Glaucoma Update 2026

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UNIVERSITY OF HOUSTON COLLEGE OF OPTOMETRY

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Experience EXPO With Us!

- Vision Stage – *Tangerine Ballroom – Room WF1*
  Our Vision Stage sessions feature free, promotional content for all attendees.
- Vision Series - *Thursday 3/12 and Friday 3/13*
  Grab a bite to eat and continue learning over *Breakfast 8:30-9:30am* or *Lunch 12:00-1:00pm!**
  Listen to industry leaders as they address the latest clinical innovations in a relaxed and collaborative environment.

  **Open to Optometrists only. Not for Credit. Meals offered on first-come, first-serve basis. Education Badge required.*
- Exhibit Hall Hours

Thursday, March 12	9:30am – 6:00pm
Friday, March 13	9:30am – 6:00pm
Saturday, March 14	9:30am – 3:00pm

- Conferee Cafe – Exhibit Hall – Booth 2902
- Education Lounge - Level 2 - Conference Area Tangerine Ballroom – Room WF2

vision expo

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Disclosures

Alcon
Balance Ophthalmics
Bausch & Lomb
Carl Zeiss Meditec
Glaukos
iCare
Topcon Healthcare

***All relationships have been mitigated

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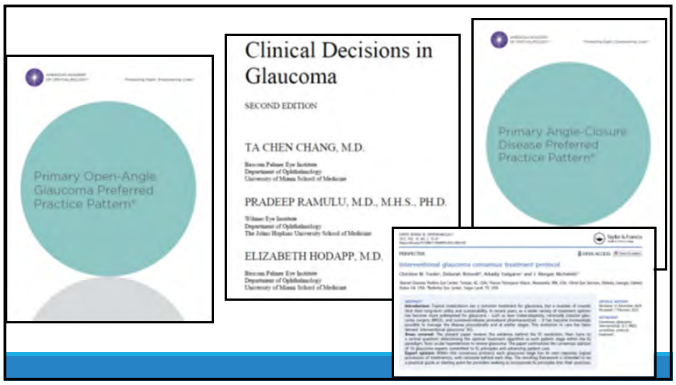

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Primary Open Angle Glaucoma

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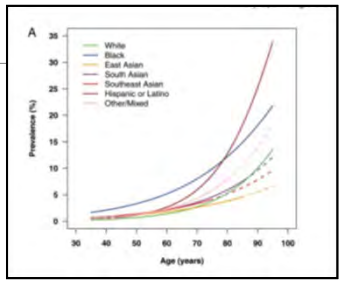
Prevalence

Leading cause of irreversible blindness in Black Americans
- 3-fold higher incidence in Black individuals compared to non-Hispanic whites in USA
  - Higher in West African and Afro-Caribbean individuals

Asian Americans and Hispanic Americans are similar to one another, higher than non-Hispanic white Americans



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Risk Factors for POAG

Elevated IOP

Older age

Family History of glaucoma

Ethnic risk

Diabetes

Lower systolic and diastolic BP (lower ocular perfusion pressure)

Myopia

Thin central cornea

Low corneal hysteresis

Disc Hemorrhage

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Diagnosis: Initial Exam

History:
- Refractive error
- Trauma
- Family history
- Systemic history (both for risk factors and for contraindications for therapy)

Exam:
- VA
- Pupils
- Confrontation visual fields
- Slit lamp biomicroscopy
- IOP
- Gonioscopy
- **ONH and RNFL *clinical* exam**
- Fundus exam

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How do we CLINICALLY assess the ONH?

Murray Fingeret: "It's become an OCT world"

AAOphth PPP: "Examination of the ONH and RNFL provides valuable structural information about glaucomatous optic nerve damage."
- Vertical elongation of cup/diffuse or focal thinning of NRR
- Large optic cup size
- Asymmetric optic nerve cupping
- Optic disc hemorrhage
- Diffuse or focal thinning of RNFL
- Beta zone peripapillary atrophy
- Nasalization of central ONH vessels
- Baring of circumlinear vessels

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Disc Damage Likelihood Scale

Disc Damage Likelihood Scale reference Spaeth Trans Am Ophthalmol Soc 2002

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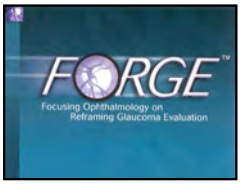

Five rules to evaluate the optic disc and retinal nerve fiber layer for glaucoma

Murray Fingeret, O.D.,[a,b] Felipe A. Medeiros, M.D.,[c] Remo Susanna, Jr, M.D.,[d] and Robert N. Weinreb, M.D.[c]

OPTOMETRY 2005;76:661-8.

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FORGE – what do we look at on ONH?

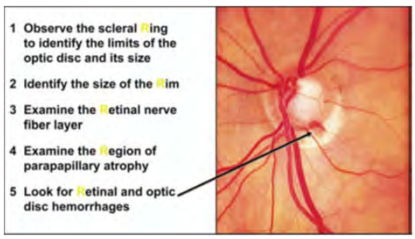
Size of disc

Rim configuration (ISNT)

RNFL dropout (largely done by OCT)

Beta zone peripapillary atrophy

Disc hemorrhage



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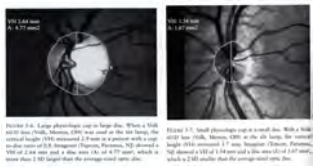
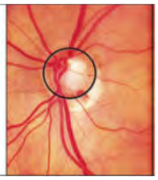
Size of Disc

Size of disc
- Mean vertical diameter 1.88mm (linear)
- How do we judge?
  - Direct ophthalmoscope (small spot)
  - 78D lens with reticle
  - SD-OCT (area, not linear)



1 Observe the scleral Ring to identify the limits of the optic disc and its size



Fingeret, et al. Optometry 2005

Litwak. Glaucoma Handbook

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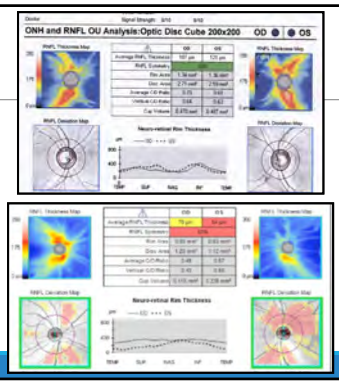
Size of Disc

SD-OCT can measure disc (area mm^2):
- Cirrus:
  - 1/3 <1.58 mm^2
  - 1/3 1.58-1.88 mm^2
  - 1/3 >1.88 mm^2
  - Gray tone = larger or smaller disc area than database, or Avg/Vert C/D <0.25



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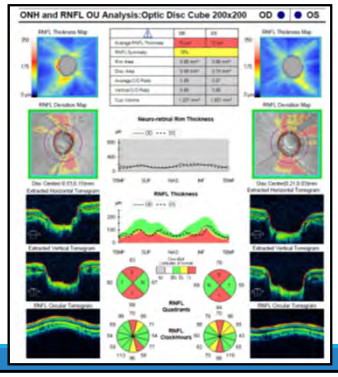

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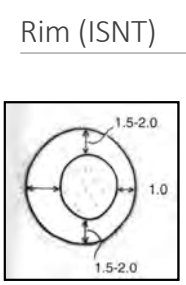
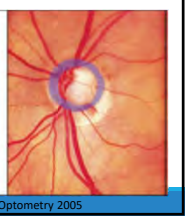
Rim (ISNT)



Litwak. Glaucoma Handbook

2 Identify the size of the Rim



Fingeret, et al. Optometry 2005

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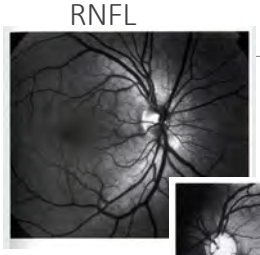
RNFL

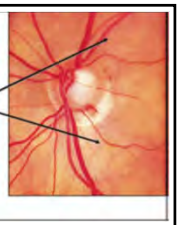


Litwak. Glaucoma Handbook

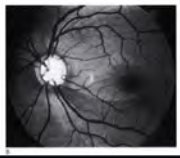
1 Observe the scleral Ring to identify the limits of the optic disc and its size

2 Identify the size of the Rim

3 Examine the Retinal nerve fiber layer



Fingeret, et al. Optometry 2005



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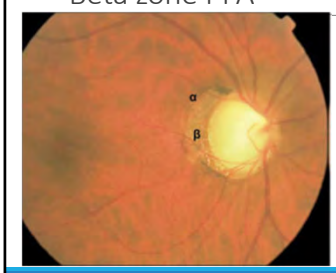
Beta zone PPA



1 Observe the scleral Ring to identify the limits of the optic disc and its size

2 Identify the size of the Rim

3 Examine the Retinal nerve fiber layer

4 Examine the Region of parapapillary atrophy

Fingeret, et al. Optometry 2005

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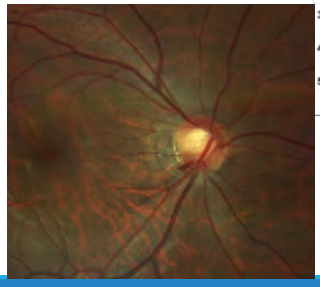
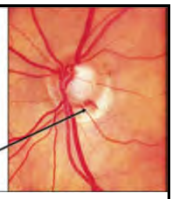
Disc Hemorrhage



1 Observe the scleral Ring to identify the limits of the optic disc and its size
2 Identify the size of the Rim
3 Examine the Retinal nerve fiber layer
4 Examine the Region of parapapillary atrophy
5 Look for Retinal and optic disc hemorrhages



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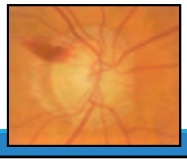

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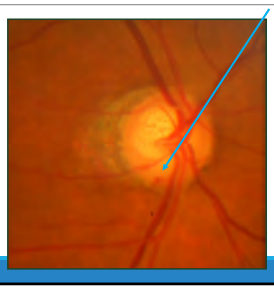
Did you see the disc hemorrhage?



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Detection and Prognostic Significance of Optic Disc Hemorrhages during the Ocular Hypertension Treatment Study

Donald L. Budenz, MD, MPH,[1] Douglas R. Anderson, MD,[1] William J. Feuer, MS,[1] Julia A. Beiser, MS,[2] Joyce Schiffman, MS,[1] Richard K. Parrish II, MD,[1] Jody R. Piltz-Seymour, MD,[1] Mae O. Gordon, PhD,[2] Michael A. Kass, MD,[2] Ocular Hypertension Treatment Study Group

Main Outcome Measures: Incidence of optic disc hemorrhages and POAG end points.
Results: Median follow-up was 96.3 months. Stereophotography-confirmed glaucomatous optic disc hemorrhages were detected in 128 eyes of 123 participants before the POAG end point. Twenty-one cases (16%) were detected by both clinical examination and review of photographs, and 107 cases (84%) were detected only by review of photographs ($P<0.0001$). Baseline factors associated with disc hemorrhages were older age, thinner corneas, larger vertical cup-to-disc ratio, larger pattern standard deviation index on perimetry, family history of glaucoma, and smoking status. The occurrence of a disc hemorrhage increased the risk of developing POAG 6-fold in a univariate analysis ($P<0.001$; 95% confidence interval, 3.6–10.1) and 3.7-fold in a multivariate analysis

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Disc hemorrhages and Rate of Progression (Medeiros et al)

Cohort of the DIGS

Pxs followed for 8 years for VF progression (using the VFI)

20% had disc hemorrhage

Eyes with disc heme had more than double the rate of VF loss

Eyes w/ more than 1 disc heme showed an even higher rate of VF progression

Persons with disc heme in general had a more severe glaucoma

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Speaking Of Optic DisC Hemorrhages

BUDENZ ET AL, (OHTS GROUP) – AJO 2/17

13 YEAR DATA

ODH ARE AN INDEPENDENT PREDICTOR FOR POAG

ODH ARE PREDICTIVE OF PROGRESSION

PREDICTIVE FACTORS FOR ODH ARE SIMILAR TO THOSE FOR POAG (IN OHT PXS)

- Thin corneas
- Thinner rims
- Higher IOP
- Older age

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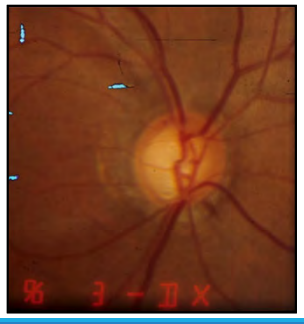

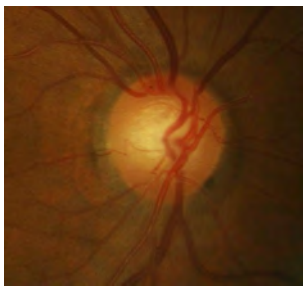

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Diagnostic Testing

Central Corneal Thickness***

Corneal Hysteresis (not routinely practiced)

Visual Field Evaluation
- Standard automated perimetry (SAP)
  - Testing strategies tailored to patient
    - 10-2 recommendation:
      - When VF defect encroaches on fixation
      - Early disease when defect is not apparent on 24-2 or 30-2
  - When defect is present on initial test, repeat testing should be performed for confirmation and establishment of good baseline
- SWAP and FDT: no longer recommended for routine glaucoma management
- Virtual reality VF testing: "Further research is needed to determine the capacity of virtual field testing to detect.. and monitor disease progression in real-world conditions"

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Diagnostic Testing

Optic Nerve Head and Circumpapillary Retinal Nerve Fiber Layer Imaging
- Optic nerve photography (stereo or non-stereo)
  - Very little value in advanced disease
- ONH/c-RNFL OCT

Macular Ganglion Cell Imaging (OCT)

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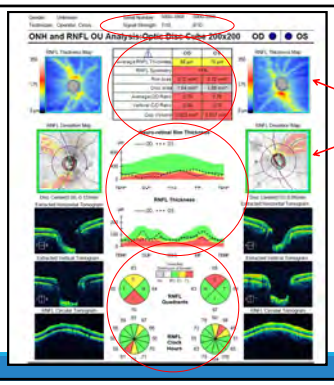

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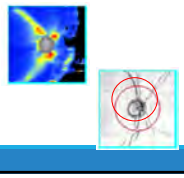
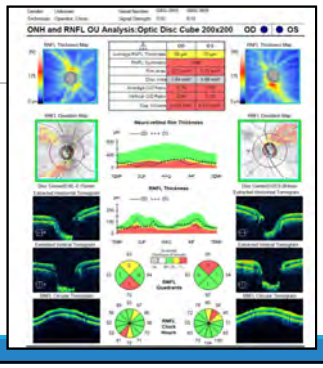
Systematic Strategy

Quality
- Signal Strength
- Circle Placement
- Movement?





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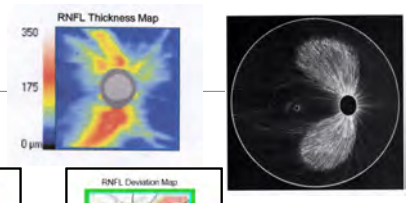
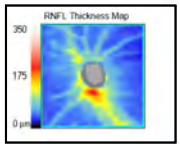
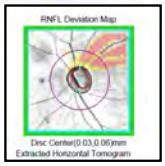
Systematic Strategy

Thickness Map

Deviation Map







IMPORTANCE OF BLOOD VESSELS!!!!

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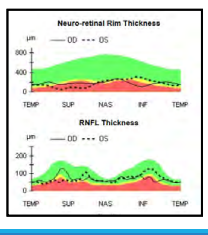
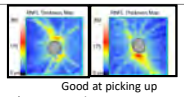
Systematic Strategy

Thickness Profiles
- Compared to normative data





Good at picking up notches in NRR

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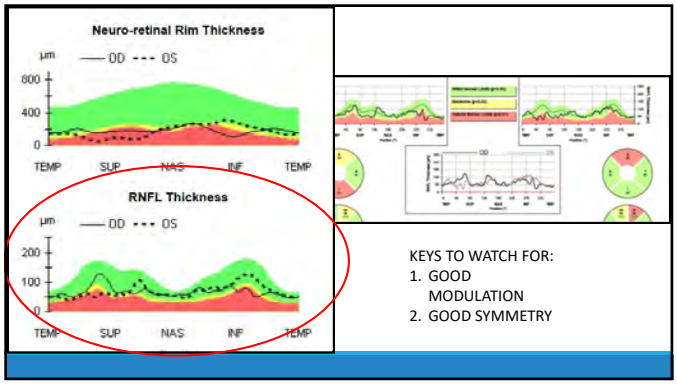

KEYS TO WATCH FOR:
1. GOOD MODULATION
2. GOOD SYMMETRY

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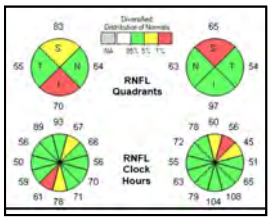
Systematic Strategy

Quadrant and Clock Hour RNFL analysis – compared to reference database



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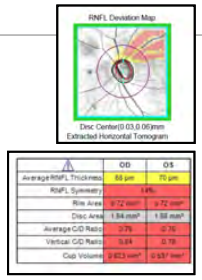
Systematic Strategy

Quantitative Parameters
- Average RNFL
  - Measures average thickness around calculation circle
  - Affected by blood vessels, astrocytes, glial cells
  - Global measure (will miss focal loss)
- RNFL Symmetry



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KEY POINTS

- Glaucoma imaging is an integral part of the glaucoma management armamentarium for glaucoma screening, diagnosis, and follow-up, that is real disease.
- Glaucoma imaging results can be easily misunderstood without a good understanding of the underlying technology limitations and result in false-positive results and diagnosis, that is red disease.
- The normative databases for the different imaging technologies have limitations in defining what is a normal versus a glaucomatous optic nerve head.

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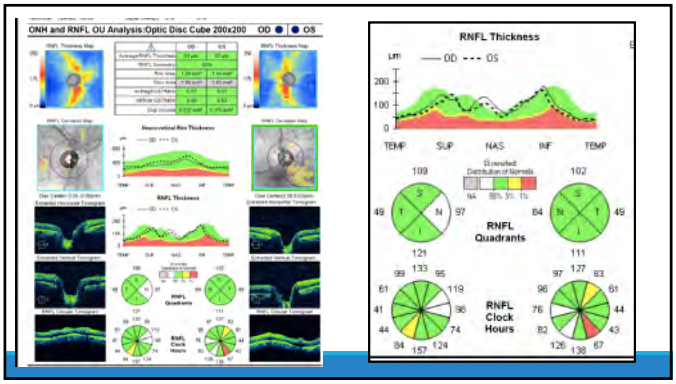

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REVIEW

Green disease in optical coherence tomography diagnosis of glaucoma

Mohamed S. Sayed[a], Michael Margolis[a,b], and Richard K. Lee[a]

Purpose of review
Optical coherence tomography (OCT) has become an integral component of modern glaucoma practice. Utilizing color codes, OCT analysis has rendered glaucoma diagnosis and follow-up simpler and faster for the busy clinician. However, green labeling of OCT parameters suggesting normal values may confer a false sense of security, potentially leading to missed diagnoses of glaucoma and/or glaucoma progression.

Recent findings
Conditions in which OCT color coding may be falsely negative (i.e., green disease) are identified. Early glaucoma in which retinal nerve fiber layer (RNFL) thickness and optic disc parameters, albeit labeled green, are asymmetric in both eyes may result in glaucoma being undetected. Progressively decreasing RNFL thickness may reveal the presence of progressive glaucoma that, because of green labeling, can be missed by the clinician. Other ocular conditions that can increase RNFL thickness can make the diagnosis of coexisting glaucoma difficult. Recently introduced progression analysis features of OCT may help detect green disease.

Summary
Recognition of green disease is of paramount importance in diagnosing and treating glaucoma. Understanding the limitations of imaging technologies coupled with evaluation of serial OCT analyses, prompt clinical examination, and structure–function correlation is important to avoid missing real glaucoma requiring treatment.

Keywords
glaucoma, green disease, optical coherence tomography

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KEY POINTS

- OCT is an integral part of modern glaucoma practice that is now considered standard of care in the diagnosis and follow-up of glaucoma patients and suspects.
- Careful evaluation of serial OCT analyses over extended follow-up periods with careful clinical examination and structure–function correlation is paramount in glaucoma practice.
- A single normal (i.e., green labeled) OCT analysis may confer false sense of security, leading to unrecognition of early-onset glaucoma or glaucoma progression.
- A number of conditions as well as limitations inherent to the imaging technology may lead to artifactual green labeling of OCT analysis in glaucoma, giving rise to 'green disease.'

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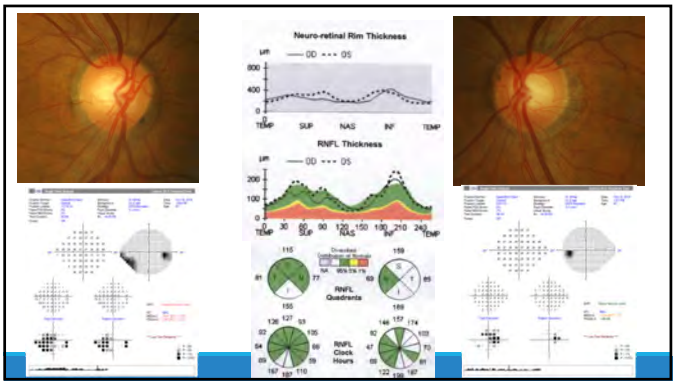

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Newest Addition to Glaucoma Diagnosis Arsenal: Macular Imaging

1998: Zeimer et al reported on macular thickness loss in patients with known glaucomatous damage

2003: Greenfield reported correlation between total macular thickness and MD on VF in glaucoma patients (time domain OCT)

2013: Hood et al – extensive investigation of segmented "RGC+" (RGC + IPL) layer and description of the "Macular Vulnerability Zone" (MVZ)

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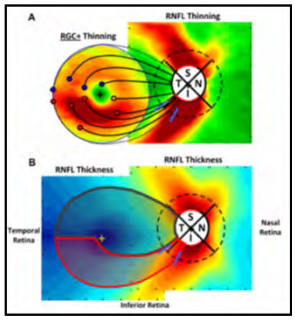

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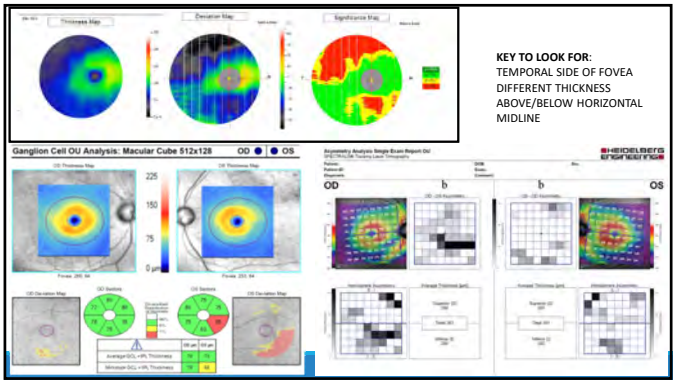

KEY TO LOOK FOR:
TEMPORAL SIDE OF FOVEA
DIFFERENT THICKNESS
ABOVE/BELOW HORIZONTAL MIDLINE

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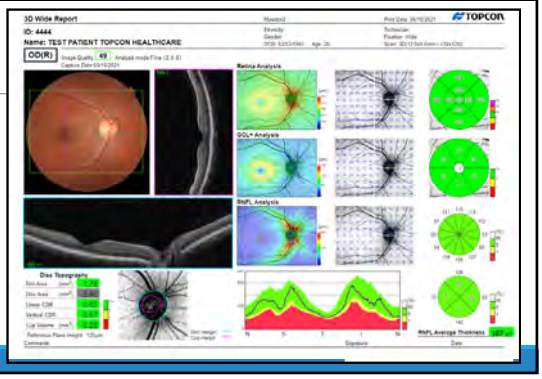
3D WIDE STANDARD REPORT

One scan blanketing the posterior pole generating RNFL, ONH, GCL and ETDRS data of nerve and macula.



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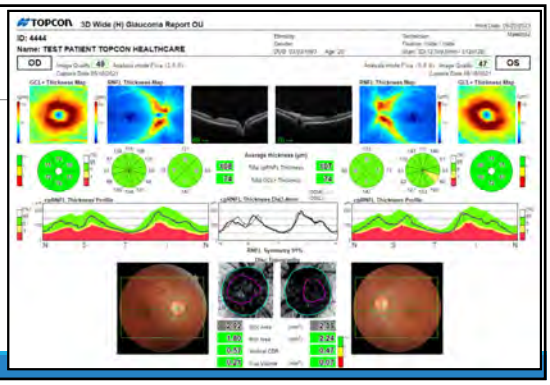
3D WIDE GLAUCOMA REPORT OU

One scan per eye presents exhaustive data for the Glaucoma suspect and known Glaucoma patients alike.



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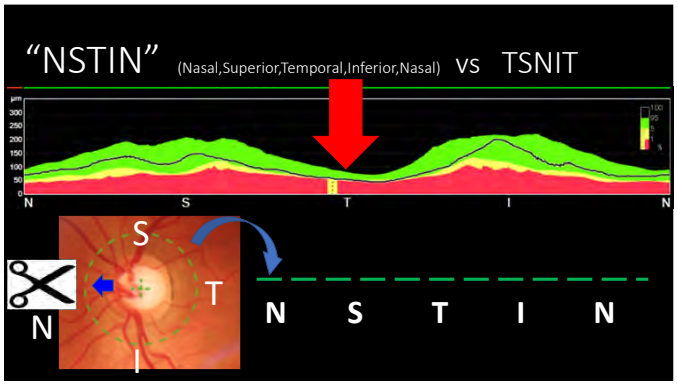
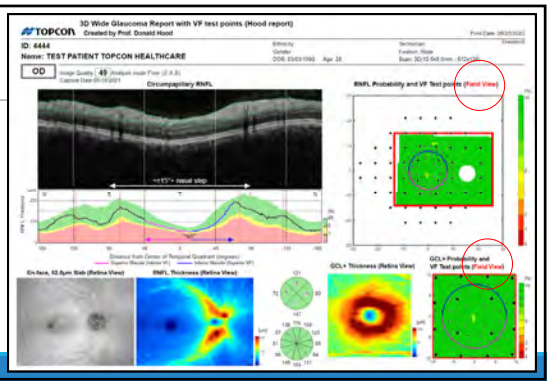


45

"HOOD REPORT FOR GLAUCOMA"

Generated from one **3D Wide Scan**

RNFL and GCL Probability Maps



46

What Are the Problems With Visual Field Testing?

- Hard tests to take
- Subjective nature can cause poor reliability
- Poor reproducibility
- Fluctuation between tests
- Takes multiple tests to establish baseline and to show progression
- Patients don't seem to like them!!

47

How To Improve VF Test Results

1. Shorten the test time
2. Change the Testing Strategy
3. Increase Spot Size
4. Improve the Testing Environment
5. Increase Frequency of Testing

48

SITA Faster

- 2/3 of the test time of SITA Fast
- ½ the test time of SITA Standard
- The test time reductions are greatest in eyes with more severe VF loss
- The average 24-2 test time w/ SITA Faster is ~2 minutes

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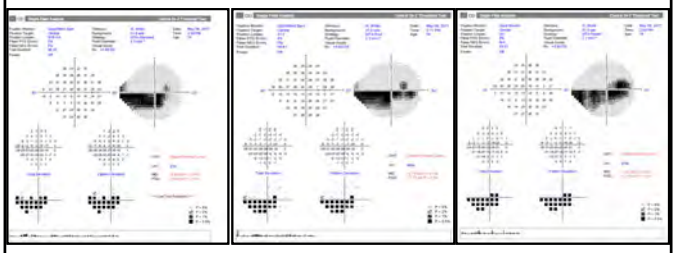


Time 6:30 | Time 4:41 | Time 3:21

50

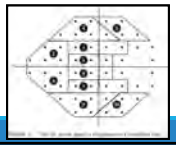
SITA Faster vs SITA Fast

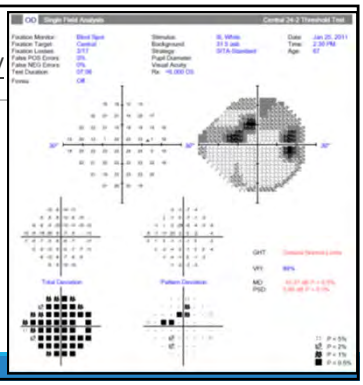
- SITA Faster produces similar results to SITA Fast
- No loss of reproducibility
- Improved reliability
- SITA Faster results integrate into the existing Guided Progression Analysis (GPA) of that individual patient

51

Quick and Easy Strategy

1. Reliability
2. Grayscale
3. Deviation Plots***
4. Global Indices – statistical significance?
5. Glaucoma Hemifield Test (GHT)

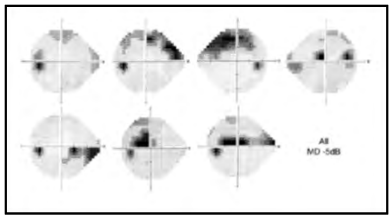




52

What are we looking for?

- Asymmetry superior-inferior
- Respect horizontal midline
- "point" back to blind spot
- Common defects: nasal, arcuate bundle, paracentral



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To Improve Visual Field Analysis Remember The "5 Rs"

- Right Test Strategy
- Reliability
- Repeatability
- Reproducibility
- Right Software

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What about the 10-2 VF in *early* glaucoma?

- Central 8 degrees from the center of the foveal contains more than 30% of retinal ganglion cells
- 24-2 and 30-2 test strategies use a 6 degree test grid pattern; these points fall outside of the densest region of ganglion cells
- 10-2 test strategy uses a 2 degree test grid
- Recent research has shown that in some patients with small regions of macular gangion cell loss, 10-2 testing may be better able to detect VF loss

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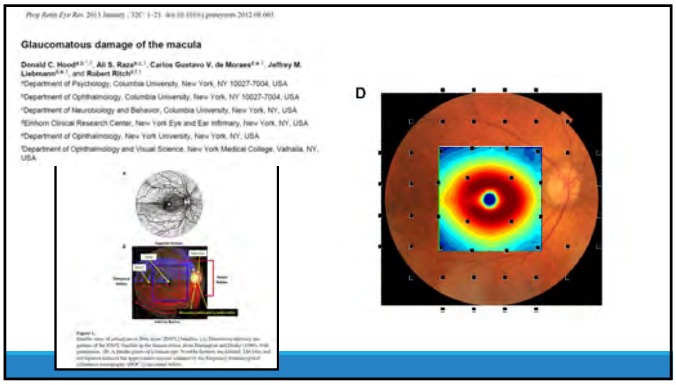

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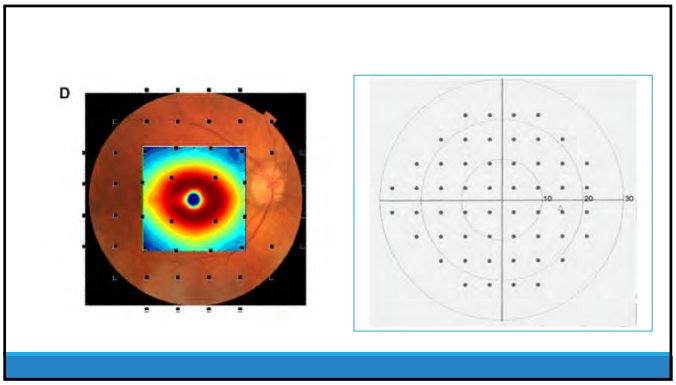

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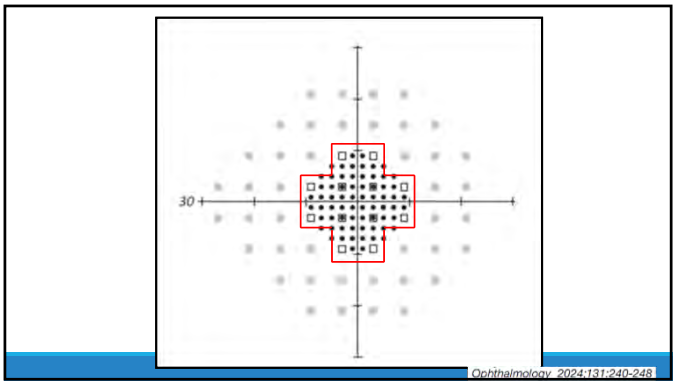

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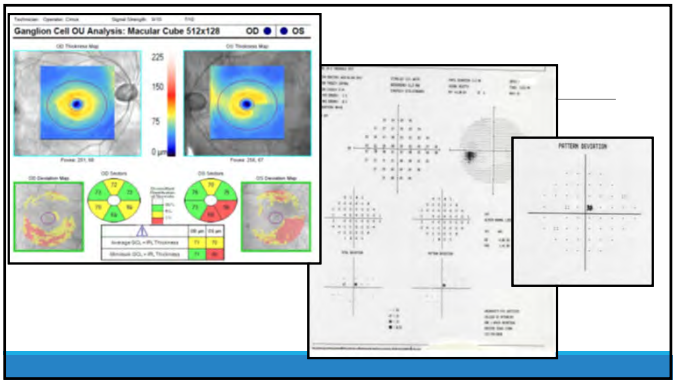

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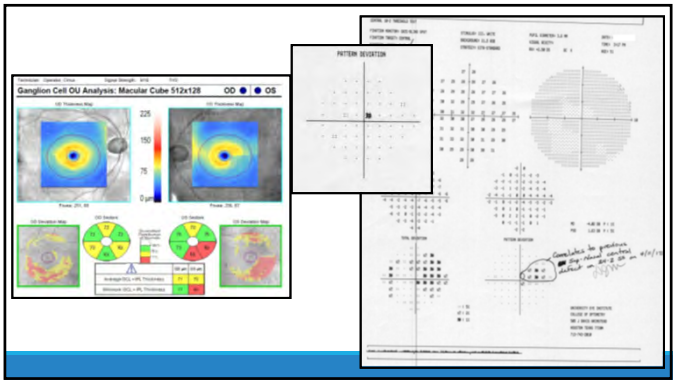


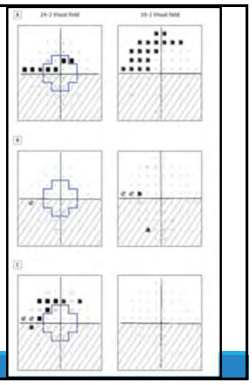
60

Original Investigation | CLINICAL SCIENCES

Prevalence and Nature of Early Glaucomatous Defects in the Central 10° of the Visual Field

Ilene Traynis, BS, Carlos G. De Moraes, MD, Ali S. Raza, BA, Jeffrey M. Liebmann, MD, Robert Ritch, MD, Donald C. Hood, PhD

JAMA Ophthalmology March 2014 Volume 132, Number 3



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Qualitative Evaluation of the 10-2 and 24-2 Visual Field Tests for Detecting Central Visual Field Abnormalities in Glaucoma

ADI ORBACH, GHEE SOON ANG, ANDREW S. CAMP, DEREK S. WELSBIE, FELIPE A. MEDEIROS, CHRISTOPHER A. GIRKIN, MASSIMO A. FAZIO, WON HYUK OH, ROBERT N. WEINREB, LINDA M. ZANGWILL*, AND ZHICHAO WU*

Am J Ophthalmol 2021;229: 26–33

Purpose:To determine whether glaucomatous central visual field abnormalities can be more effectively detected using a qualitative, expert evaluation of the 10-2 test compared with the topographically corresponding central 12 locations of the 24-2 test

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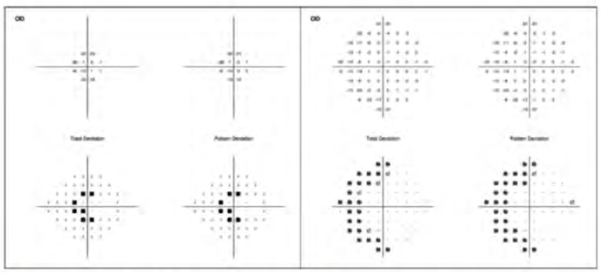

FIGURE 1. Example of the 24-2 (Left) and 10-2 visual field reports (Right) used in this study, with the results of only the central 12 locations shown for the 24-2 visual field test to ensure that only the topographically matched locations to the 10-2 test are shown. OD = right eye.

63

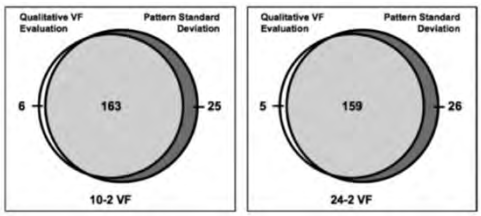

FIGURE 2. Proportional Venn diagram illustrating the level of agreement between the number of cases (eyes with, suspected of, or at risk of having glaucoma) that were detected at 95% specificity based on a qualitative evaluation by grader 1 of the 10-2 (Left) and central 12 locations of the 24-2 visual fields (VF; Right) or their pattern standard deviation values.

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What does this mean?

"These findings should still not be taken to imply that 10-2 visual field testing is not useful in the early detection of glaucomatous central visual field abnormalities."

Consider:

- Potential impact on already limited healthcare resources if additional testing is routinely performed
- Potential delay in time taken to recognize visual field progression in non-central regions if 10-2 are performed in lieu of 24-2 testing strategy.

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Value of 10-2 Visual Field Testing in Glaucoma Patients with Early 24-2 Visual Field Loss

Michael E. West, MASc, Glen P. Sharpe, MSc, Donna M. Hutchison, BSc, Paul E. Rafuse, MD, PhD, Lynne M. Shuba, MD, PhD, Marcelo T. Nicolela, MD, Jayme R. Vianna, MD, Balwantray C. Chauhan, PhD

Ophthalmology 2021;128:545-553

10-2 and central 12 test locations of 24-2 compared (total deviation and pattern deviation) for 97 glaucoma patients and 65 controls

Results: No significant difference between 24-2 and 10-2 test

- Sensitivity of 24-2 was significantly higher

Conclusion: Little evidence that adding the 10-2 test revealed additional undetected defects

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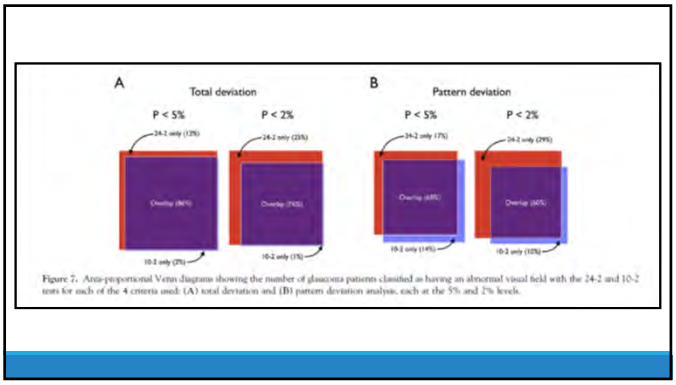

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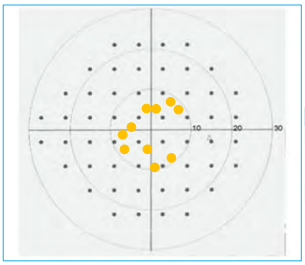
SITA Faster 24-2C Pattern on HFA3



The 24-2C test pattern combines all 24-2 points + ten selected 10-2 points (shown in OD orientation)

Large Gray	24-2 pattern
Large Orange	Ten additional 24-2C points
Small Gray	10-2 pattern

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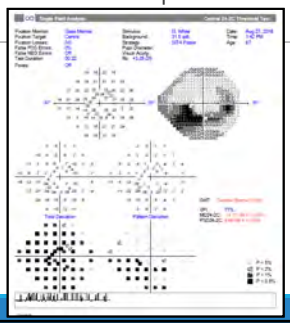
24-2C: The newest pattern on the HFA



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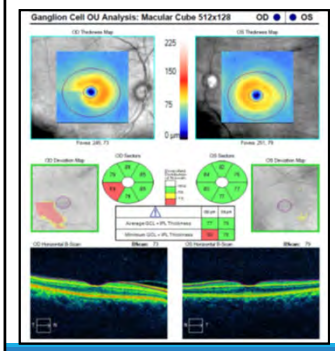

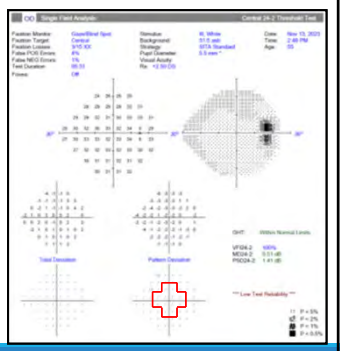

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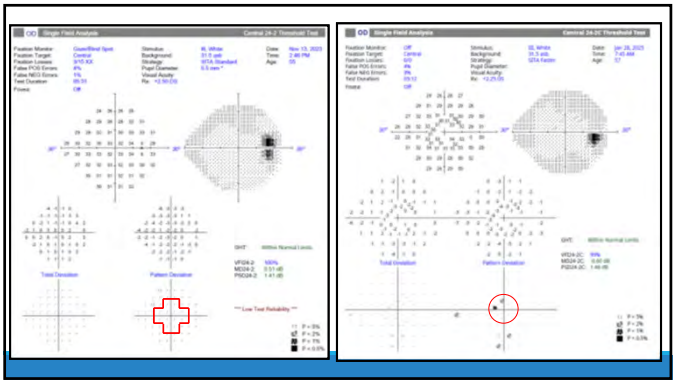

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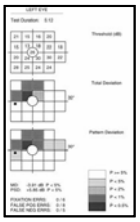
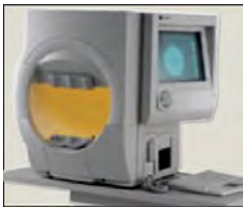
What's OUT in perimetry?

Frequency Doubling Technology (FDT)



Short Wavelength Automated Perimetry (SWAP)



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Newest Addition to Perimetry Landscape?

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Headset Perimetry ("Virtual Reality")

Pros:
- Cost-effective
- Portable
- Patient comfort
- Space-saving
- Potentially time-saving
  - More frequent testing is feasible

Cons:
- Lack of validation studies
- Concordance of summary statistics doesn't mean concordance at individual test locations
- Brightness of headset can't achieve what bowl perimetry does
  - Suspect/early glaucoma
  - Moderate to advanced glaucoma
- Changing background luminance – is this a work-around?

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OPEN

Comparison of Visual Field Test Measurements With a Novel Approach on a Wearable Headset to Standard Automated Perimetry

Catherine Johnson, B.A. Ahmed Sayed, PhD,†‡§ John McSoley, OD,* Mary Durbin, PhD,§ Rashed Kashem, BS,*§ Alexandra Nicklin, OD,§ Valeria Lopez, BS,§ Georgeanne Mijares, BS,* Michael Chen, OD,§ Abdalla Shaheen, MD,* Steven Segarra, BS,*¶ Nadine Rady, MD,* Christian Andres Duque, B.A.*§ Collins Opoku-Baah, PhD,§ and Mohamed Abou Shousha, MD, PhD*§*

Précis: This study of inter-test comparability of a novel visual field application installed on an augmented-reality portable headset and Humphrey field analyzer Swedish interactive thresholding algorithm (SITA) Standard visual field test demonstrates the excellent correlation of mean deviation (MD) and mean sensitivity (MS).

Purpose: To determine the correlation between visual field testing with novel software on a wearable headset versus standard automated perimetry.

Patients and Methods: Patients with and without visual field defects attributable to glaucoma had visual field testing in one eye of each patient with 2 methods: n/Imagine Strategy (Hertz, Inc.) and the Humphrey field analyzer (Carl Zeiss Meditec, Inc.) SITA Standard 24-2 program. Main outcome measures included MS and MD, which were evaluated by linear regression, intraclass correlation coefficient (ICC), and Bland Altman analysis for assessment of the mean difference and limits of agreement.

Results: Measurements from 69 eyes of 39 patients (18 normal and 21 glaucomas) were compared with both instruments. Linear regression analysis demonstrated an excellent Pearson correlation coefficient of $r = 0.94$ for MS and $r = 0.95$ for MD. ICC analysis demonstrated high levels of concordance (ICC = 0.95, $P < 0.001$ for MS and ICC = 0.94, $P < 0.001$ for MD). Bland-Altman analysis determined a small mean difference between the two devices (Hertz minus Humphrey) of 1.15 dB for MS and 1.06 dB for MD.

Conclusions: The Hertz visual field test correlated well with SITA Standard in a population of normal eyes and eyes with glaucoma.

Key Words: standard automated perimetry, visual field, glaucoma, augmented reality, virtual reality

(*J Glaucoma* 2023;32:647–657)

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tvst

Glaucoma

Repeatability of a Virtual Reality Headset Perimeter in Glaucoma and Ocular Hypertensive Patients

Rafaella Nascimento e Silva[1], Julia A. Kim[1], Yihao Li[1], Chen Chen[1], Anisa F. Chaudhry[2], Andrew R. Berneshawi[2], Miao Zhang[1], Adam Villarreal[1], Jocelyn Liu[2], Ann Shue[2], Dolly S. Chang[1,2], and Robert T. Chang[2]

[1] Genentech, Inc., South San Francisco, CA, USA
[2] Byers Eye Institute, Stanford University School of Medicine, Palo Alto, CA, USA

Purpose: The VisuALL 5 is an automated, static threshold, virtual reality–based perimeter for mobile evaluation of the visual field. We examined same-day and 3-month repeatability.

Methods: Adult participants with a diagnosis of glaucoma or ocular hypertension underwent two VisuALL 24-2 Normal T- Full threshold strategy tests at baseline and one additional exam at 3 months for each eligible eye. Spearman, intraclass correlation coefficients (ICCs), and Bland–Altman plots were used to assess the correlation of individual point sensitivities and mean deviation (MD) among three tests.

Results: Eighty-eight eyes (44 participants) were included. Average age was 68.1 ± 14.3 years, and 60.7% were male. VisuALL MD was highly correlated between tests (intravisit: $r = 0.89$, intervisit: $r = 0.82$; $P < 0.001$ for both). Bland–Altman analysis showed an average difference in intravisit MD of −0.67 dB (95% confidence interval [CI], −6.04 to 4.71 dB) and −0.15 dB (95% CI, −8.04 to 7.73 dB) for intervisit exams. Eight-five percent of pointwise intravisit ICCs were above 0.75 (range, 0.63 to 0.93), and 65% of pointwise intervisit ICCs were above 0.75 (range, 0.55 to 0.91).

Conclusions: VisuALL demonstrated high correlation of MD between tests and good repeatability for individual point sensitivities among three tests in 3 months, except at the points around the blind spot and superiorly.

Translational Relevance: The preliminary reproducibility results for VisuALL are encouraging. Its portable design makes it a potentially useful tool for patients with glaucoma, enabling more frequent assessments both at home and in clinical settings.

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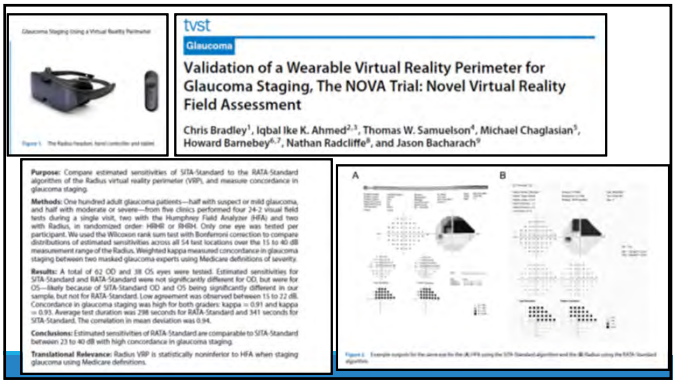

tvst

Glaucoma

Validation of a Wearable Virtual Reality Perimeter for Glaucoma Staging, The NOVA Trial: Novel Virtual Reality Field Assessment

Chris Bradley[1], Iqbal Ike K. Ahmed[2,3], Thomas W. Samuelson[4], Michael Chaglasian[5], Howard Barnebey[6,7], Nathan Radcliffe[8], and Jason Bacharach[9]

Purpose: Compare estimated sensitivities of SITA-Standard to the RATA-Standard algorithm of the Radius virtual reality perimeter (VRP), and measure concordance in glaucoma staging.

Methods: One hundred adult glaucoma patients—half with suspect or mild glaucoma, and half with moderate or severe—from five clinics performed four 24-2 visual field tests during a single visit, two with the Humphrey Field Analyzer (HFA) and two with Radius, in randomized order. HFA® or RHR®. Only one eye was tested per participant. We used the Wilcoxon rank sum test with Bonferroni correction to compare distributions of estimated sensitivities across all 54 test locations over the 15 to 40 dB measurement range of the Radius. Weighted kappa measured concordance in glaucoma staging between two masked glaucoma experts using Medicare definitions of severity.

Results: A total of 62 OD and 38 OS eyes were tested. Estimated sensitivities for SITA-Standard and RATA-Standard were not significantly different for OD, but were for OS—likely because of SITA-Standard OD and OS being significantly different in our sample, but not for RATA-Standard. Low agreement was observed between 15 to 22 dB. Concordance in glaucoma staging was high for both graders: kappa = 0.91 and kappa = 0.93. Average test duration was 298 seconds for RATA-Standard and 341 seconds for SITA-Standard. The correlation in mean deviation was 0.94.

Conclusions: Estimated sensitivities of RATA-Standard are comparable to SITA-Standard between 23 to 40 dB with high concordance in glaucoma staging.

Translational Relevance: Radius VRP is statistically noninferior to HFA when staging glaucoma using Medicare definitions.

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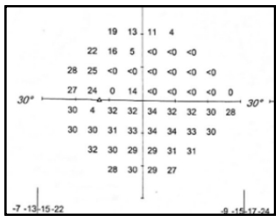
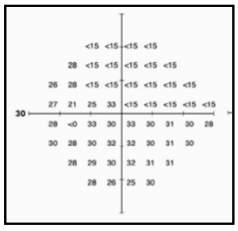


HFA



"Radius XR"

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Headset Perimetry - Summary

Positive addition to perimetry space

Need for future advances in technology and continued comparative studies

Likely good for suspect/early glaucoma

Unable to reach threshold in lower sensitivity points

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Management (AAO PPP)

Goals of POAG management:

- Control IOP in the **target range**
  - Stable ON/c-RNFL status
  - Stable VF

Target IOP: "The IOP range at which VF loss is unlikely to substantially reduce a patient's health-related quality of life over his/her lifetime"

- Factors to consider:
  - Stage of glaucoma damage
  - Baseline IOP at which damage occurred
  - Age of patient
  - Additional considerations (CCT, life expectancy, prior rate of progression)
- Lower IOP by at least 25%

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Precepts for Glaucoma Decision-Making (CDIG)

1. The higher the IOP, the greater the risk of acquiring glaucoma damage and the faster the rate of progression
2. Elevated IOP is not the only risk factor, but it's the only thing we can treat.
3. Lowering IOP helps, but we can't tell how low is ok prospectively
4. All methods of lowering IOP have costs, risks, and side effects
5. GOAL OF TREATMENT is to preserve good vision for life as inoffensively as possible

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Steps to Glaucoma Management (CDIG)

1. Treat the treatable cause of elevated IOP, if possible
2. Establish baseline
3. If treatment is needed, set a target
4. Treat to achieve target (re-evaluate if difficult)
5. Follow IOP and follow for progression
6. Modify treatment and target based on the clinical course of the dz

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Establish a Baseline – maybe over months

Multiple IOP readings, preferably at different times of day

- "Patients benefit more from multiple IOP readings than they do from 2 extra weeks of drug therapy" (Hodapp)

Gonioscopy

Pachymetry

Visual fields x2 (or x3 if first two are very different)

RNFL and macular OCT

ONH photography

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"The Baseline and Target IOP Approach"

Quigley, 21st Century Glaucoma Care Eye 2019

- Avoid beginning treatment on first visit; suggests at least 3 visits
  - **"Do we really want to base decades of therapy on one IOP reading?"**
- The acceptable amount of IOP lowering needs to be set as a medium term goal (couple of years)
- Suggests 20% reduction for OHT and for early POAG eyes
- CIGTS showed that we can tailor the target to the degree of glaucoma, extending to 40% reduction for patients with severe loss at baseline


REVIEW ARTICLE

21st century glaucoma care

Harry A. Quigley

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Target IOP: What? How?

- Target IOP is IOP at which you *expect* to maintain functional vision or limit progression
- Target IOP should strike a balance between over- and under-treatment
- Target IOP is "arbitrary and imperfect" (Hodapp)
- Target IOP should balance benefit of preserving vision with risk of treatment
- Target IOP is not set in stone

Set target according to age, severity of disease, and other factors
- "AGE AND STAGE"

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Initial Target IOP

No universal accepted formula

% reduction from baseline

Fixed range of IOP based on stage

Formula based on age, visual field loss, baseline IOP

Consider:
- Risk tolerance
- Life expectancy
- Family history

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Initial Target IOP Considerations

More advanced disease = lower target IOP to protect remaining nerve

OHT: 20% reduction (OHTS)

Early disease: 25% reduction / <21mmHg (EMGT, CIGTS)

Moderate disease: 30-35% reduction / <18 (CIGTS, AGIS)

Severe disease: low teens (AGIS)

Singh. Setting Target Pressures. Glaucoma Today 2015

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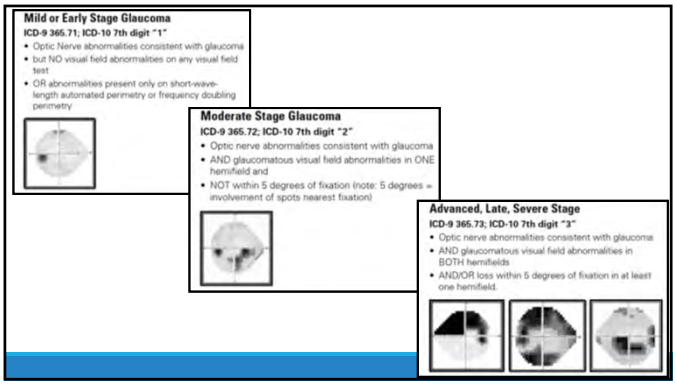

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Risk Factors for Progression (AAO PPP)

Increased IOP, larger diurnal fluctuation

Older age*

Disc hemorrhage

Thinner CCT

Lower corneal hysteresis

Lower ocular perfusion pressure

Poor adherence to medication regimen

Progression in fellow eye

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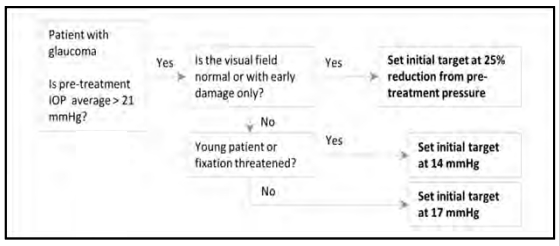

Clinical Decisions In Glaucoma

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Other Considerations

Family History of blindness from glaucoma

Monocular status

Poor visual field test taker

Other optic nerve or retinal disease

Life expectancy/systemic disease history

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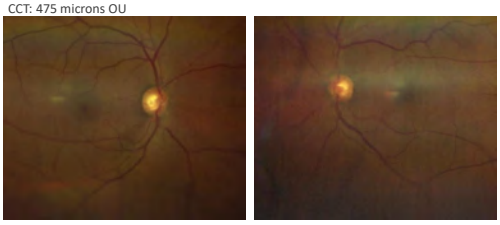
Case Example: CW, 56yo AAF

Tmax: 23mmHg OU

CCT: 475 microns OU



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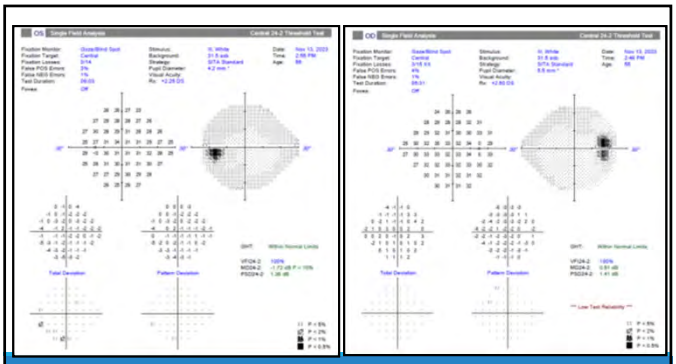

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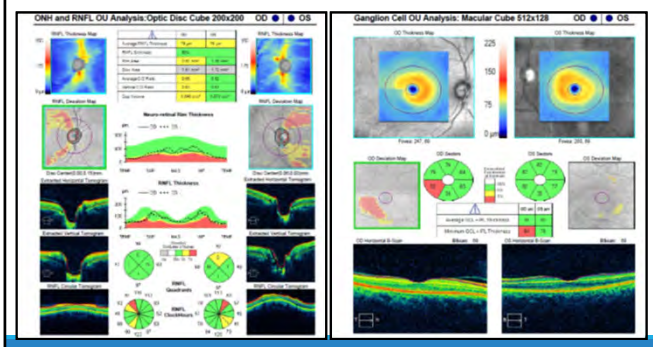

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CW, 56yo AAF: Initial Target IOP

Tmax: 23mmHg

CCT: 475 microns

No VF loss (mild according to ICD-10)*

Reasonable starting point 20-30% reduction (AAO)

- 25% reduction from peak = 17

Are there any particular concerns?

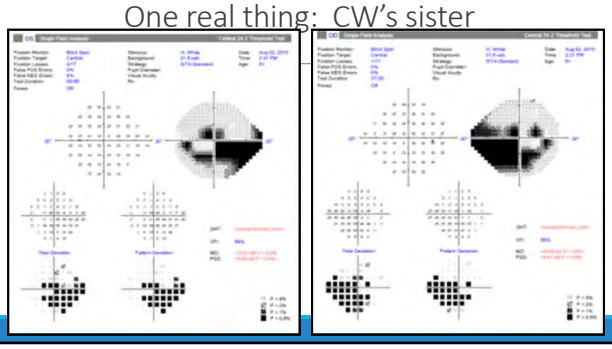
95

Let's Play "Change One Thing"

1. Change to *blind in one eye* from glaucoma
2. Change to *blind in one eye* from unrelated condition
3. Change age to 82yo
4. Change medical history to stage 4 lung cancer

96

One real thing: CW's sister



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CHOICE OF INITIAL THERAPY

Choice of Therapy

The IOP can be lowered by medical treatment, laser therapy, or incisional surgery (alone or in combination). Thorough discussion about the relative risks and benefits of a given treatment should be conducted with the patient prior to its initiation. The patient and ophthalmologist together decide on a practical and feasible regimen to follow in terms of dosing, cost, and adherence in the context of the patient's age, preferences, and degree of optic nerve damage.[259] Systemic comorbidities that deserve consideration when choosing medical therapy for glaucoma include asthma/chronic obstructive pulmonary disease, cardiac arrhythmia, and depression. Patients who are pregnant or nursing also deserve special consideration.

Medical treatment

Medical therapy is presently the most common initial intervention to lower IOP (see Table 4 for an overview of options available). Prostaglandin analogs are the most frequently prescribed eye drops for lowering IOP in patients with glaucoma because they are most

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CHOICE OF INITIAL THERAPY

Choice of Therapy

The IOP can be lowered by laser surgery, medical treatment, or incisional surgery (alone or in combination). Thorough discussion about the relative risks and benefits of a given treatment should be conducted with the patient prior to its initiation. The patient and ophthalmologist together decide on a practical and feasible regimen to follow in terms of dosing, cost, and adherence in the context of the patient's age, preferences, and degree of optic nerve damage.[304] Systemic comorbidities that deserve consideration when choosing medical therapy for glaucoma include asthma/chronic obstructive pulmonary disease, cardiac arrhythmia, and depression. Patients who are pregnant or nursing also deserve special consideration.

Laser trabeculoplasty surgery

Laser trabeculoplasty surgery may be used as initial or adjunctive therapy in patients with POAG.[360, 385-388] Laser trabeculoplasty surgery lowers IOP by improving aqueous outflow and can be performed using argon or solid-state lasers.[389, 390] Laser trabeculoplasty surgery

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IS THERE A *BEST* INITIAL TREAMENT FOR GLAUCOMA?

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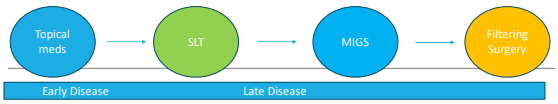

American Optometric Association EBCPG: No specific recommendation for first line therapy (medical treatment, laser, surgery)

American Academy of Ophthalmology Preferred Practice Patterns: No specific recommendation for first line therapy

National Institute for Health and Care Excellence (NICE): Recommends SLT first (over medication) for initial therapy in at-risk OHT and OAG patients except for advanced stage and for pigment dispersion patients

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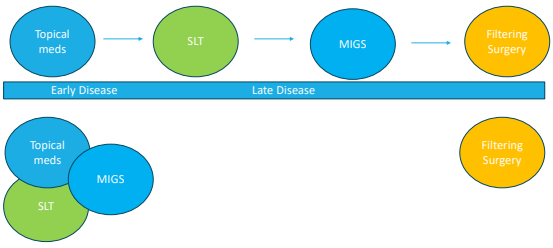

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Why the Shift?

Increased acceptance of minimally invasive procedures

More compelling evidence on success of SLT

May enable:

- More continuous 24-hour IOP control
- Delayed progression of visual field loss
- Reduced need for more invasive surgical procedures
- Avoidance of limitations of topical medications

Katz et al. Clinical Ophthalmology 2024:18 3365–3374

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Interventional Glaucoma Consensus Paper

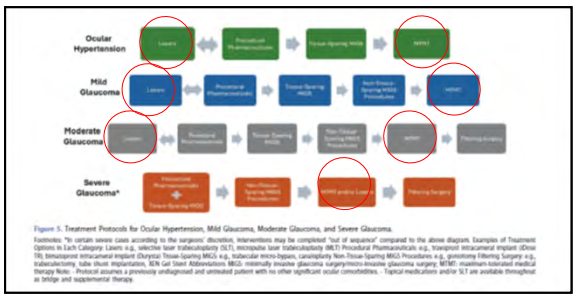

Figure 5. Treatment Protocols for Ocular Hypertension, Mild Glaucoma, Moderate Glaucoma, and Severe Glaucoma.

Footnotes: "In certain severe cases according to the surgeons' discretion, interventions may be completed 'out of sequence' compared to the above diagram. Examples of Treatment Options in Each Category: Lasers e.g. selective laser trabeculoplasty (SLT), micropulse laser trabeculoplasty (MLT) Procedural Pharmaceuticals e.g. travoprost intracameral implant (iDose TR), bimatoprost intracameral implant (Durysta) Tissue-Sparing MIGS: e.g., trabecular micro-bypass, canaloplasty Non-Tissue-Sparing MIGS Procedures e.g., goniotomy Filtering Surgery: e.g., trabeculectomy, tube shunt implantation, XEN Gel Stent Ribbondotomy MIGS: minimally invasive glaucoma surgery/micro-invasive glaucoma surgery MTMT: maximum-tolerated medical therapy Note: - Protocol assumes a previously undiagnosed and untreated patient with no other significant ocular comorbidities. - Topical medications and/or SLT are available throughout as bridge and supplemental therapy.

Funke et al. Expert Review of Ophthalmology 20(2):79-87

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Topical Medications: Pros and Cons

PROS	CONS
Non-invasive	Higher degree of IOP fluctuations
Effective in lowering IOP	Local and systemic side effects
Wide range of options/multiple classes	Preservative toxicity
Access	Patient adherence is critical
Well-studied	Cost

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Medical Therapy: Preservatives

Long term use BAK can cause ocular surface disease and increasing evidence that long term use can jeopardize success of conjunctival based surgery [1,2, 3]

Improving tolerability may improve adherence; ameliorating ocular surface disease in glaucoma patients can improve clinical outcome

Mitigation: may consider fixed-dose combination medications and/or preservative-free drops

1. Thygeson J. Clinical Ophthalmology 2018:12,707–717
2. Baudouin et al. Prog Retin Eye Res 2010;29(4):312-334
3. Baudouin C. Curr Opin Ophthalmol 1996;7(2):80-86

106

Medical Therapy: Adherence

To be effective, high level of adherence to topical therapy is needed

Glaucoma Adherence and Persistency Study[1]:

- Nearly ½ of patients who filled a prescription had discontinued all topical therapy within 6 months
- Only 37% had a recent refill of their initial medication at 3 years after diagnosis

Lower adherence leads to higher IOP, greater fluctuation IOP, and worsening VF defects[2]

Adding more glaucoma medications is linked to worse adherence with original medications[3, 4]

Mitigation:

- Limited evidence on what works to improve adherence
- Patterns of adherence in first year is similar to that of year 3 or 4[5]

1. Friedman et al. Invest Ophthalmol Vis Sci 2007;48(11):5052-7
2. Rossi et al. Eur J Ophthalmol 2011; 21(4): 410-414
3. Robbin A, Covert D. Ophthalmology 2005;112:863–868
4. Bedrood et al. Clin Ophthalmol 2023;17:3899-3913
5. Newman-Casey et al. Ophthalmology 2015;122(10):2010-21

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Anything New in Medications?

Latanoprostene Bunod:

- Nitric oxide-releasing prostaglandin analog
  - Well tolerated
  - Additional mechanism of action from nitric oxide (relax TM & increase conventional outflow)
  - "Real World Studies" show significant portion of patients have improved IOP control
  - No additional side effects

Netarsudil:

- Rho-kinase inhibitor
- Once daily dosing
- Mechanisms of action:
  - Increase conventional (trabecular) outflow
  - Decreased episcleral venous pressure
- Side Effects
  - Conjunctival hyperemia
  - Conjunctival hemorrhage
  - Corneal verticillata

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Anything New in Medications?

Iyuzeh (latanoprost 0.005%) Thea
- Preservative-free latanoprost
- Well tolerated
- Market leader in Europe

Omlonti (omidenepag isopropyl, Santen)

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A Brand New Molecule to Discuss!!!

Omlonti – omidenepag isopropyl

MOA - EP2 Receptor

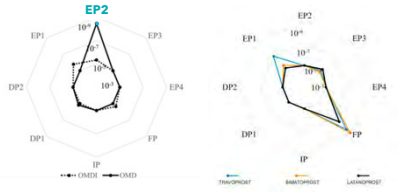
Ocuvex/ Santen

Approved for lowering IOP in Glaucoma and OHTN

1 drop QD

110

Receptor Affinity



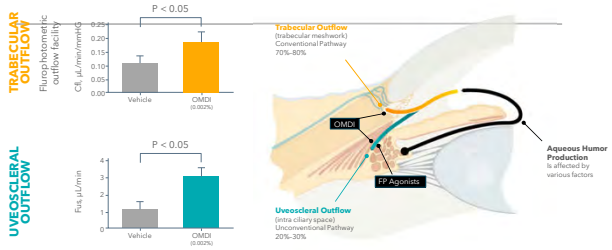
Activity[3]

EC_{50}, nM	EP1	EP2	FP
OMDI	>10,000	>10,000	>10,000
OMD (FREE ACID)	-	8.3	-

1. Kinhara T, Taniguchi T, Yamamura K, Iwamura R, Yoneda K, Odani-Kawabata N, Shimazaki-A, Matsuo T, Shams N, Zhang LZ. Pharmacological Characterization of Omidenepag Isopropyl, a Novel Selective EP2 Receptor Agonist, as an Ocular Hypotensive Agent. Invest Ophthalmol Vis Sci. 2018 Jan 1;59(1):145-153.
2. Matsuo M, Matsuoka Y, Tanito M. Efficacy and Patient Tolerability of Omidenepag Isopropyl in the Treatment of Glaucoma and Ocular Hypertension. Clin Ophthalmol. 2022 Apr 26;16:1267-1279.
3. Kinhara T, Taniguchi T, Yamamura K, Iwamura R, Yoneda K, Odani-Kawabata N, Shimazaki-A, Matsuo T, Shams N, Zhang LZ. Pharmacological Characterization of Omidenepag Isopropyl, a Novel Selective EP2 Receptor Agonist, as an Ocular Hypotensive Agent. Invest Ophthalmol Vis Sci. 2018 Jan 1;59(1):145-153.
4. Stjernschantz J, Resul B. Unoprostone isopropyl ester to latanoprost: a review of the development of unoprostone, the Proctor Lecture. Invest Ophthalmol Vis Sci. 2001 May;42(6):1134-45. PMID: 11328719.

111

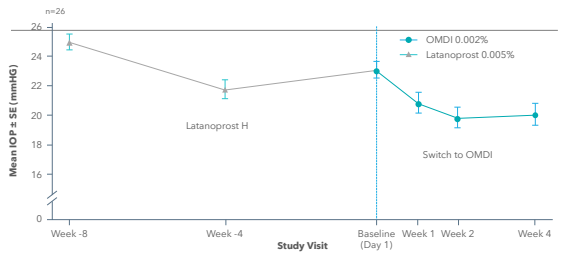
OMDI Affects Both Outflows



1. Matsuo M, Matsuoka Y, Tanito M. Efficacy and Patient Tolerability of Omidenepag Isopropyl in the Treatment of Glaucoma and Ocular Hypertension. Clin Ophthalmol

112

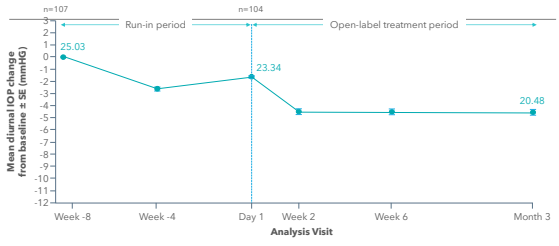
In Latanoprost Non-Responders



1. Aihara M, Ropo A, Lu F, Kawata H, Iwata A, Odani-Kawabata N, Shams N. Intraocular pressure-lowering effect of omidenepag isopropyl in latanoprost non-flow

113

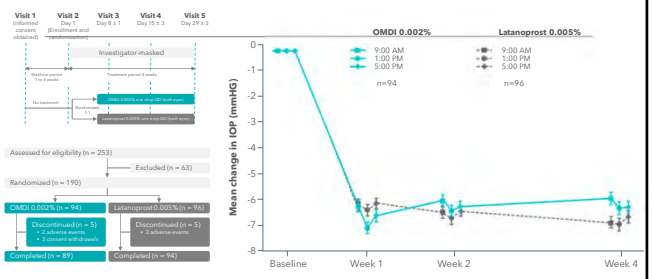
Repeatable Results



1. Panarelli JF, Bowden EC, Tepedino ME, Odani-Kawabata N, Pei Z, McLaurin EB, Ropo A. Omidenepag Isopropyl in Latanoprost Low/Nonresponders With Primary

114

Non-Inferiority — Latanoprost



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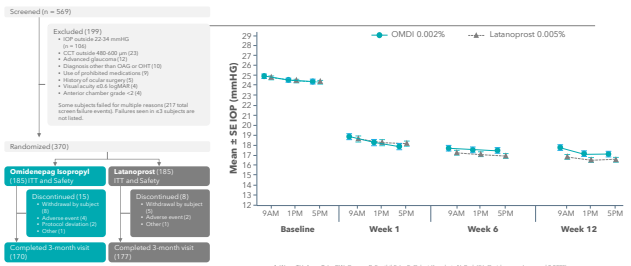
Non-Inferiority – 12 Weeks



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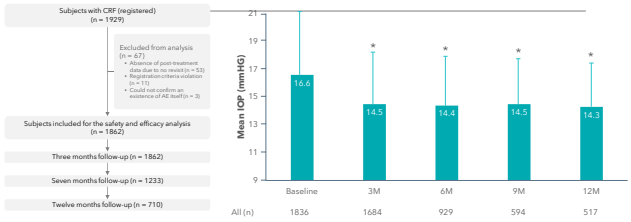
Long-Term Benefit



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EP2 Agonist PAP | Side-effect profile

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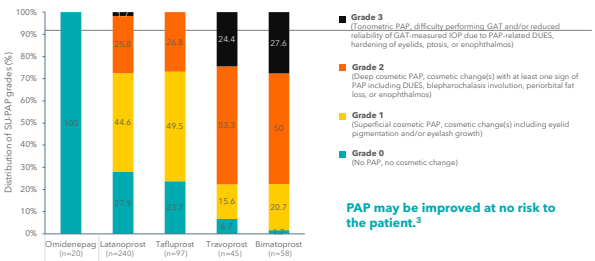
Prostaglandin-Associated Periorbitopathy



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A Predictable, Well-Tolerated Safety Profile

Appearance-altering AEs:
2.0% for OMLONTI (n = 4/204)[1]

Hyperemia:
Most hyperemia events were mild in the trials.

Only 2% discontinuation from Pivotal Phase 3 (n = 4/185)

Most common AEs
Pooled across all clinical trials.

Adverse Event	Rate % (n = 600)
Conjunctival hyperemia	9%
Photophobia	5%
Blurred vision	4%
Dry eye	3%
Instillation site pain	3%
Eye pain	2%
Ocular hyperemia	2%
Punctate keratitis	2%
Headache	2%
Eye irritation	1%
Visual impairment	1%

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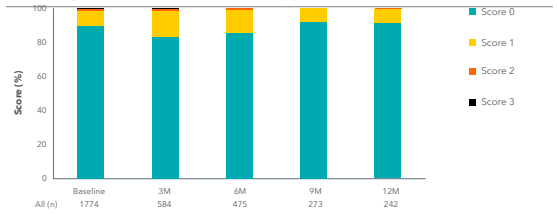
Slide 119

JK1 Please also Include percentages as in the original figure

Please also include the n=values)

Jan Kowalczewski, 2024-12-03T23:21:53.875

Percentage of Patients for Each Hyperemia Score



1. Nakazawa T, Takahashi K, Kuwayama Y, Nomura A, Shimada F. Interim Results of Post-Marketing Observational Study of Omidenepag Isopropyl for Glaucoma and

121

SLT – LiGHT Trial (Introduction)

Multicenter RCT comparing initial treatment with SLT with initial treatment with IOP-lowering eye drops for treatment-naïve patients with OHT or OAG

- Assess health-related quality of life (HRQoL)
- Assess cost-effectiveness
- Assess clinical efficacy

3-year results:

- SLT more cost-effective
- No difference in HRQoL between two initial treatments
- 74.2% SLT-first patients at target *without* drop therapy

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SLT – LiGHT Trial **6 year results**

692 patients completed 3 years of LiGHT; 633 entered the 3-year extension (313 SLT and 320 drops); 524 completed the extension

HRQoL:

- No significant difference in HRQoL found between two groups on EQ-5D, GUI, and GQL-15 scores
- Glaucoma Symptom Scale measures favored SLT group

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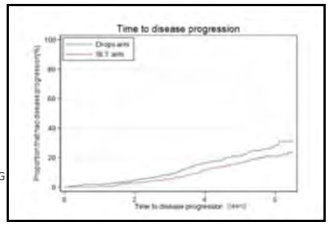
SLT – LiGHT Trial 6 year results

Efficacy & Safety:

- At target IOP:
  - SLT first: 94.2%
  - Meds first: 94.7%
- Drop-free control without incisional surgery:
  - SLT first: 69.8%
  - Meds first: 18%
- Need for trabeculectomy*:
  - SLT first: 2.4% (13 eyes; none in the first 3 years)
  - Meds first: 5.8% (32 eyes; 11 eyes in first 3 years)
- IOP*:
  - SLT first: 16.3mmHg
  - Meds first: 15.4mmHg
- Progression from OHT to OAG –or- deterioration of OAG
  - SLT first: 19.6%
  - Meds first: 26.8%
- Excellent safety profile



Gazzard et al. Ophthalmology 2023;130:139-151

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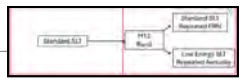
The Future of SLT



COAST Trial[1]

- Efficacy and repeatability of SLT has been established
- May be upper limit to number of times SLT can be repeated at standard energy
- COAST trial will compare standard energy SLT with repeat as needed vs standard energy SLT with annual low-energy SLT repeat

Direct SLT (DSLT)[2]

- Delivers 360° energy to TM at once
- Technically easier than traditional SLT

1. Realini et al. *J Glaucoma* 2021;30(7):545-551
2. Congdon et al. *Br J Ophthalmol*. 2023;107(1):62-65

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Glaucoma treatment is always individualized

Age/life expectancy

Stage

- How low and how quickly do we need to lower IOP

Ocular surface disease

Lens status

Physical and cognitive limitations

Insurance limitations

Patient preference?

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Patient Preferences?

Questionnaire-based assessment University of Colorado

126 patients on drop therapy for glaucoma surveyed about attitudes related to proposed other treatments

- 55% preferred to continue drop therapy over
  - Primary reason to avoid risks and discomfort of more invasive treatments
- 45% more accepting of more invasive treatments to decrease burden and side effects of drops
- Topical meds vs refillable reservoir or punctal plug: 50% preferred drops
- Topical meds vs incisional surgery or repeated injection: 80.5% preferred drops
- Comparing responses from patients on monotherapy vs multi-drop therapy: no difference in responses

SooHoo J et al. Ophthalmology 2016;123(7): 1621

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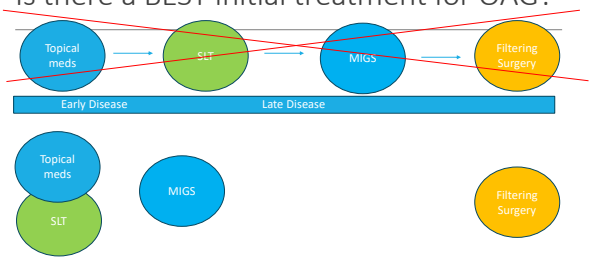
Is there a BEST initial treatment for OAG?



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ANGLE CLOSURE SPECTRUM

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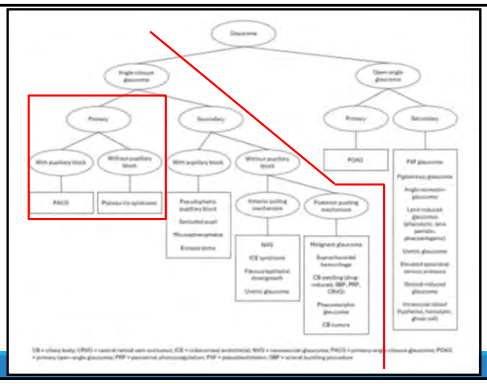

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CLASSIFICATION (AAO PPP)

TABLE 1 Clinical Findings That Define Primary Angle-Closure Disease

	Primary Angle-Closure Suspect	Primary Angle Closure	Primary Angle-Closure Glaucoma
≥180 degrees ITC	Present	Present	Present
Elevated IOP and/or PAS	Absent	Present	Present
Glaucomatous optic neuropathy	Absent	Absent	Present

IOP = intraocular pressure; ITC = iridotrabecular contact; PAS = peripheral anterior synechiae.

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CLINICAL OBJECTIVES (AAO PPP)

Identify patients who currently have – or are at risk for – PACG or AACC

Successfully manage AACC

Prevent or alleviate angle closure by using LPI and LPIridoplasty when indicated

Confirm by repeat gonioscopy that the angle is open after intervention; if not, consider lens extraction or incisional glaucoma surgery when laser and medical therapy do not sufficiently lower IOP

Identify and manage patients with chronic IOP elevation that persists after LPI or LPIridoplasty

In AACC, promptly perform LPI in a phakic *fellow* eye due to high risk of developing AACC without prophylactic treatment

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PRIMARY ANGLE CLOSURE SUSPECT

ZAP Trial (Zhongshan Angle Closure Prevention Study)

- 47% reduction in risk of PAC over 6 years
- 70% reduction in risk of PAC over 14 years

- Progression from PACS to PAC or AACC was relatively infrequent
  - 4% at 6 years
  - 12% at 14 years

- CAUTION: Extrapolating results to dissimilar populations

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ZAP – 14 year data!!!

69% reduced risk of PAC with LPI

NNT to prevent 1 case of PAC at 14 years is 12.35

"prophylactic LPI should be recommended preferentially to those at the highest risk because the annual incidence of PAC was low"

Yuan Y, Wang W, Xiong R, Zhang J, Li C, Yang S, Friedman DS, Foster PJ, He M. 14-Year Outcome of Angle-Closure Prevention with Laser Iridotomy in the Zhongshan Angle Closure Prevention Study: Extended Follow-Up of a Randomized Controlled Trial. Ophthalmology. 2023 Apr 6.

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AAO PPP RECOMMENDATIONS - PACS

LPI should be considered to reduce the risk of developing AACC or progression to PAC.

Alternately, PACS eyes may be followed for development of IOP elevation, evidence of angle narrowing, or synechial angle closure (because LPI can cause post-laser symptoms and adverse events)

Additional factors that may influence the decision to perform prophylactic LPI in PACS:

- Family history of PACG
- Use of a medication that may precipitate pupillary block
- Symptoms that suggest prior intermittent angle closure
- Patient's health or other status hinders access to immediate care
- Need for frequent dilated eye exams

Warn PACS patients who have not undergone LPI about medications that may induce AACC

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