

VA TO VEP: Update on structure and function testing in glaucoma

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Professor and Director of Research



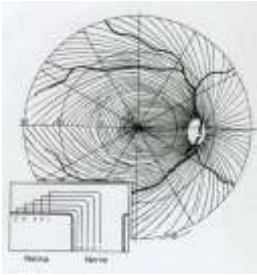
Disclosure

- Research Grants VectorVision, ZeaVision, Topcon
- Consultant Bausch & Lomb, ZeaVision
- Speaker Optovue, Sanofi, Bausch & Lomb

If damage occurs
throughout the retina,
how does visual acuity
remain stable?

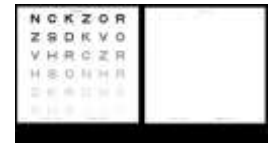
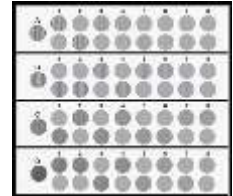
What about other visual
tasks?

Axonal facts



- 700,000 to 1.2 million
- Large variation
- Count of axons increase with increase in area.
- 50% of axons to the macula

Contrast sensitivity



So many types of CS which one to use?

- To some extent it does not matter...
- The values from one can predict the values of other... in healthy population
- So use any CS testing
- In part specific testing at various cycles per degree
- 3, 6, 12 and 18 cycles/degree testing

Association of Structural and Functional Measures With Contrast Sensitivity in Glaucoma



NIMA FATEHI, SARA NOWROOZIZADEH, SHARON HENRY, ANNE L. COLEMAN, JOSEPH CARRIOLI, AND KOURKOS NOURI-MAHDAYI

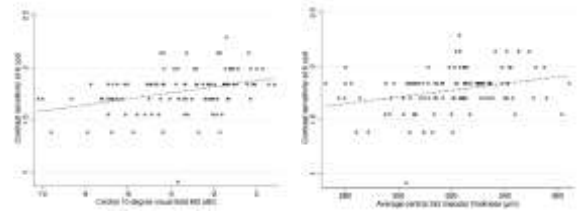
- **CONCLUSIONS:** Structural and functional measures showed a fair relationship with contrast sensitivity. This association was most prominent between full-thickness macular measures or central VF parameters and CS at 6CPD

AJO 2017;178:129-139.

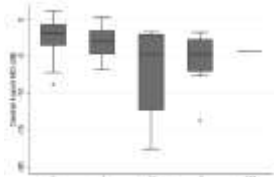
CSV-1000



- Varying spatial frequencies and contrast levels
- Without and with glare



Summary



- Contrast sensitivity is affected in patients with glaucoma.
- Mid spatial frequencies perhaps the most indicative of damage
- Visual acuity is affected when central 4 visual field points are affected

Risk Assessment technology

- Amount of nerve tissue remaining
- Level of damage
- Cellular damage- sub-clinical
 - Electrophysiology
 - Blood Flow

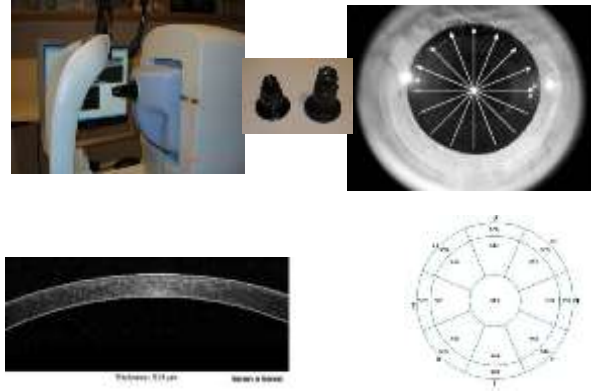
The Scoring Tool for Assessing Risk (S.T.A.R. II) calculator



- OHTs and EGPS data
- Intended for use only in untreated OHT patients
- Age (30-80)
- IOP 20-32 mmHg
- CCT 475 to 650 microns
- PSD 0.50 to 3.00 dB
- C/D ratio vertical 0.00 to 0.8
- On average OCT corneal thickness lesser than ultrasound

Probability of conversion in 5- years
 <5% observe and monitor
 5 to 15% consider treatment
 >15% treat

Anterior segment OCT

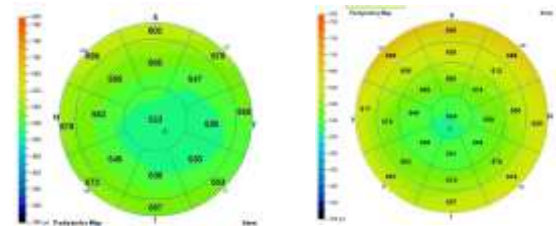


Difference between optical and ultrasound pachymetry measurements

Author	Difference in OCT and ultrasound values
Kim et al <i>AJO</i> 2008	26 microns
Wang et al <i>J Refract Surg</i> 2008	38 microns
Gunvant & Darner <i>Medical Imaging</i> 2011	13 microns

Kim, H.Y., Budenz, D.L., Lee P.S, et al. " Comparison of central corneal thickness using anterior segment optical coherence tomography vs ultrasonic pachymetry. *Am J Ophthalmol*; 145:228-232 (2008).
 Wang, J.C., Bunce, C., and Lee, H.M. " Intraoperative corneal thickness measurement using optical coherence pachymetry and corneo-gauge plus ultrasound pachymetry *J Refract Surg*; 24(6):600-4 (2008)
 P Gunvant, R Darner: Evaluation of corneal thickness measurements obtained using optical coherence tomography and ultrasound technique and determination of specificity in keratoconus screening *Medical Imaging*; 7966: B-88

Corneal Thickness Maps



Glaucoma Symptom Scale

Have you experienced any of the following problems in the last 4 weeks?
(Please respond for both the left and right eye)

0 Booming, roaring, ringing
 Left Eye: No Yes (booming/roaring/ringing) No Yes (booming/roaring/ringing)
 Right Eye: No Yes (booming/roaring/ringing) No Yes (booming/roaring/ringing)

1 Itching
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

2 Dryness
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

3 Stinging, burning
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

4 Feeling of something in the eye
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

5 Hard to see in the dark
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

6 Hard to see in bright light
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

7 Hard to see in dark places
 Left Eye: No Yes No Yes
 Right Eye: No Yes No Yes

8 Reduce Ambient Light

Symptom	No. (%) Reporting Presence of Symptom		P
	Glaucoma Group	Reference Group	
Booming	75 (57)	17 (30)	.13
Itching	79 (54)	13 (23)	.04
Dryness	75 (50)	14 (25)	.04
Stinging	75 (48)	9 (16)	.01
Feeling of something in eye	86 (52)	17 (30)	.48
Hard to see in dark	49 (32)	14 (25)	.88
Hard to see in bright light	120 (82)	14 (25)	.01
Hard to see in dark places	135 (70)	19 (37)	.01
Reduce ambient light	89 (58)	9 (16)	.01
Hard to see in daylight	87 (56)	7 (13)	.01

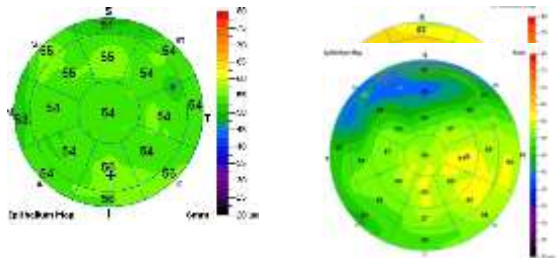
*P² Tests were used to compare the distribution of positive values.

Lee B et al. Arch Ophthalmol 1998

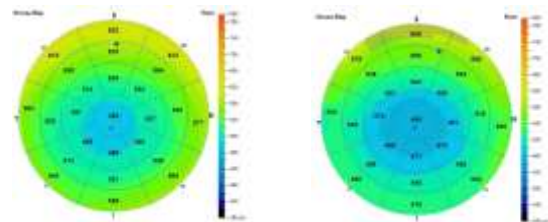
Evaluate the cornea and conjunctiva

- Look at Epithelium
- Pay attention to dry eye and glaucoma –particularly if multiple meds
- Even when patient does not complain they may have sub-clinical dry eyes.
- Extreme dryness changes in stromal thickness
 - Erroneous estimates of risk ??

Anterior segment OCT- Epithelium



Stromal thickness



Gonioscopy

- A = Above Schwalbe line, totally occluded angle.
- B = Behind the Schwalbe line, peripheral iris is in contact with TM.
- C = Scleral spur Iris root at the level of scleral spur
- D = Deep anterior ciliary body seen.
- E = extremely deep

Guidelines recommend once a year procedure



Iris insertion



Angle approach

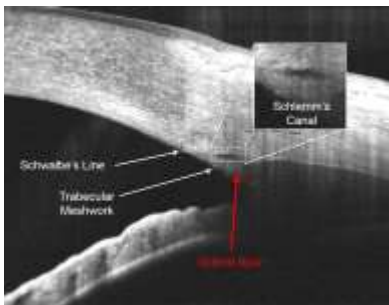


Curvature of peripheral iris

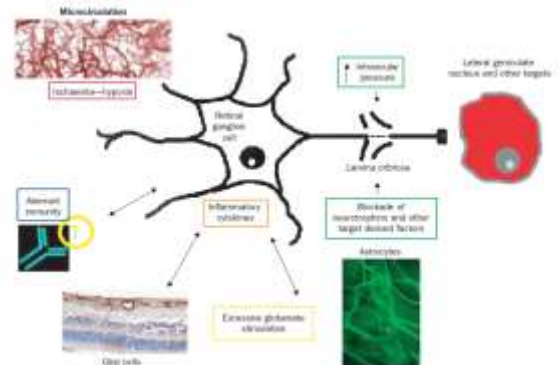
Angle Measurement with Quantification



Anterior segment Angle Analysis



Factors contributing pathophysiology in glaucoma



Changes in visual function after intraocular pressure reduction using antiglaucoma medications

TJ Foss, MV Riva and LAS Mesi F
 Eye (2016) 33, 1281–1281
 © 2016 Elsevier Publishing Limited. All rights reserved. ISSN: 0270-1286
 www.elsevier.com/locate/eye

54 patients, timolol 0.5% or brimonidine 0.2% or travoprost 0.004%

Table 2 Intraocular pressure and visual function at baseline and after treatment including all participants

Variable	Baseline mean (SD)	After treatment mean (SD)	Difference mean (SD)	P-value
IOP (mmHg)	21.8 (4.0)	16.9 (4.3)	7.9 (3.6)	<0.001*
RCVA (logMAR)	0.23 (0.20)	0.20 (0.30)	-0.03 (0.12)	0.26*
VAS	6.86 (2.28)	7.72 (2.01)	0.86 (1.95)	0.043*
Mean				
Mean deviation (SD)	-0.56 (0.83)	-5.72 (0.73)	0.84 (0.43)	0.02*
Patient #1 (SD)	0.10 (0.01)	0.05 (0.01)	0.79 (0.06)	0.30*
Contrast sensitivity				
1.5 cycles/degree	1.61 (0.78)	1.63 (0.20)	0.02 (0.30)	0.21*
3 cycles/degree	1.56 (0.40)	1.05 (0.28)	0.07 (0.28)	0.21*
6 cycles/degree	1.42 (0.44)	1.42 (0.52)	-0.00 (0.38)	0.24*
12 cycles/degree	0.87 (0.55)	0.97 (0.34)	0.10 (0.57)	0.33*
18 cycles/degree	0.87 (0.40)	0.35 (0.40)	0.18 (0.42)	0.002*

Summary

- Contrast sensitivity, glare and difficulty in seeing at night time is prevalent in patients due to glaucoma
- The contrast sensitivity when measured shows decline even with clinical tests.
- Changes post treatment in visual function is present **independent of IOP levels decline.**

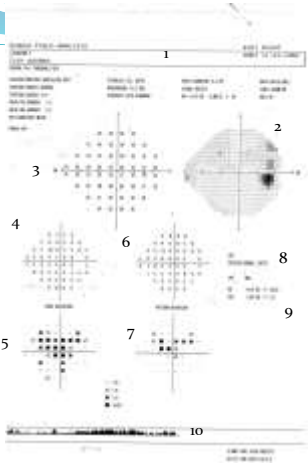
Summary cont

- Evaluating contrast sensitivity can give a quality of life measure and perhaps additional information on treatment efficacy.
- Corneal evaluations with OCT may give insights that may be missed by ultrasound measurements
- Angle evaluations a must and OCT may be quick and comfortable method

Visual fields



Visual fields – don't like them; cant live without them.

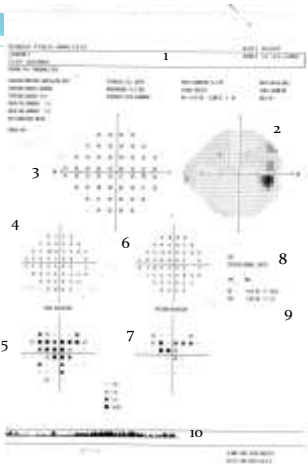


1 Watch out for
Pupil size
Reliability index
Type of test
24-2 SITA STD
age
refractive error

2 Grey Scale
Look for patterns
Global view
Not for diagnosis
Types of visual field defects

3 Raw data
Normals centrally low 30's
Peripherally high 20's

4 5 6 7 8 9 10



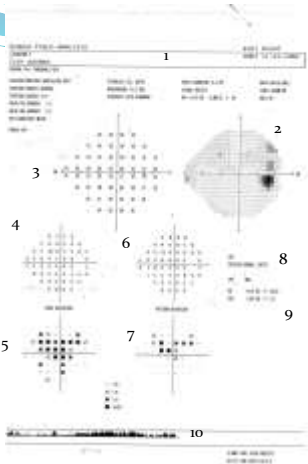
4 Total deviation
Deviation from average

5 Total deviation
probability plot

6 Pattern
deviation
Removes any generalized defects
Cataract
Pupil miosis

7 Pattern
deviation probability plot

1 2 3 4 5 6 7 8 9 10



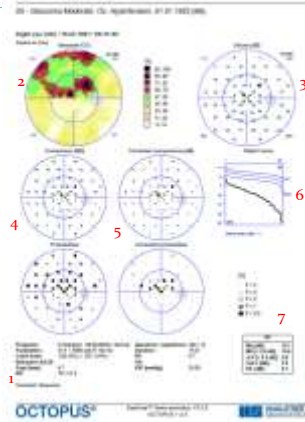
8 glaucoma hemifield test
Outside normal limits
Borderline
Generalized reduction in sensitivity

9 global indices
MD mean deviation
PSD pattern Standard Deviation

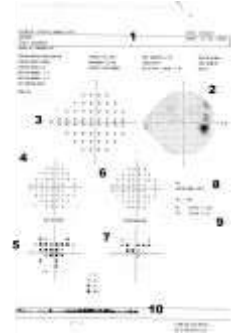
10 gaze tracking

1 2 3 4 5 6 7 8 9 10

Octopus

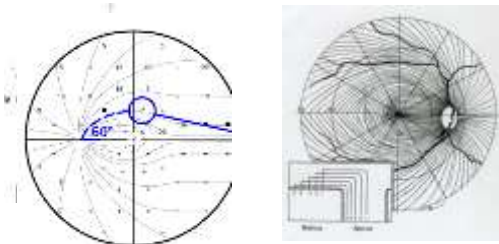


Humphrey "Gold standard" ?



Some problems with HFA

- Points spread evenly
- Data not representative of RNFL



Problems continued

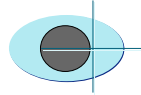
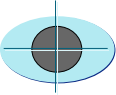
- No real blind spot monitoring



Octopus Features: Fixation Control

True Fixation Control

Correct
fixation

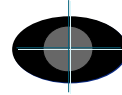


Fixation
lost

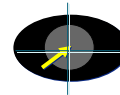
- No stimuli during fixation loss
- Automatic repetition of stimuli after blinking or darting
- Most accurate test possible

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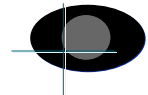
Octopus Features: Auto Eye Tracking



Correct fixation



Eye movement



Automatic
readjustment

- ❖ The perimeter centers the patient automatically to the optical axis
- ❖ Less interrupts, less time to finish

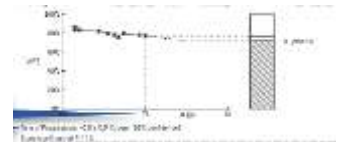
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HFA II versus HFA 3

- Larger touch screen
- Liquid crystal lens -8 to +8 only sph correction

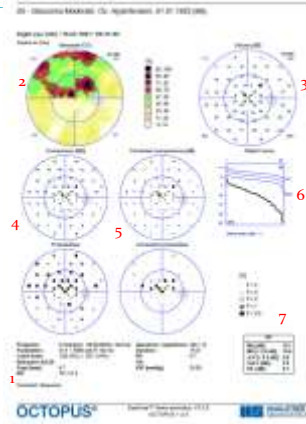
Visual Field Index

- Percentage of normal age adjusted field
- Greater the number more normal
- Trend over time is given with a probability values as well
- Should work in theory; in reality does not!



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Octopus

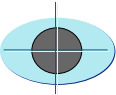


Unique features of Octopus

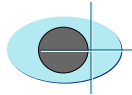
Octopus Features: Fixation Control

True Fixation Control

Correct fixation



Fixation lost

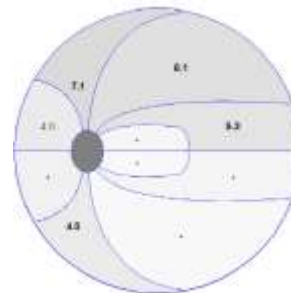


- No stimuli during fixation loss
- Automatic repetition of stimuli after blinking or darting
- Most accurate test possible

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Cluster analysis

Why cluster analysis?

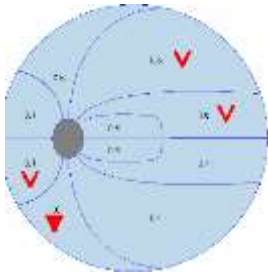


- Individual points may vary
- Overall clusters are more stable
- Also close representation to various bundles of RNFL
- So in some respect better structure function relationship.

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Trend analysis

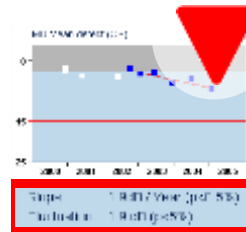


- Numerical Progression rate (differ)
- Worsening at 1% probability
- Worsening at 5% probability
- Recovery at 1% probability
- Recovery at 5% probability
- Fluctuation at 1% probability
- Fluctuation at 5% probability

45



Global rate of progression



Color codes

- Worsening at the 5%, 1% level
- Improvement at the 5%, 1% level
- Fluctuation at the 5%, 1% level

Scale

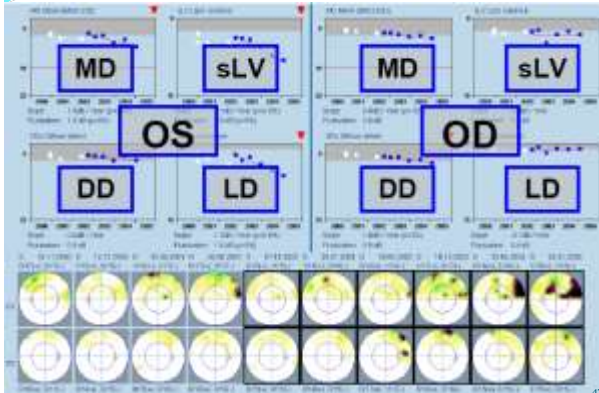
- Grey: Normality
- 15dB: Seriously impaired vision
- 25dB: Considered legally blind

Progression rate

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Global trends

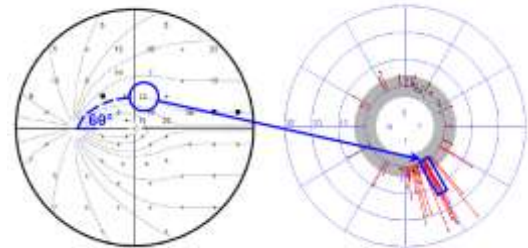


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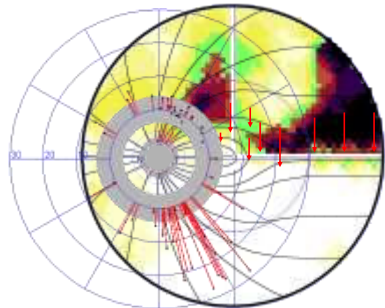
Polar graph

Polar Graph



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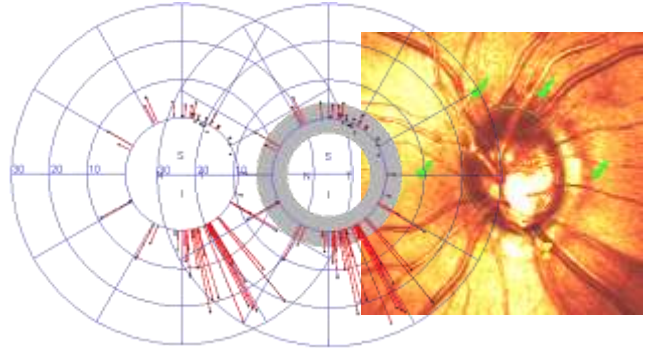
OCTOPUS Polar Diagram Principle



The bridging structure of the OCTOPUS defect test:

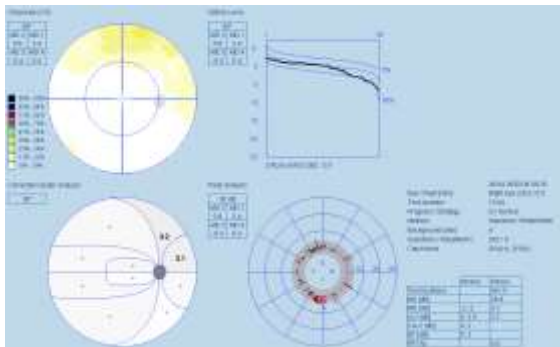
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OCTOPUS Polar Diagram Bridging structure & function



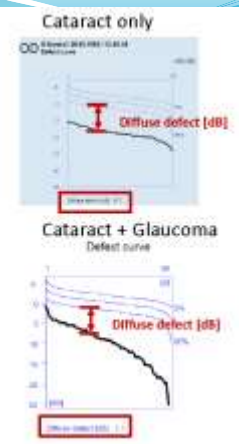
50

The 4-in-1 screen

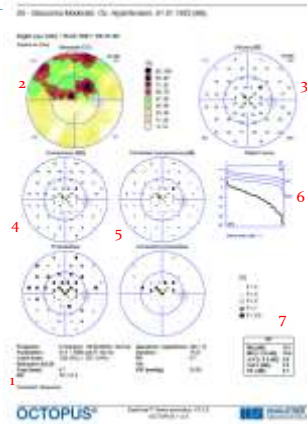


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Bebie curve



Octopus



Is this defect a sign of
"early glaucoma"

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Criteria for glaucomatous damage

- 1) GHT outside normal limits
- 2) PSD < 5% of normal individuals
- 3) A cluster of three or more **non-edge** points (pattern deviation plot) all of which are depressed at a $p < 5\%$ and one of which is depressed at a $p < 1\%$ on two occasions (respecting horizontal meridian)
 - This criterion was written for 30-2, if 24-2 field is analyzed edge points are included.
 - Criteria should be met on 2/3 issues mentioned above
 - Confirmed on two occasions!

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Staging of disease



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Why is staging important?

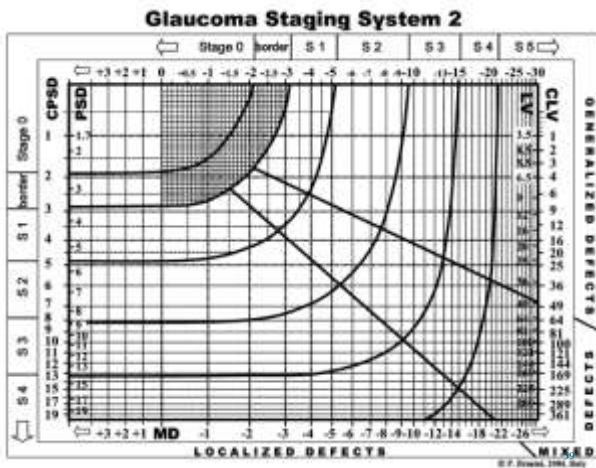
- Treatment issues
- Management issues
- Prognosis
- Research

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Glaucoma staging system- Brusini

GSS -2

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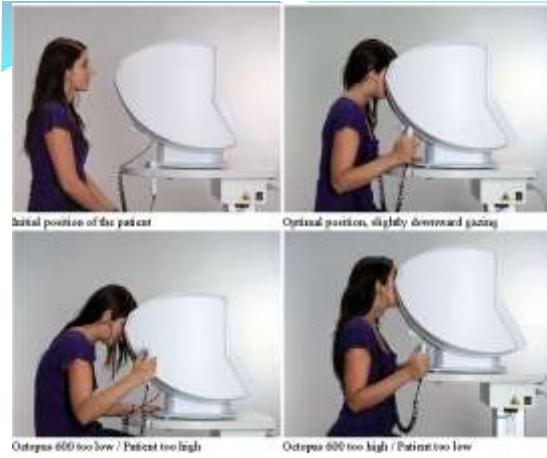
Clear text analysis



Stages

- normal VF
- borderline VF
- early VF defects (Brusini stage 1)
- moderate VF defects (Brusini st. 2)
- advanced VF defects (Brusini st. 3)
- severe VF defects (Brusini stage 4)
- most severe VF defects (Brusini st. 5)

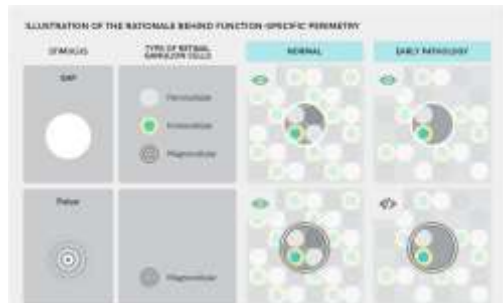
Octopus -600



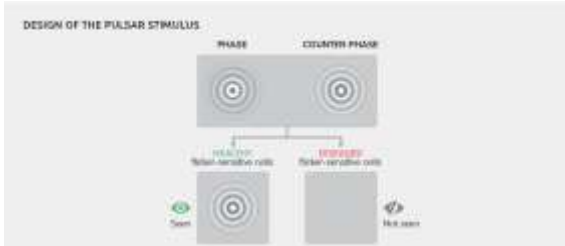
Pulsar perimetry



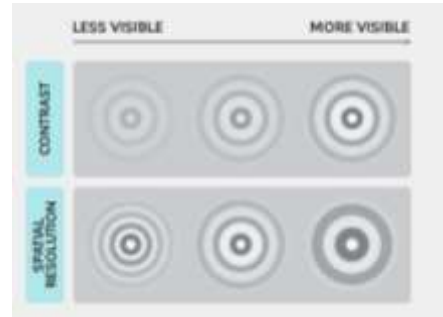
Why does it help targeting specific ganglion cells?



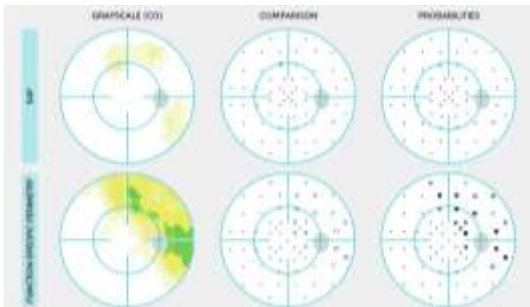
Design of the PULSAR stimulus



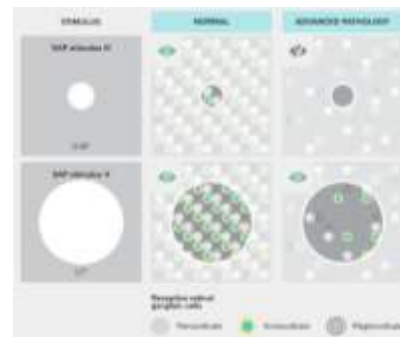
Sensitivity thresholds with PULSAR perimetry



Example of SAP and function-specific perimetry in the same eye



Principle of using stimulus V for low vision patients



Patient has cataract what do I do with Visual fields?

ORIGINAL ARTICLE

Effect of Cataract Opacity Type and Glaucoma Severity on Visual Field Index

Hye Jin Chung¹, Jeong Hoon Choi¹, Young-Chan Lee¹,
and Su-Young Kim²

- Visual field parameters improved after cataract surgery
- MD, PSD and VFI- less influenced in nuclear sclerosis
- MD, PSD and VFI – greater effect in cortical cataract, particularly for early glaucoma

JAMA Ophthalmol. 2016;34(10):1151-1157. doi:10.1001/jamaophth.2016.2222
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Cataract in glaucoma patient

- Dilate as much as possible
- Depend on PSD plot more than total deviation
- Use imaging modalities more.

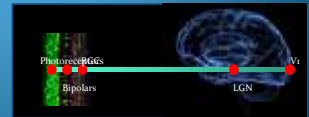
Sources of error

- Miosis: decreases threshold peripherally, increases variability centrally
- Lens opacities
- Uncorrected refractive error –decrease in contrast sensitivity
- Spectacles
- Ptosis

Summary

- Time for change is here.
- Doing what we have always done is unlikely to yield progress.
- Great programs that make a lot of sense clinically
- New technology may identify glaucoma early and easier to follow

Electrophysiology



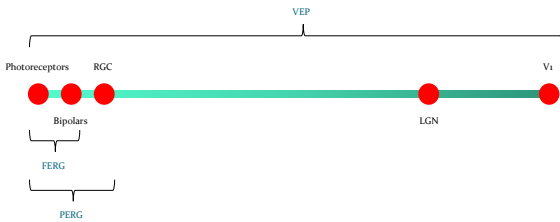
Electrophysiology has come a long way



Electrodes have come a long way

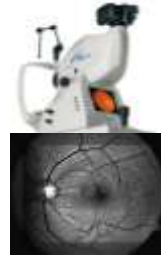


Which test when?



Structure

Fundus Photograph
(Subjective)



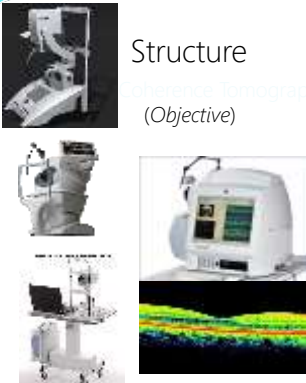
Function

Visual Field
(Subjective)



Structure

Optical Coherence Tomography
(Objective)



Function

ERG
(Objective)



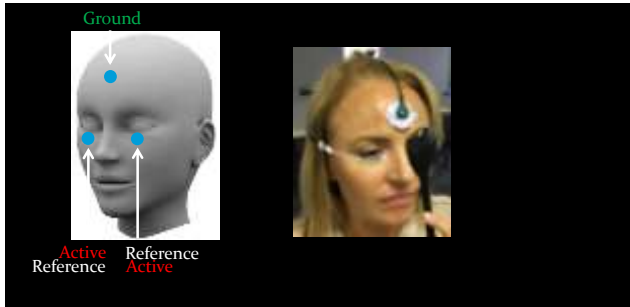
PERG Indications

- Glaucoma
- Maculopathies

AMD
ERM
DME
etc.



ERG sensors



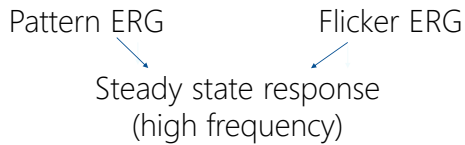
Pattern Electroretinogram (PERG)



Retinal ganglion cell signal recorded at the lower lid in response to pattern stimuli



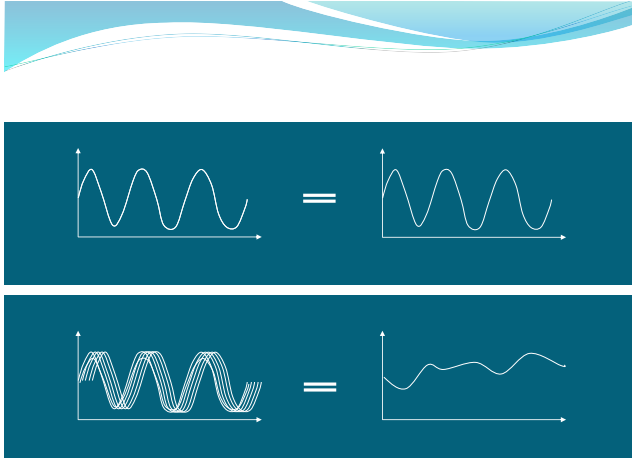
Steady state- clinical state



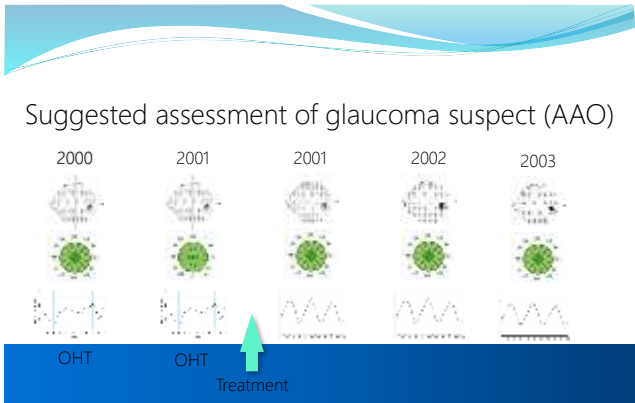
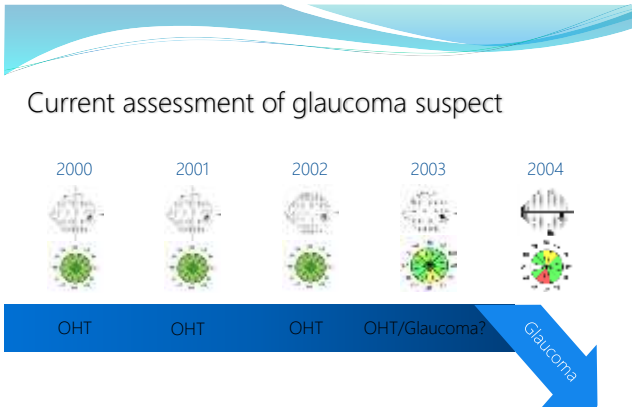
Greater amount of information in shorter time:
300 responses

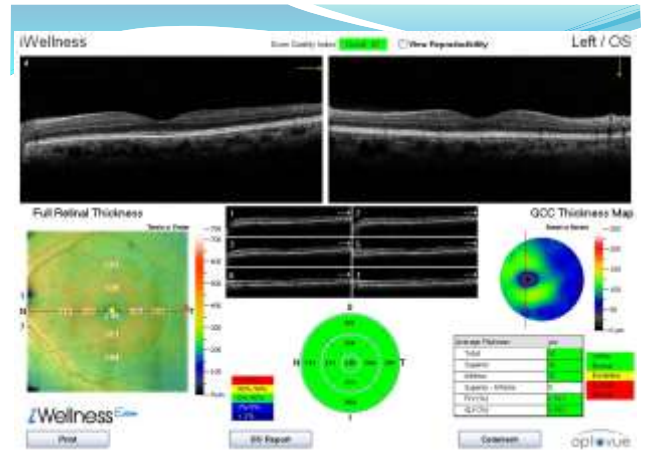
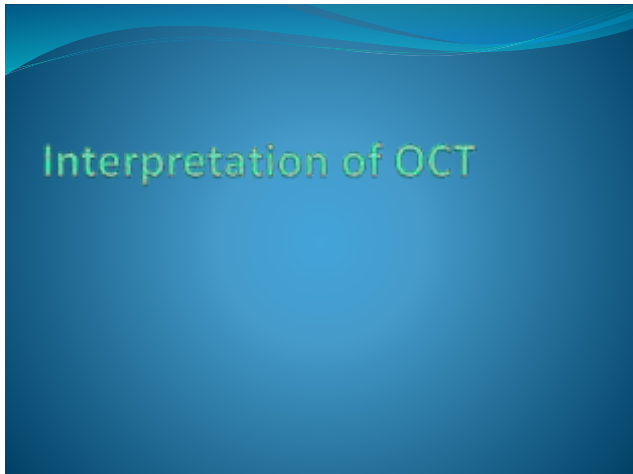
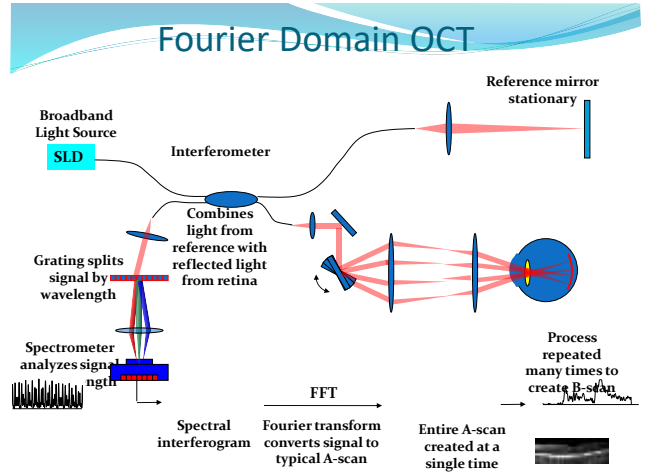
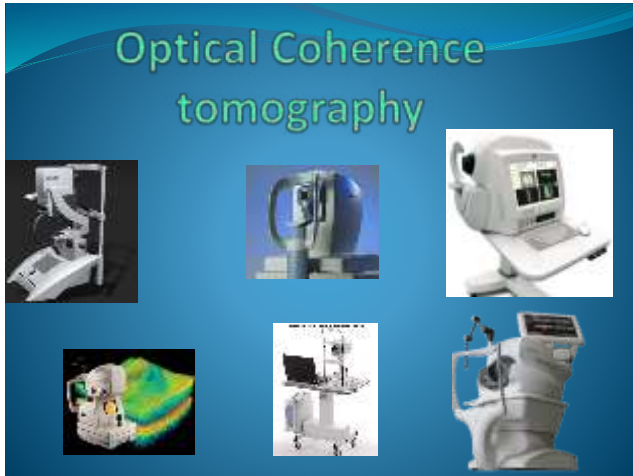
So where are the a, b, c waves?

- Transient ERG that are less in frequency produce them.
- Variable and very much laboratory dependent.
- Difficult to obtain clinically.



Sick versus dead ganglion cells- a debate





Eye and Brain

Dovepress

ORIGINAL RESEARCH

Sensitivity and specificity of the iVue iWellnessExam™ in detecting retinal and optic nerve disorders

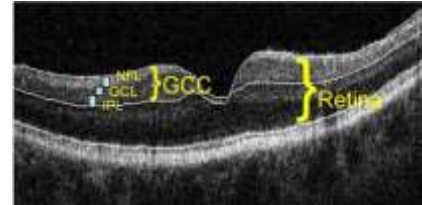
Catherine Awad¹
Samantha Slatnick^{1,2}
Sanjeev Nath¹
Jerome Sherman²⁻⁴

¹Non-Southwestern College of Optometry, All India Institute of Medical Sciences, New Delhi, India
²UNLV Reno College of Optometry, UNLV Eye Institute, Eye Institute and Laser Center, New York, NY, USA

Sensitivity and specificity were calculated for identifying normal and abnormal individuals

99 % Specificity
95.5% sensitivity in identifying retinal diseases
90% identifying optic nerve disease

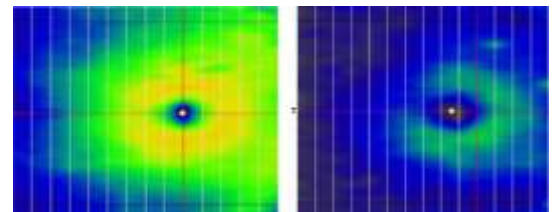
Ganglion Cell Complex (GCC)



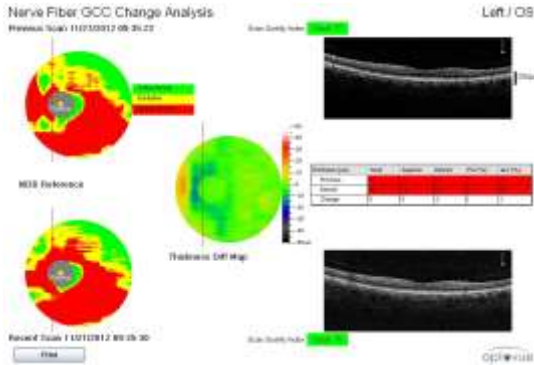
Other devices

- Zeiss Ganglion Cell analysis- GCL+ IPL
- Topcon Maestro gives both
 - NFL+ GCL+ IPL
 - GCL+IPL
- Spectralis gives individual layers.

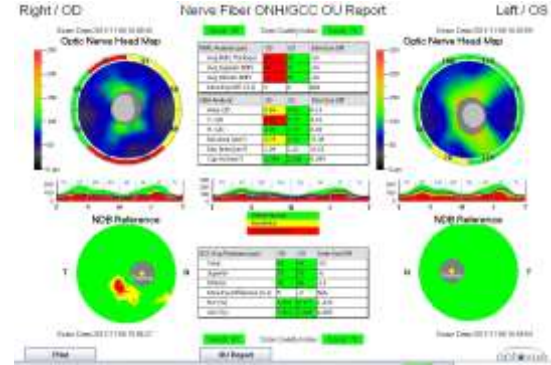
How is GCC measured



GCC Change



Case



Can GCC be used as an independent parameter to diagnose glaucoma?

The Applicability of Ganglion Cell Complex Parameters Determined From SD-OCT Images to Detect Glaucomatous Eyes

Paramasri Arinawati, MD,* Takashi Sone, MD,* Tsuneyuki Akita, PhD,†
Junko Tanaka, PhD,† and Yoshiaki Kushi, MD, PhD*

(*J Glaucoma* 2013;22:713–718)

Methods: Two hundred sixty-one eyes, including 68 normal eyes and 32 preperimetric glaucoma, 81 early glaucoma, and 80 advanced glaucoma were analyzed in the present study. The thicknesses of the GCC and retinal nerve fiber layer were measured using RTVue spectral-domain optical coherence tomographic (SD-OCT) images. The area under the receiver operating characteristic (AUROC) curve and sensitivities at fixed specificities were calculated for each parameter. A logistic regression analysis was used to determine the risk factors for glaucoma.

Evaluation of the OCT Parameters as Diagnostic Tests With the AUROC Curve

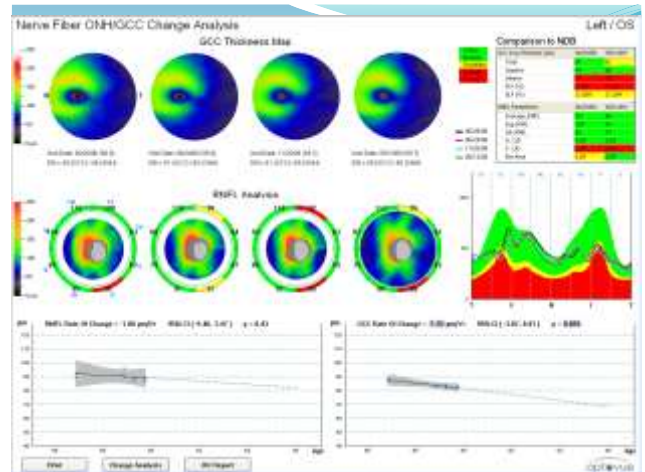
	N vs. PG	N vs. EG	N vs. AG
GCCa	0.795 (0.667-0.882)	0.806 (0.727-0.866)	0.902 (0.838-0.942)
GCCs	0.754 (0.617-0.853)	0.761 (0.678-0.828)	0.880 (0.809-0.928)
GCCi	0.815 (0.690-0.897)	0.795 (0.714-0.858)	0.915 (0.851-0.953)
FLV	0.745 (0.622-0.839)	0.789 (0.709-0.851)	0.948 (0.888-0.977)
GLV	0.806 (0.679-0.891)	0.816 (0.740-0.874)	0.929 (0.871-0.961)
RNFLa	0.740 (0.620-0.832)	0.734 (0.647-0.806)	0.910 (0.846-0.949)
RNFLs	0.748 (0.626-0.840)	0.725 (0.636-0.798)	0.889 (0.817-0.935)
RNFLi	0.723 (0.605-0.816)	0.700 (0.611-0.776)	0.912 (0.858-0.947)

Arintawati et al / Glaucoma • Volume 22, Number 9, December 2013

Progression and glaucoma

Progression

- Consensus is limited
- Visual fields tend to fluctuate in early glaucoma
- Reliable and repeatable structural measurements is very valuable
 - Fourier domain OCT 5 microns accuracy.

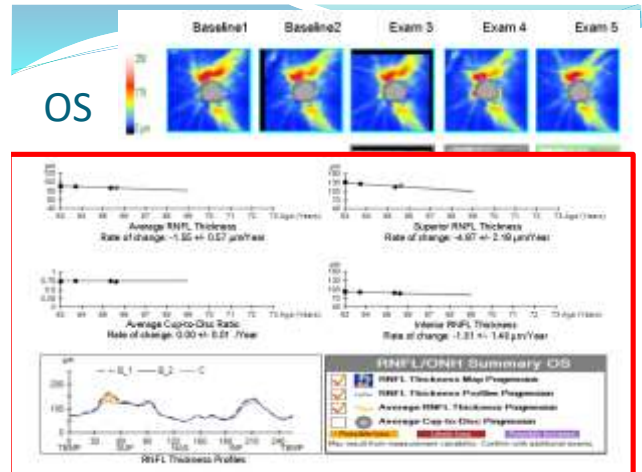


CASE MR.X

- DOB 1951
- Asian Male
- Medical unremarkable
- Family medical Brother Glaucoma
- Tmax – 23 OU
- On PGA IOPs 15-18 OU
- Overall quite regular in care and compliance

During follow-up

- One year had changed to generics PGA
- Seen by 4 different doctors in practice....
- Charts And observations



Case # 1 Easy Case /OCT helps Management

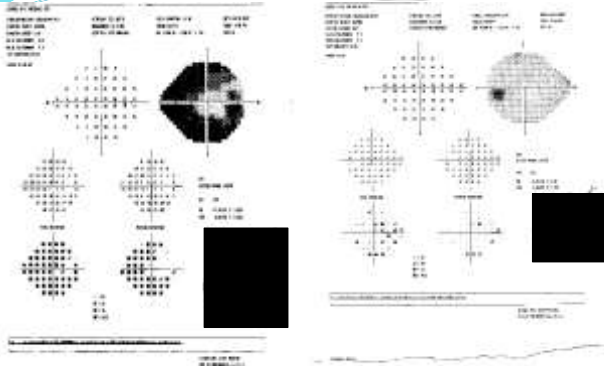
- 61 year old male referred to UEC for high IOP readings (pt. asymptomatic)
- MH: Atrial fib. (2 yrs.), HTN (10yrs.), Pre-diabetic (3 yrs.)
- POH: Wears bifocals, no Ocular surgeries
- FOH: Glc (maternal), RD (paternal)
- Meds.: eliquis, metoprolol, Multi-V
- CC: Reports loss of side Vision/OD x 2 mon.

Courtesy David Sendrowski OD

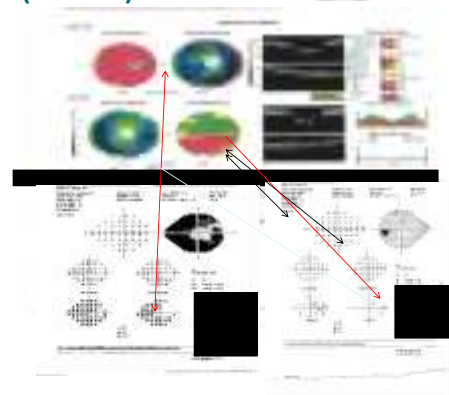
Exam Data

- BCVA: R 20/20 L 20/20
- Pupils: Normal (-) APD
- IOP: R 34,35 mm Hg L 29,29 mm Hg
- Pachymetry R 525, L 523
- C/DR .90 L .80
- VF (see next slides)
- OCT (see next slides)

VF (Right and Left)



OCT (R & L)



OCT results: what does it mean?

- Right:
 - Ave RNFL 65 microns, Ave GCC 58.27 microns
 - Patient has advanced POAG
 - Both RNFL and GCC near “floor effect” need to follow patient with VF
- Left:
 - Ave RNFL 76 microns, Ave GCC 75.15 microns
 - Patient has mod/advanced POAG
 - Can use OCT for GCC and RNFL for monitoring progression

Questions

- Would you treat?
- How did the OCT help with the decision for treatment for the right eye? Left eye?
- What VF would be best to do in the right?
- What would be your best management of the right eye?
- What might the best management be in the left eye?
- When would you do the next VF and OCT?

Macular Pigment and glaucoma

- We know the advantages of multivitamins and AMD
 - Prevents oxidative damage
 - Quenches any free radical
 - Prevents photoreceptor death
 - Absorbs stray light
- Oxidative damage can also occur in glaucoma

Where is the evidence?

- Aqueous humor has lot of vitamin-C
- Macular pigment optical density is lower in glaucoma patients than individuals without glaucoma

Evidence of lower macular pigment optical density in chronic open angle glaucoma

Esteris Igras,¹ James Loughman,^{2,3} Matthew Ratzlaff,¹ Rónán O'Caoláin,⁴ Colm O'Brien^{1,5}

Igras E, et al. *Br J Ophthalmol* 2012;97:964-968. doi:10.1136/bjophthalmol-2012-021153

Macular pigment is a modifiable risk factor and can be increased with vitamin intake



Lower Macular Pigment Optical Density in Foveal-Involved Glaucoma

Ophthalmology 2015;124:2000-2007 © 2015

1011-0126/15/124-2000-07 © 2015

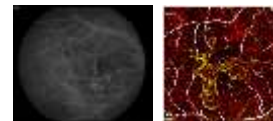
Summary

- Measure Macular pigment in glaucoma patients
- Measure Ganglion Cell Complex/ Analysis
- Recommend multivitamin intake with good amount of Lutein and Zeaxanthin- **Dosage matters!**
- Helps all age related diseases.

Whats new with OCT

OCT Angiography: A New Approach to Protecting Vision

- **Non-invasive** visualization of **individual layers of** retinal vasculature
- Pathology **not obscured** by fluorescein staining or pooling
- Image acquisition requires **less time** than a dye-based procedure
- Reduced patient burden allows more frequent imaging to **better follow disease progression and treatment response**



FA of CNV

OCTA of CNV

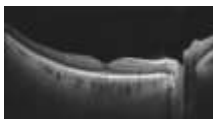
How Does AngioVue Work?

Principles of AngioVue OCTA

- Uses motion contrast to detect blood flow
- Rapidly acquire multiple cross-sectional images from a single location on the retina
- Flow is the difference between two sequential scans
 - Flow = Frame #1 - Frame #2



Structure + Function: Retina



High Resolution OCT B-Scan



Widefield En Face



OCTA: Superficial & Deep Capillary Plexus

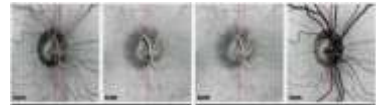


OCTA: Outer Retina & Choriocapillaris

Structure + Function: Optic Nerve



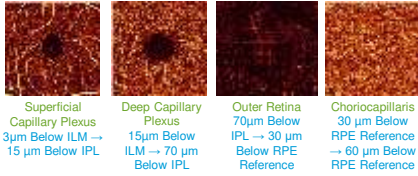
Function: OCTA



Structure: En Face

See The Vessels Like You've Never Seen Them Before!

- Segment retinal vasculature into individual layers
- Eliminate effects of dye-based blurring and pooling
- Isolate areas of interest
- View 3x3mm and 6x6mm scans

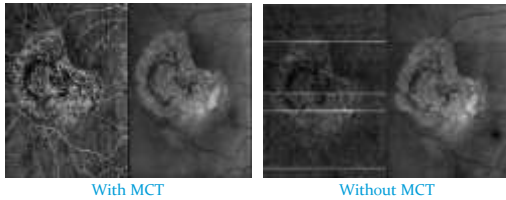


Non-Invasive, Dye-Free & Fast

- No injection, no fluorescein
- Order test as needed to more closely monitor disease progression and treatment response
- Image acquisition in less than three seconds
- Total time in room approximately 10 minutes

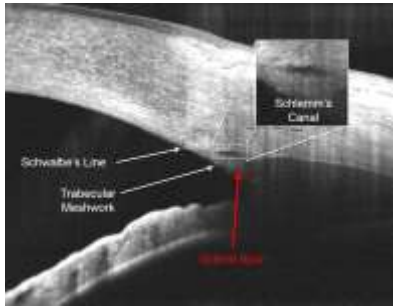


Motion Correction Technology (MCT™): Minimizes Saccadic Motion to Enhance Image Intensity

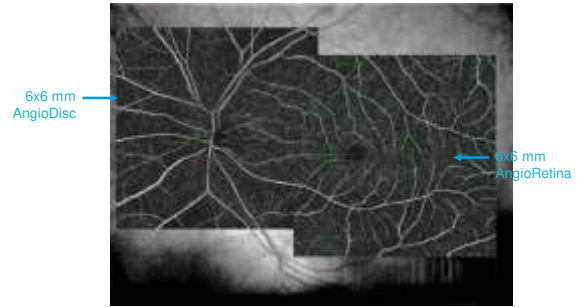


Angle Measurement with Quantification

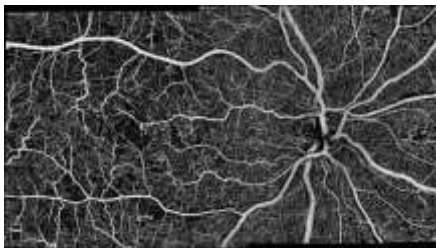




AngioMontage Provides a Wider Field of View



AngioVueHD High-Resolution Automatic Montage



AngioVue^{HD} Montage for imaging outside the macula.

10x6 mm FOV with outstanding resolution of retinal vasculature in the macula and optic disc.

Images courtesy of Adil El Mafrouhi, O.D., Lyon, France



Glaucoma

OCT Angiography: Function

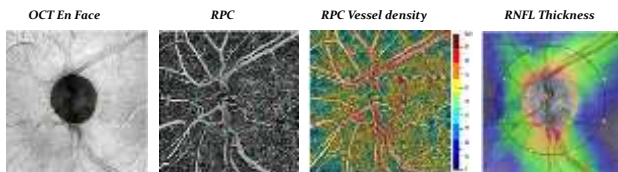
Normal Optic Disc Moderate Glaucoma Severe Glaucoma

OCT: Structure

Trend Analysis: GCC + ONH
Optic Disc En Face View

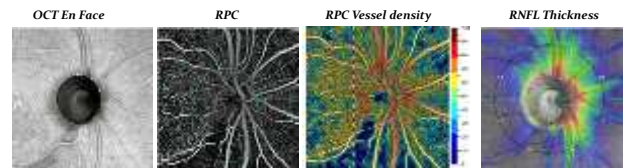
Previously diagnosed patient. Images courtesy of Michel Puech, MD, FRCS

Normal Eye



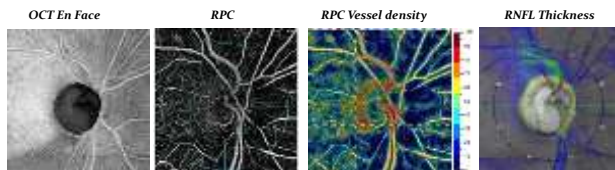
Images and data courtesy of Robert Weinreb, MD and Linda Zangwill, PhD, UC San Diego

Moderate Glaucoma



Images and data courtesy of Robert Weinreb, MD and Linda Zangwill, PhD, UC San Diego

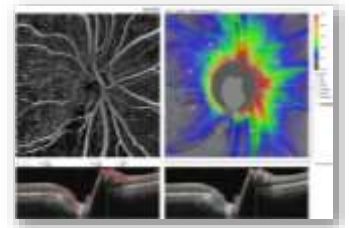
Advanced Glaucoma



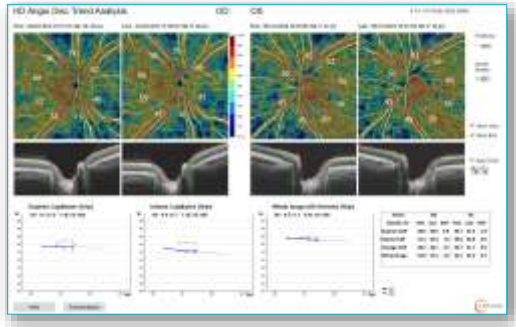
Images and data courtesy of Robert Weinreb, MD and Linda Zangwill, PhD, UC San Diego

Quantification of Optic Disc Vasculature

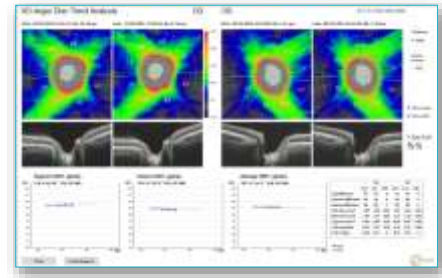
- OCT and OCTA analysis from the same scan:
 - Automatic detection of BMO
 - Rim and Cup area measured within BMO plane
 - Vessel density analysis based on RPC (ILM~NFL)
- Enables extensive analysis of disc structure and vasculature



AngioDisc Trend Analysis



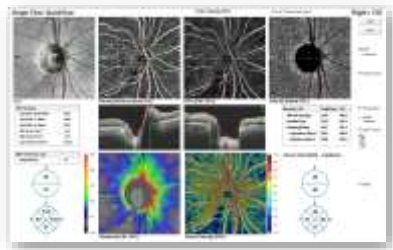
RNFL Thickness Trend Analysis



Overview Report Provides Disc Health at a Glance

One scan generates report showing:

- OCT Intensity
- RPC
- RPC Density
- RNFL
- Cup/Disc



Disc Overview Report Brings New Information to Glaucoma Management

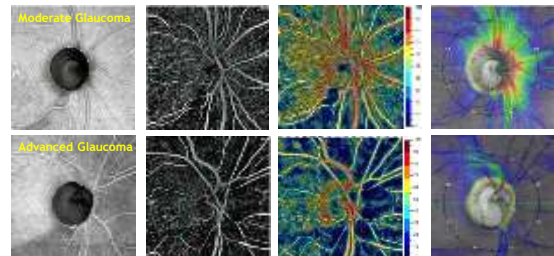


Image Courtesy: Drs. Weinreb, Nudelman, Goldbaum, Zangwill, UCSD, San Diego, CA (USA)



Summary

- We live in exciting times
- Early detection is getting within reach.
- Functional measures and structural measures are improving rapidly.
- Next step....reverse glaucomatous damage