza, Italy;
3 Department of Biostatistics, The University of Texas MD Anderson Cancer Center, Houston, TX.

ARVO 2013 Annual Meeting Abstracts

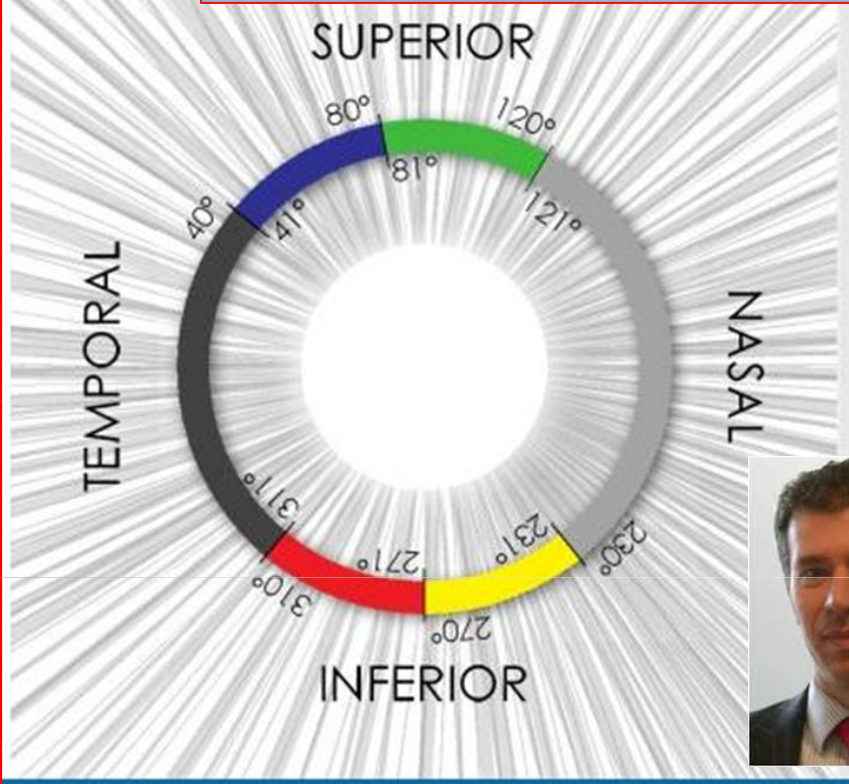


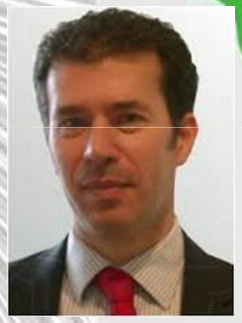
Piattaforme Multimediali & Combo Report

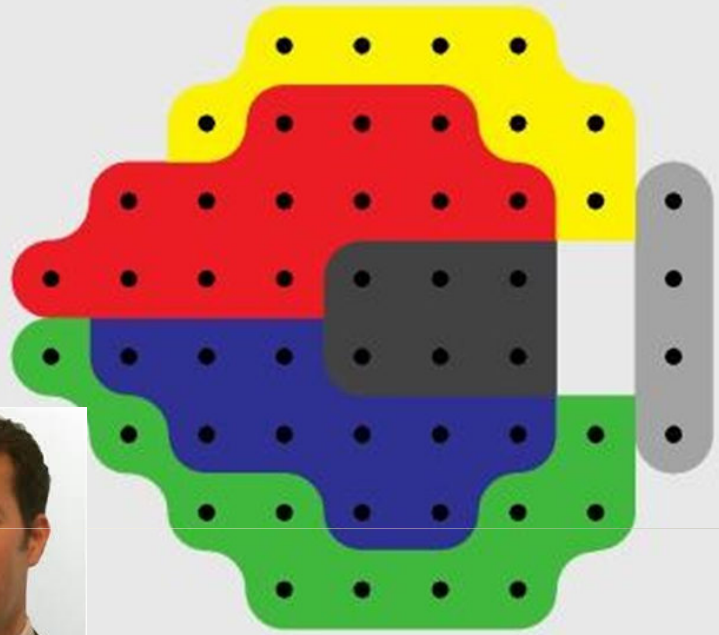
- ***Zeiss Cirrus & Humphrey con FORUM***
- ***Heidelberg Spectralis & HEP con HEYEX***
- ***Optovue & Octopus Bundle Haag-Streit ****

Medscape

Garway-Heath, Moorfields Eye Hospital London







Source: BMC Ophthalmology © 1999-2011 BioMed Central Ltd

Map representing the ***relationship between Standard Automated Perimetry*** visual field sectors and sections of the ***peripapillary OCT scan circle***. This map is based on the ***work of Garway-Heath et al*** and shows the correspondence ***between areas of the visual field and peripapillary retinal nerve fiber layer*** due to the anatomical configuration of the retinal nerve fiber bundles.

First Release : Presented in part at the Glaucoma Society (UK & Eire) Annual Meeting, London, England, November **1998**

Six corresponding ***regions*** of ***neuroretinal rim area (A), peripapillary retinal nerve fiber layer (B), and visual field (C),*** used to measure the structure–function relationship (based on structure–function map introduced by ***Garway-Heath*** et al.) **Nilforushan N et al. Invest Ophthalmol Vis Sci. 2012 May**

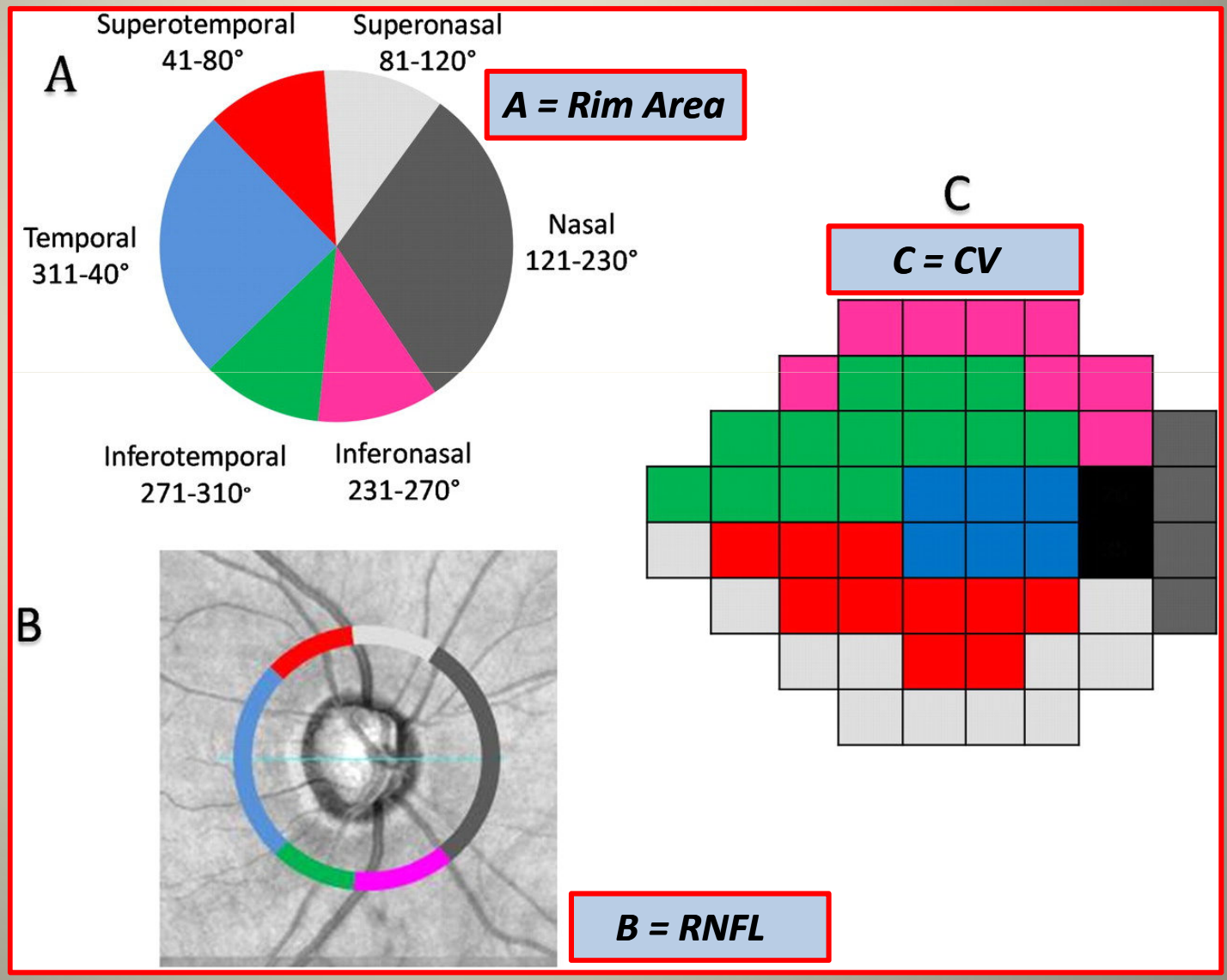
ST + SN : 80°+

IN + IT : 80° +

Nasal : 110° +

Temporal : 90° =

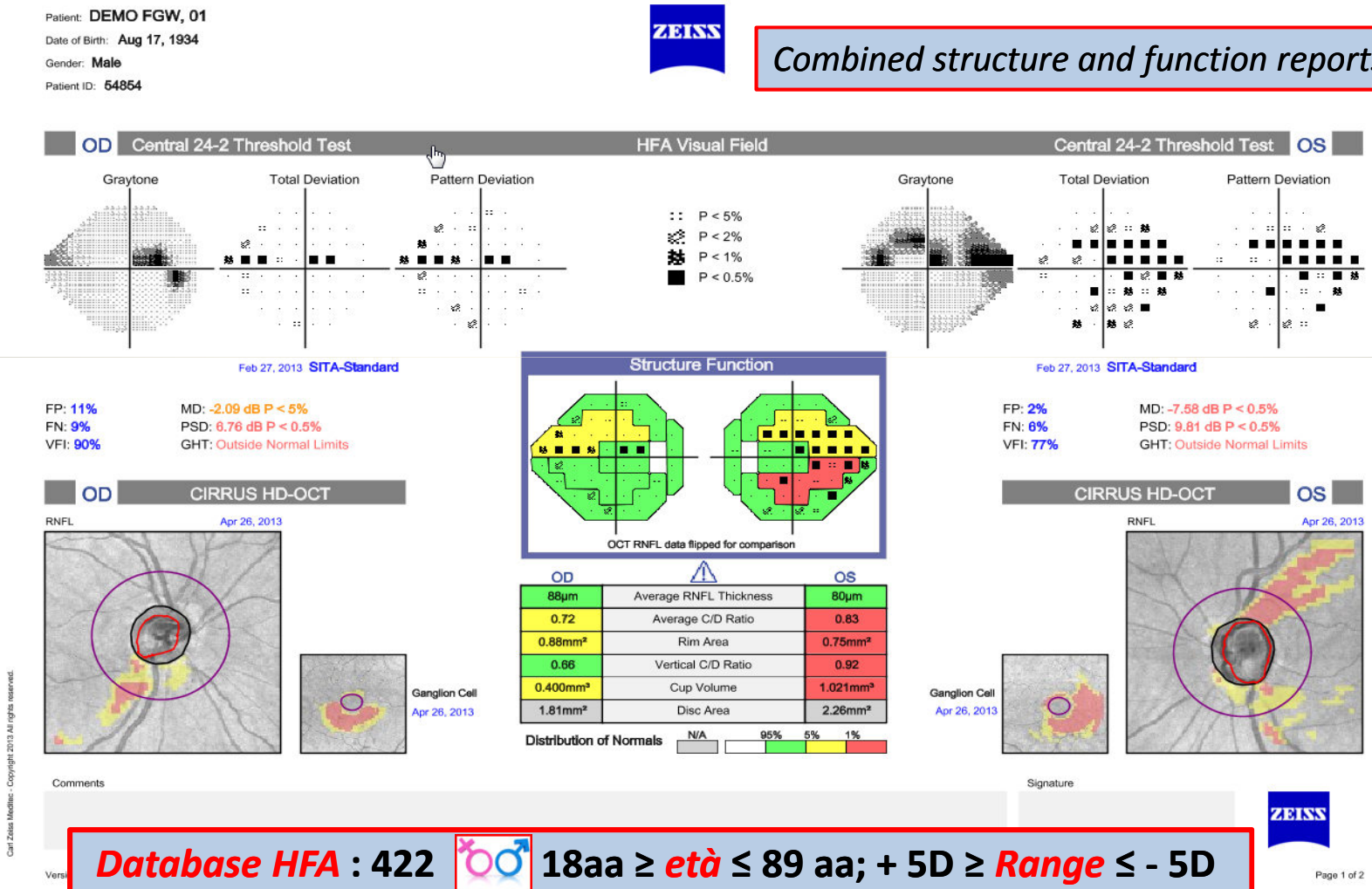
Rim / RNFL: 360°



Forum Glaucoma Workplace

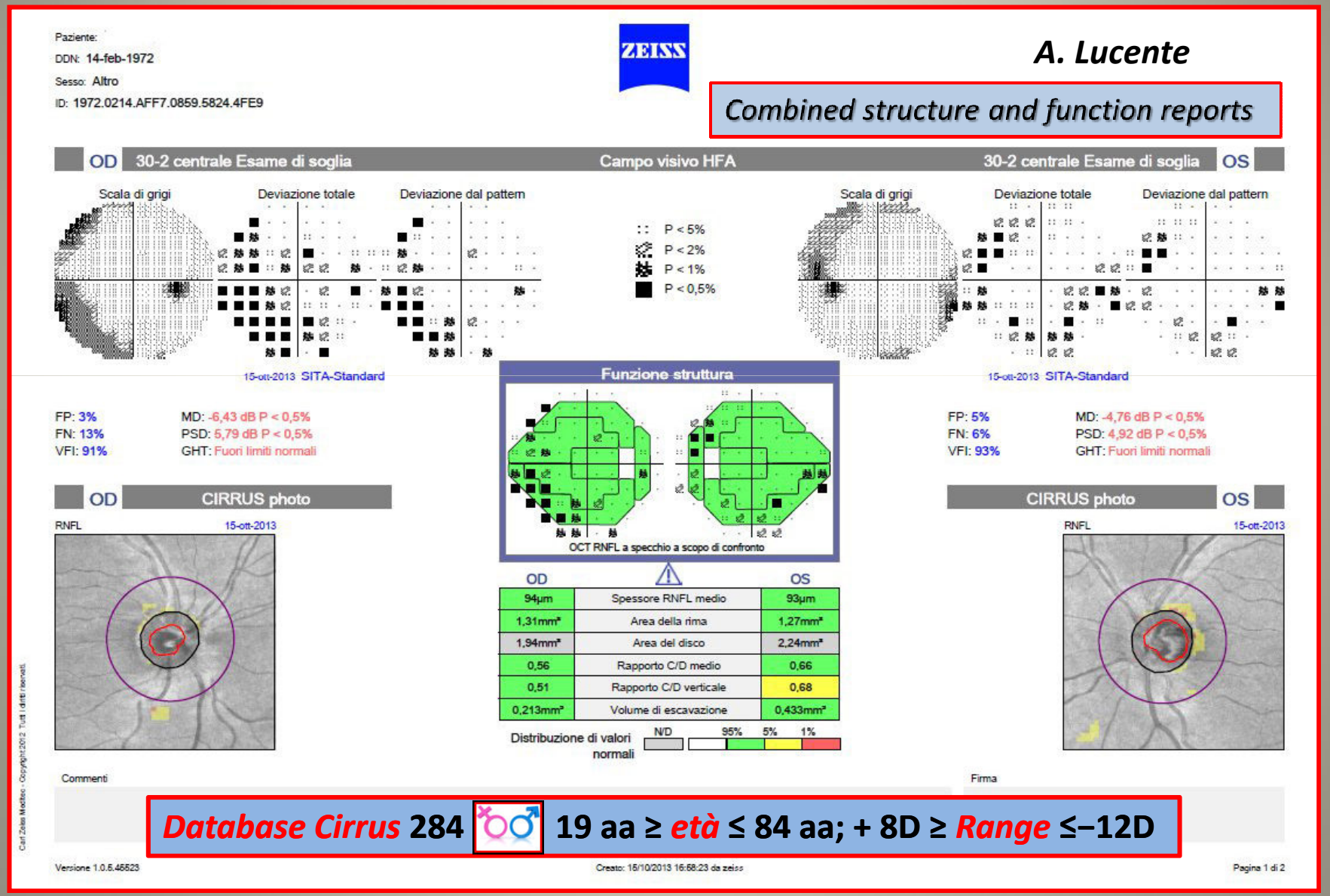
A. Lucente

Combined structure and function reports



Database HFA **: 422** ⚥ **18aa ≥ *età* ≤ 89 aa; + 5D ≥ *Range* ≤ - 5D**

Forum Glaucoma Workplace



UltraHigh-Speed Swept-Source OCT

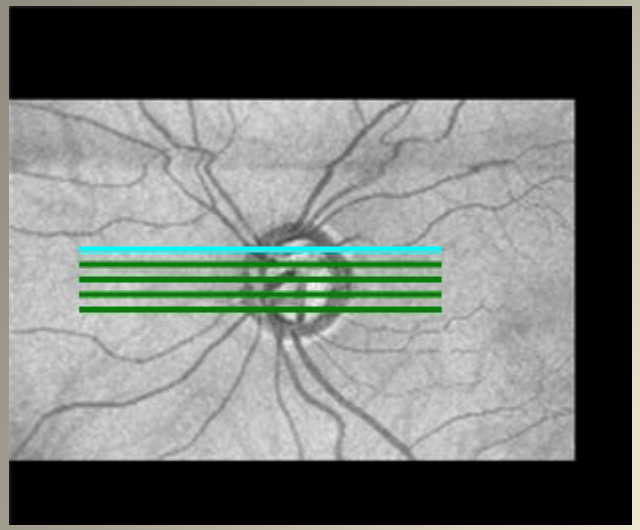
Developed by MIT Optic & Quantum Electronic Group (Fujimoto) and OHSU Center for Ophthalmic Optics and Lasers (Huang)

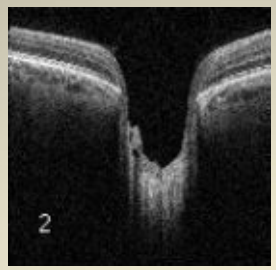
Performance features:

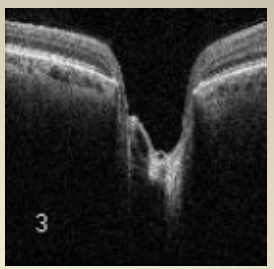
- ***100,000 axial scans/sec***
- ***1050 nm tunable laser (deep penetration)***
- ***5.3 µm axial resolution in tissue***

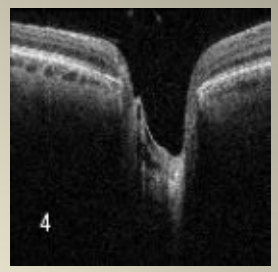
Potsaid B, et al., Optics Express 2010; 18:20029

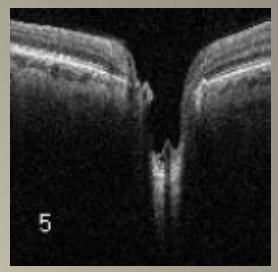
dr Amedeo Lucente





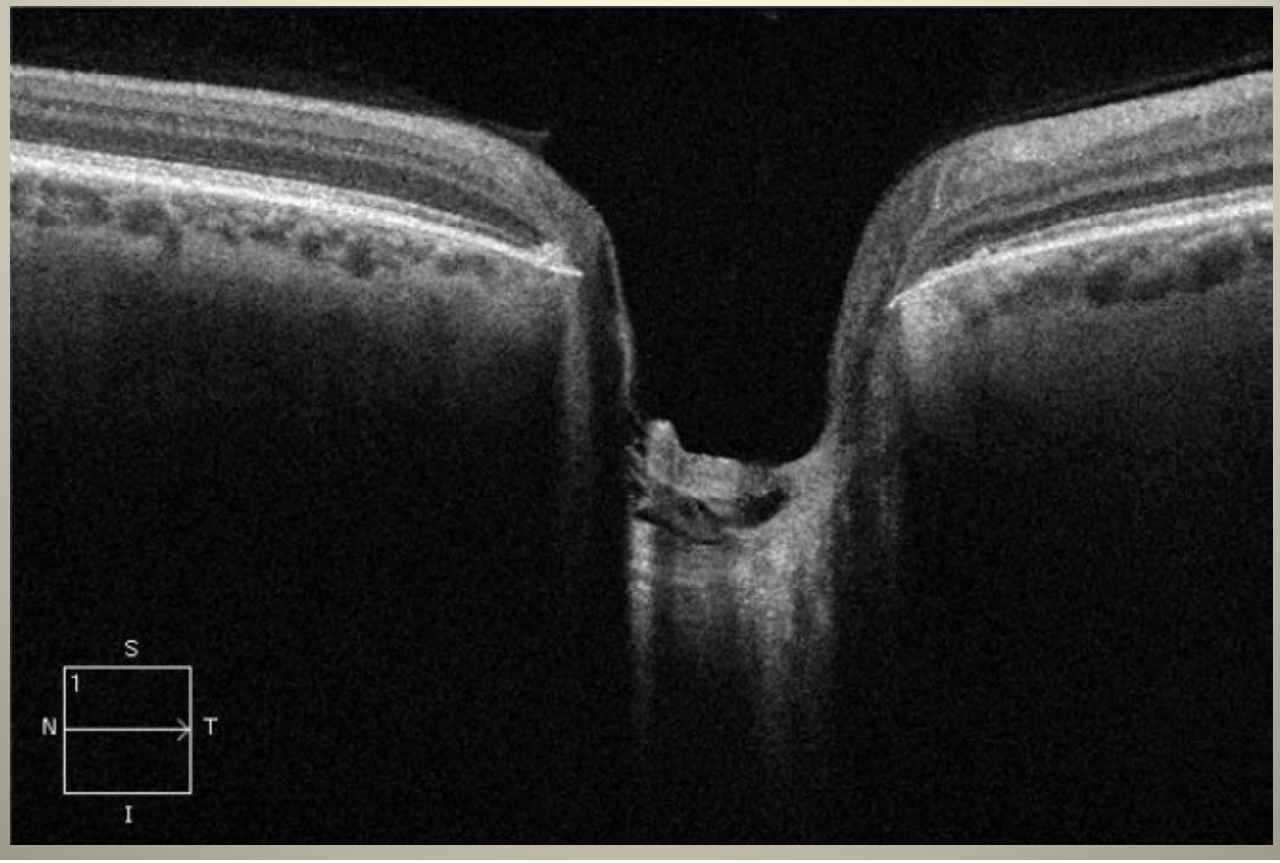


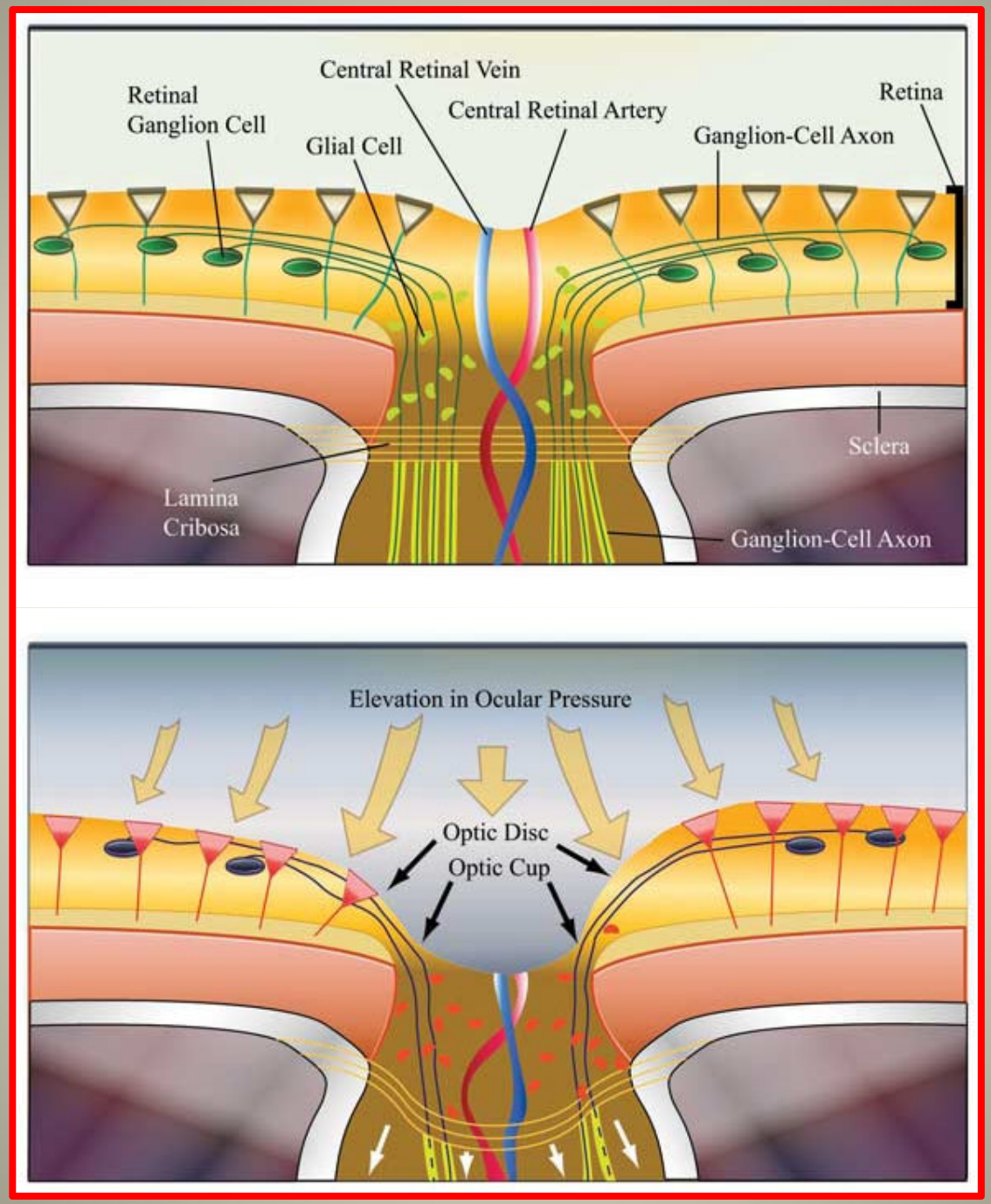




Immagini ad alta definizione: HD 5 Line Raster OS

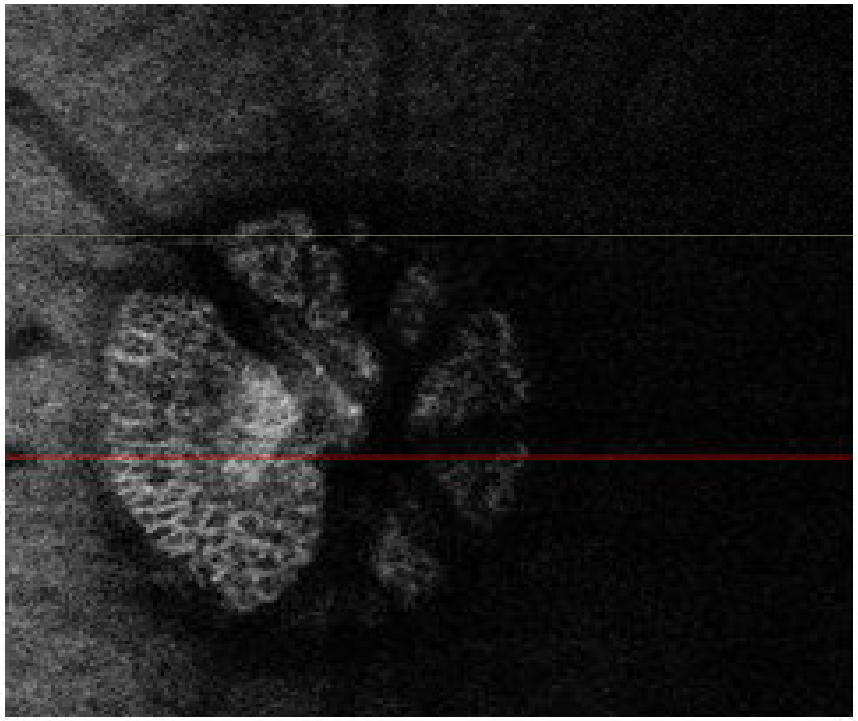
ZEISS




Central Retinal Vein
Retinal
Ganglion Cell
Central Retinal Artery
Retina
Glial Cell
Ganglion-Cell Axon
Sclera
Lamina
Cribosa
Ganglion-Cell Axon
Elevation in Ocular Pressure
Optic Disc
Optic Cup

SS-OCT Zeiss *Key factors: lamina cribrosa*

Immagini EN-FACE ad alta densità
Lamina Cribrosa

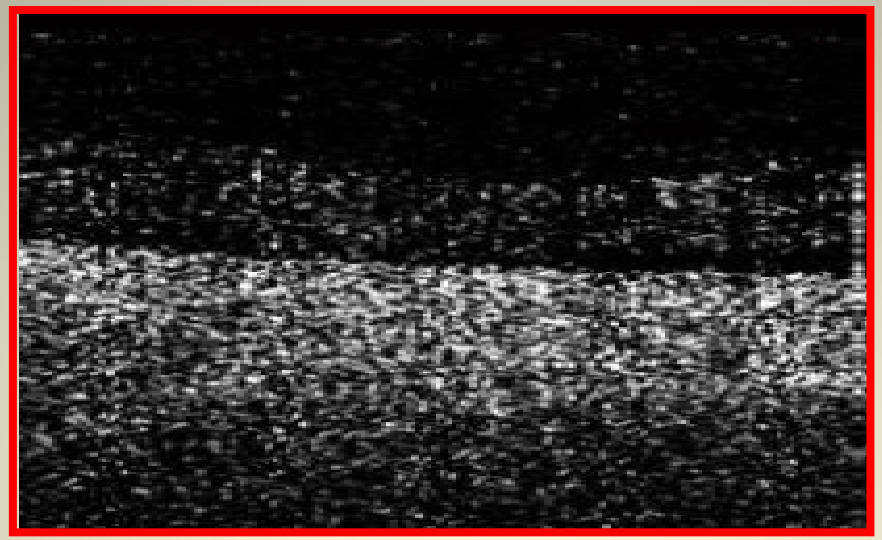


Visualizzare pori laminari usando FOV 3 x 3 mm

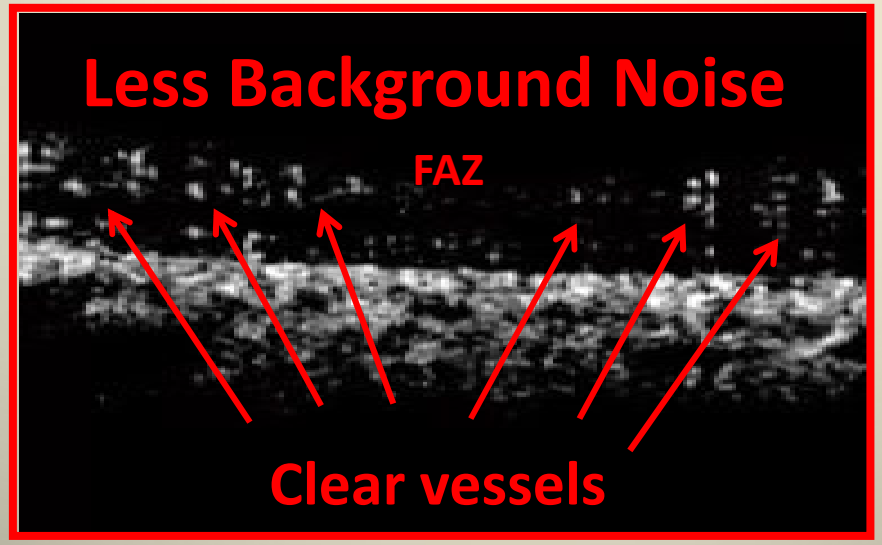
Zeiss SS-OCT prototype (investigational device, not FDA cleared) data courtesy of Srinivas Sadda MD, Doheny Eye Institute

SSADA Split-Spectrum Amplitude Decorrelation Algorithm

Full Spectrum



Improves signal to noise ratio of flow detection



Split Spectrum

Jia Y, Tan O, Tokayer J, Potsaid B, Wang Y, Liu JJ, Kraus MF, Subhash H, Fujimoto JG, Hornegger J, Huang D. Split-spectrum amplitude-decorrelation angiography with optical coherence tomography. Optics Express 2012; 20:4710

Glaucoma tra struttura e funzione

di Amedeo Lucente

Introduzione

E' passato oltre un secolo dalla controversia tra la teoria *"reticolarista"* di Camillo Golgi (Corteno 1843 – Pavia 1926) e la *"dottrina del neurone"* di Santiago Ramon y Cajal (Petilla de Aragón 1852 – Madrid 1934), entrambi Premi Nobel per Medicina nel 1906. Le conoscenze sulla conduzione dell'impulso neurale sono notevolmente migliorate nel tempo. Il sistema nervoso ha sempre affascinato studiosi e ricercatori; le cellule ganglionari retiniche non sono state indenni dai lunghi travagli scientifici che hanno caratterizzato la conoscenza del sistema nervoso.

In questo percorso di conoscenza la natura ha spesso costituito un importante campo di confronto, un punto di riferimento formale e funzionale [1]. Struttura e funzione in medicina sono state spesso indagate e messe a confronto pensando a cosa succede in natura; ad alterazioni anatomiche/istologiche dovrebbero corrispondere altrettanti deficit funzionali, ma non sempre è facile trovare le relative correlazioni. Il dualismo struttura/funzione nel glaucoma ha caratterizzato fortemente studi e conoscenze di quest'affezione.

Alterazioni strutturali e funzionali rilevate con strumenti sempre più moderni, non sono spesso in accordo nel follow-up di questa patologia. Danni strutturali più spesso precedono quelli funzionali, come evidenziato da studi e ricerche [2→4]. L'avvento dei nuovi OCT Spectral Domain ha aperto forme alternative d'imaging, approfondite possibilità di studio, modi più efficaci e iconograficamente affascinanti di correlazione tra istologia e funzione. Queste innovative possibilità sono oggi fruibili nei nostri Report grazie al dialogo tra dati tomografici e cluster campimetrici per mezzo di piattaforme informatiche. I risultati raccolti, elaborati e assemblati, sono convogliati in un unico Report Combo. Al momento non tutti gli SD-OCT in commercio permettono questa correlazione, possibile solo tra device compatibili della stessa casa costruttrice. Questo articolo tratterà brevemente delle recenti ricerche scientifiche per quanto riguarda il rapporto struttura/funzione, dei Combo Report, delle novità sugli SD-OCT, campi di studio e imaging Hi-tech che stanno aprendo nuove e più approfondite conoscenze sulle cellule ganglionari, sul nervo ottico e sulla lamina cribrosa nel glaucoma.

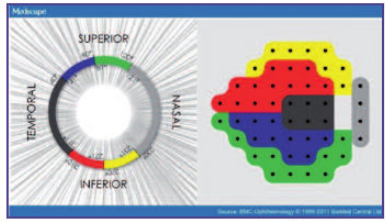


Fig. 1 - Rapporto tra settori RNFL e cluster del campo visivo secondo Garway-Heath.

Stato dell'arte

L'imaging tomografico si è ritagliato un ruolo sempre maggiore nel management del glaucoma. Inizialmente l'interesse strumentale OCT nel glaucoma è stato diretto essenzialmente sulla testa del nervo ottico ONH e lo strato delle fibre nervose peripapillari RNFL. David F. Garway-Heath è tra i maggiori studiosi della relazione struttura/funzione nel glaucoma. A lui si deve la definizione puntuale e goniometrica dei campi settoriali del RNFL nei confronti di singoli cluster del campo visivo[5]. Uno dei suoi primi studi del 1997 *"Aging changes of the optic nerve head in relation to open angle glaucoma"*, termina con alcune considerazioni di fisiologia:

"Neuroretinal rim area declined at the rate of between 0.28% and 0.39% per year. Vertical optic cup diameter and optic cup area increased with age. The mean cup/disc diameter ratio increased by about 0.1 between the ages of 30 and 70 years".

Queste informazioni sono preziose e indispensabili per un più obiettivo giudizio dei dati riportati nei Report Glaucoma e per validare meglio i database dei nostri

www.amedeolucente.it

Lord William Thomson Kelvin *(1824-1907)*

« When you can measure what you speaking about and express it in numbers you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind»

«Possiamo conoscere qualcosa dell'oggetto di cui stiamo parlando solo se possiamo eseguirvi misurazioni, per descriverlo mediante numeri; altrimenti la nostra conoscenza è scarsa e insoddisfacente»

Thanks for your attention