Glaucoma Update
Identifying Progression

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Identifying Progression to Improve Outcomes

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  • Dr. Fanelli has received honoraria in previous presentations from:
    • Alcon
    • Heidelberg
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    • CE in Italy
    • Review of Optometry

Improved Outcomes

• Best case scenario:
  • PREVENTION OF VISION LOSS

• Second best case scenario:
  • REDUCTION OF CONTINUED VISION LOSS

IOP Control in Glaucoma Management

• Population studies indicate\(^1-3\):
  • Incidence, severity, & progression of glaucoma consistently correlate with elevated IOP
  • IOP reduction is currently the only treatment available for decreasing risk of disease progression\(^4\)
  • Accurate understanding of individual patient IOP affects treatment decisions and guides treatment plan


Setting Targets in Glaucoma Management

• Years ago, it was simple.
  • You just kind of guessed
  • Gestalt management

• Now its not so simple
  • The more we know about a disease, the more we realize what we don’t know

Aids to Setting Target IOP

• New advances have helped us to hone in on what target IOP should be

  • Advances in:
    • Technology
    • Controlled studies
    • Better understanding of the A and P of the optic nerve
    • Identification of risk factors
Aids to Setting Target IOP

• In setting target IOP’s, quantification is an essential part of the equation

• What are we quantifying?
  • The severity of the disease
  • In general, the severity of the disease dictates the formulation of the target IOP

Quantifying the Severity of the Disease

• Glaucoma disease severity is quantified by:
  • Structure
    • OCT, HRT, GDX
  • Function
    • VISUAL FIELDS, VEP
  • But it is also quantified by an analysis of the Risk Factors associated with glaucoma

Categories of Risk Factors for OAG

• State of the Individual
  • Sex, race, family history
• Anatomic and physiologic characteristics of the eye
  • IOP, pigment dispersion, CCT, optic nerve diameter
• Signs of glaucomatous damage
  • Optic cup size, disc hemorrhage, visual field loss
• Systemic diseases and medications
  • Eg hypertension, diabetes, cardiovascular diseases, migraine, sleep apnea, Raynauds, steroids, Ca+ channel blockers
• Personal behaviors
  • Exercise lowers IOP in OH, tight neckties, inversion and wind instruments increases venous pressure which increases IOP

Boland and Quigley
J. Glaucoma July 2007

• Risk Factors for OAG Incidence
  • 6 studies as data sources
    • High IOP
    • Older age
    • Family History
    • Race
    • Thinner corneas, lower perfusion pressure, exfoliation, systemic beta blockers each found in only 1 study
    • Larger CD, NFL defects, and worse baseline VF also noted, but may denote damage already done

Boland and Quigley
J. Glaucoma July 2007

• Risk Factors for OAG Progression
  • AGIS
    • Older, greater IOP fluctuation, higher IOP
  • EMGT
    • Older, bilateral disease, higher baseline IOP, disc hemorrhages, worse baseline VF
    • CCT NOT risk for progression, but certainly for development (CHTS)
  • CNTG
    • African Americans, females with migraines
  • Asrani et al
    • Fluctuations in IOP were greater predictor of progression than office based IOP

Glaucoma Clinical Trials: Study Design
Stages in GON

- Apoptosis
- Ganglion cell death
- Undetectable
- RNFL/cupping
- Quantifiable
- Observable
- Visual Field Loss
- Impairment

Lessons from OHTS: How Conversion Occurs

- The majority of patients in OHTS who developed glaucoma had defects in the optic disc only.\(^1\)

Lessons from OHTS: Prediction

Lessons from OHTS: IOP Management

- In the treated group, 4.4% of patients still progressed to glaucoma. Why?
- Treatment goal was:
  - ≥20% or more IOP reduction, AND
  - IOP < 24 mmHg
- Study accomplished:
  - ≥22.5% average IOP reduction and
  - IOP average 19.3 mmHg

Lessons from AGIS: IOP Needs to Be Consistently Low

Glaucoma Clinical Trials: IOP-Lowering and Progression

- OHTS\(^5\) 20% target 4.4%/9.5% (over 5 years)
- EMGT\(^2\)* 25% (average) 45%/62% (over 6 years)
- CNTGS\(^3\) 30% target 12%/35% (over 7 years)
- CIGTS\(^4\) med ~38% (average) No progression (average)
- CIGTS\(^4\) surg ~46% (average) No progression (average)
- AGIS\(^5\) <18 mm Hg target No progression (average)

*10% reduction in risk with every 1 mm Hg of additional IOP lowering
Glaucoma Clinical Trials: Summary of Implications

- Treat newly diagnosed glaucoma\(^1,2\)
  - Patients with early glaucoma should be treated to reach low pressures that reduce the risk of progression
  - Both medical treatment and surgery effectively reduce IOP and risk of progression
- IOP needs to be consistently low\(^3\)
  - IOP fluctuation over long time periods increases risk of VF loss in glaucoma
  - Results show that to be effective, patients need lower IOP
    - Not just most of the time
    - Need it lower consistently, all the time
  - When pressures are low enough, patients on average have much lower risk of progression


Target IOP

- Remember, the ‘quantification’ of the severity of the glaucoma is a principal variable in calculating target IOP
- Structural Damage
- Functional Damage
- Risk Factors
  - Each of the above drives DOWN target IOP

On Topic of Targets, Is there a......

- Magic Bullet?
- Magic IOP?

Calculating Target IOP

- 16 mmHg
- +/- 10 mmHg

Target IOP Should be Established as a Goal of Therapy

- General rule: initial target IOP based on degree of glaucoma damage
  - No VF damage, intact neuroretinal rim → high teens/low twenties
  - VF loss on one side of the horizontal meridian → mid-teens
  - VF loss on both sides of the horizontal meridian → <12 mmHg
- Target IOP range should be
  - Dynamic
  - Reviewed and adjusted over course of treatment

Target IOP: How Low Is Low Enough?

- Individualize
- Factors
  - Damaged Structure
  - Damaged Function
  - Risk Factors
    - Age
    - Family History
Target IOP: Recommendations

• Larger IOP reductions associated with decreased risk of glaucoma & progression (DHTS, EMGT, CIGTS)\textsuperscript{1-3}
• For some patients, IOP should be reduced to levels lower than were considered acceptable in past
• Guidelines for setting target pressures in glaucoma developed by the AAO, EGS, and others
  • Based on evidence from clinical trials and clinical experience

Target IOP in Clinical Practice

• Set an individualized target IOP range for each glaucoma eye
• Target often more aggressive than in past
• Get IOP down to target
• Keep IOP down to target
• May need to adjust target over time

Target IOP in Clinical Practice (contd.)

• Target IOP ranges
  • Low teens (10-12 mm Hg)
  • Mid teens (14-16 mm Hg)
  • High teens (17-19 mm Hg)
• Determine range of % IOP reduction
  • % reduction needed is proportional to degree of damage and risk factors
    • More damage = more reduction
    • More risk factors = more reduction

Target Pressure Pearls

• Evaluate and document the Optic Nerve to
  • Diagnose glaucoma
  • Determine disease severity
  • Evaluate progression
• Set target pressure based on risk factors, optic nerve appearance, and fields
  • Aim for lower targets: every mm Hg counts
• Prescribe therapy with best ability to achieve and maintain target IOP (or lower)
• Re-evaluate structure/function critically as patient is followed
• Readjust target IOP and treat more effectively when subtle progression is noted

Integrating Structure and Function

• Structural changes to the optic nerve that are consistent with glaucomatous damage include:
  • Damage to the disc or rim
  • Thinning of the retinal nerve fiber layer (RNFL)
  • Which is more predictive of glaucoma?
    • Which comes first?
    • When do fields become involved?
Structural Damage Precedes Functional Change

• NFL injury can be observed up to 6 years before VF defects
  • Mean number of axons in normal ON ~800,000–1,200,000
  • 25-40% of ON fibers can be lost from an eye that retains a normal visual field

Visual Defects Are Associated With ON Damage

• Quadrants with fewer axons correlate with regions of greatest VF loss
  • Clinical measurements of disc rim and nerve fiber layer depth correlate quantitatively with visual function in glaucoma

Structure vs. Function: Initial detectable damage

• The majority of patients in OHTS who developed glaucoma had defects in the optic disc only

OCT Technologies

• Development of many new instruments over the past few years to evaluate the structure of the optic nerve
  • GDx
  • OCT
  • Multiple manufacturers
  • The 800 lb gorilla
  • HRT
Spectral Domain OCT

- OCT – Fourier Domain OCT (Spectral)
  - New imaging method greatly improves resolution and speed of OCT
  - High resolution allows more detailed images and layer by layer assessment
  - High speed allows more data to be collected (3-D) and helps diminish eye motion artifacts

Glaucoma Analysis: Nerve Head Map

OCT Glaucoma applications

OCT and Glaucoma Analysis

- RNFL
- Progression over time
- Posterior pole analysis
  - Reliable and accurate as resolution of system is 2-3 microns
  - Ability to integrate structure and function together*
- Cross section scans
  - Identification of BMO as new norm in quantifying NRR tissue and monitoring progression over time*
Why should we be Interested in the Macula in Glaucoma?

- Glaucoma is a disease manifest by ganglion cell losses which are reflected in loss of axons or ONH cupping
- Ganglion cell layer is multi-layered in the macular region – with NFL, 40% of total retinal thickness
- The majority of the entire retinal ganglion cell population is in the macula (> 50% of all the ganglion cells)

Topography of Ganglion Cells

- Large variation in total ocular axonal count (0.5 to 1.2 mil) among normals and thus large variation in normative databases.
  - However, the variation in ganglion cell numbers in the central macula is small.

Why is Early Glaucoma Diagnosis Difficult

- Much larger variation in optic nerve head (size, orientation, slope, shape)
- Measurements from both macular retinal thickness and peripapillary RNFL may be more robust than that of the optic nerve

Is the Macula Overlooked

- The visual field relatively under-samples the macula
- The visual field is relatively less sensitive to ganglion cell loss in the macula
Strategy Change

• Measure retinal thickness in the posterior pole in a large area that corresponds to the 24-2 visual field.

• Use entire retinal thickness rather than ganglion cell layer (since it is difficult for automated software to identify thinning in layers that do not differ significantly in optical density).

• Increase accuracy and reproducibility with eye tracking.

• High density measurements which can be subdivided into small areas for comparison.

Asymmetry Analysis: Compare retinal thickness measurements between eyes.

Asymmetry is the hallmark of glaucoma. Retinal thickness measurements from each eye can be compared to the other eye since most individuals have their own internal control.

Asymmetry between eyes:

For each small 3° x 3° square area of one eye, the mean retinal thickness is compared to the value in the corresponding area of the other eye.

Asymmetry display: Gray scale depiction of difference in thickness from -0 to -30 microns.
Hemisphere Asymmetry:
Displays the asymmetry between the superior and inferior hemisphere of each eye. The fovea-to-disc axis is the horizontal symmetry line.

I-S Asymmetry Map:
Each small area in the lower hemisphere is compared to the corresponding area in the superior hemisphere.

Asymmetry Analysis:
Compare retinal thickness measurements between hemispheres of each eye.

Macula Scan Case 1: Moderate pre-perimetric RNFL defect
Macula Scan Case 2: Glaucoma Suspect with Normal Visual Field
Macula Scan Case 3: Glaucoma Suspect with Normal Visual Field

Break Time
Structure and Function Cases
68 y/o White Female

- Advanced OAG
- Bilateral SLT's x 2
- Maximum medical therapy
  - 0.5% timolol qd
  - Travatan Z HS OU
  - Dorzolamide TID OU

- What is the question at hand?????
68 y/o White Female

* Not Clinically Useful:

Is she worsening?
68 y/o White Female

73 y/o White Female

- Advanced OAG OS
- IOP's average 11 mmHg
- Maximum medical therapy

- Is she worsening?
- What is next step?

73 y/o White Female

- Advanced OAG OS
- IOP's average 11 mmHg
- Maximum medical therapy

- Is she worsening?
- What is next step?
73 y/o White Female

Is her OS worsening?????

What to do???

Where OCT Imaging is Going

• Is her OS worsening?????

• What to do???
Clinically Identified Cup Margin

- Evaluated using stereoscopy, either by biomicroscopy or stereoscopic optic disc photographs
- Cup margin is subjectively defined on basis of its contour, color, and position of blood vessel bending
- Cup-to-Disc Ratio
  - Optic cup used as a reference of empty space in optic disc
  - Used to provide some form of quantitative measure of neuroretinal rim width

Clinical Evaluation of Neuroretinal Rim

- Disc margin is:
  - The inner edge of the scleral lip or the edge of the retinal pigment epithelium (RPE)
- Cup margin is:
  - The inner edge of the rim, based on clinical appearance
- Rim width measured as:
  - The distance from disc margin to cup margin

Clinical Assessment of Neuroretinal Rim is Variable

- Poor agreement on disc margin
- Poor agreement on cup margin
- Significant neuroretinal rim area discordance

Clinically Identified Disc Margin

- Internally oblique border tissue configuration
- Externally oblique border tissue configuration
- Non-oblique border tissue configuration

Clinical DM is an inconsistent anatomical landmark for the outer border of the neuroretinal rim
SD-OCT Imaging of the ONH

3D Anatomy visualized with SPECTRALIS

SD-OCT Imaging of the ONH

BMO – Objective Outer Edge of Rim

Objective Landmark of Inner Edge of Rim

Correct Geometric Orientation

Accurate SD-OCT Neuroretinal Rim Measurements

- Rim tissue must be measured in the correct geometric orientation to avoid overestimation
- In a single eye, the orientation of rim tissue varies around the ONH
- Axons may exit the eye almost parallel to visual axis or even perpendicular to it
- If measurement plane is fixed, potential significant errors in rim measurements can occur*

- Neural tissue (axons) cannot cross Bruch's membrane and must exit the eye beyond its edge (BMO)**
- BMO defines the outermost edge of neural tissue at the disc level (disc margin)


** BM = Bruch's membrane
BMO = Bruch's membrane opening
RPE = Retinal pigment epithelium
BT = Border Tissue of Elschnig

Accurate SD-OCT Neuroretinal Rim Measurements

- BMO–minimum rim width (BMO-MRW): BMO is used as landmark and rim width is quantified as minimum distance between BMO and internal limiting membrane (ILM)
- Quantification of neuroretinal tissue made perpendicular to the axis at which nerve fibers exit the eye via the ONH
- BMO-MRW overcomes limitation of overestimating rim tissue when using an arbitrary horizontal reference plane (BMO-HRW)

Accurate Anatomical Orientation of Scans

Anatomical Regionalization

- BMO is the anatomic boundary at the ONH level where retinal ganglion cell (RGC) axons exit the eye
- Fovea is the anatomic center of the retina
- All human eyes: The path of axon bundles remains constant relative to the fovea to BMO axis*

*OD = Optic Disc

Anatomic Variation in Fovea Position Relative to BMO

- In most eyes, fovea is located below the level of the center of BMO
- Inter-subject variability in the axis connecting the fovea and BMO is large

2. Chauhan BC, Burgoyne CF. From clinical examination of the optic disc to clinical assessment of the optic nerve head: a paradigm change

SPECTRALIS Glaucoma Module Premium Edition (GMPE): Features and Functionalities

ONH Radial
ONH Circle
PPole
Vertical
ONH Analysis
RNFL Analysis
Retinal Thickness
GCL Thickness
Progression Analysis

Functionalities

- Optic Nerve Head (ONH) Analysis
- Retinal Nerve Fiber Layer (RNFL) Analysis
- Total Retinal Thickness – Posterior Pole Asymmetry Analysis
- Ganglion Cell Layer (GCL) Thickness
- Progression Analysis

Demonstration: Defining the Anatomic Map
Acquisition: APS-Based Unique Scan Patterns

ONH-RC
PPoleH
PPoleV

Head-Tilt/Cyclo torsion Compensation

Live Centration of Radial Scan is Important

- Superior disposition of radial scan
- Higher sampling of data points in superior region, less sampling in inferior region
- Radial scan centered during live acquisition
- Even sampling of data points all around ONH margin

GCL: Most Sensitive Macular Thickness Parameter

- Macular GCL and RNFL are diminished in preperimetric glaucoma
  - GCL is substantially more diminished than RNFL or RGC complex (RNFL, GCL and IPL)
  - The asymmetric loss of GCL is more apparent when superior and inferior hemisphere are compared
  - Therefore, GCL is more sensitive to glaucomatous damage than RNFL, IPL or RGC complex

Less Sampling
More Sampling
Even Sampling

Vertical Macular GCL Scan: Most Sensitive

- Vertical scans show significantly higher sensitivity than horizontal scans for GCL assessment
  - Vertical = 81.1%
  - Horizontal = 40.5%
- "De-speckle noise-reduced SD-OCT images, the boundary of each retinal layer, including the boundary between the GCL and IPL, was clearly distinguishable"

GCL: Most Sensitive Macular Thickness Parameter

PPoleH Scan For GCL Asymmetry Analysis: Pitfall 1

- Two separate B-scans within a volume scan are used for assessment of superior vs. inferior asymmetry of GCL
- Each B-scan may have different signal quality which affects segmentation and results
PPoleH Scan for GCL Analysis: Pitfall 2
• Perpendicular alignment reduces possibility of major horizontal vasculature causing long stretches of shadowing

PPoleV: Optimal GCL Segmentation & Analysis
• Perpendicular alignment to horizontal raphe (FoBMOC axis) provides symmetrical analysis of superior vs. inferior macular GCL thickness on each individual vertical B-scan
• Major horizontal vasculature does NOT create long stretches of shadowing

Review Software: Analyses

ONH Analysis
• BMO-MRW analysis using 48 equidistant data points
• BMO identified and BMO-MRW calculated using automated segmentation algorithm with possibility for manual override
• BMO-MRW thickness analysis adjusted for BMO area and age
• Garway-Heath BMO-MRW sector analysis for better structure/function correlation
• “BMO Overview” tab provides an overview of ONH anatomy at 12 equidistant locations around disc margin

BMO-MRW Analysis
• 48 equidistant BMO-MRW data points are used to create a thickness profile around the ONH
• These values are plotted on normative database profile (just like previous RNFL analysis)

Global and Sector Analysis
• Each individual Garway-Heath sector (T, TS, NS, N, NI, TI) and global sector is compared with the normative database (NDB) values of that sector and given a classification
• The overall classification below the Garway-Heath sector map reflects results of thinnest sector
Reference Database Analysis

- The percentile within which BMO-MRW global and sector values correspond to in the Normative Database (NDB) are presented in parentheses below the thickness value.
  - Values ≥ 5% are given a “Within Normal Limits” classification (green).
  - Values 1% < 5% are given a “Borderline” classification (yellow).
  - Values ≤ 1% are given an “Outside Normal Limits” classification (red).

Less than 7% of healthy eyes have thinner values (123 µm) at this sector than this eye.

Less than 3% of healthy eyes have thinner values (116 µm) at this sector than this eye.

Less than 1% of healthy eyes have thinner values (105 µm) at this sector than this eye.

BMO Overview

- Provides clinicians an overview of how the BMO is demarcated relative to the perceived clinical disc margin.
- Shows OCT-based neuroretinal rim (BMO-MRW) anatomy at 12 equidistant points along the ONH.
- Indicates classification of the BMO-MRW relative to RDB at each of the 12 points.

BMO-MRW Printout

- Overall classification
- Global classification
- Garway-Heath sector classification
- Thickness profile
- BMO area in mm²

RNFL Analysis

- Three circle scans of 3.5mm, 4.1mm, and 4.7mm are automatically centered around BMO centroid.
- 768 data points analyzed.
- RNFL thickness analysis adjusted for BMO area and age on all three scans.
- Range of BMO area: 1.0 mm² - 3.4 mm².
- Garway-Heath sector analysis for better structure/function correlation.

3.5mm RNFL Circle Scan

- Default scan for analysis.
- Percentile values and Temporal-Superior-Nasal-Inferior-Temporal (TSNIT) profile adjusted for BMO size and age.
- Accurate sector analysis due to FoBMOC adjustment.

Importance of Corneal Curvature for best results

- RNFL is thicker closer to Disc margin (DM) and thinner further from DM.
- Therefore, RNFL circle scan should be scaled relative to true optic nerve head area (BMO area) for accurate assessment.
Three different circle scans for detecting progressive loss of RNFLT

- RNFL thickness decreases as distance from BMO margin increases
- Slope of this decrease over time may provide very useful information about progressive loss of RNFL

- Rate of RNFL loss may be faster or slower depending on distance from BMO margin
- The combination of RNFL thickness from three different distances may provide complementary information

### Slope of RNFL Thickness at Baseline

![Graph showing RNFL thickness at baseline](image)

### Slope of RNFL Thickness During Follow-Up

![Graph showing RNFL thickness during follow-up](image)

- Faster progression closer to BMO: Slope flattens
- Faster progression further from BMO: Slope steepens

### BMO-MRW & RNFL Printout

- Overall classification
- Global classification
- Garway-Heath sector classification
- Thickness profile
- BMO area in mm²
- BMO overview

### Progression Analysis: BMO-MRW & RNFL

- Available for:
  - BMO-MRW
  - 3.5mm, 4.1mm, and 4.7mm RNFL thickness

- **Slope of progression** is calculated over time and compared to normal aging regression slope
- Slope of decreasing thickness is compared to slope of decreasing thickness due to normal aging to confirm true change
- Calculated for global and sectorial values

![Graph showing progression analysis](image)
GCL Thickness Color Map
- PPoleH: GCL thickness color map presented on circular grid
  - Significantly thicker?
- PPoleV: GCL thickness color map presented on circular grid
  - Significantly thicker?

GCL Thickness Heat Map
- PPoleH and PPoleV: lack of a continuum of colors in the color map may lead to misleading of thickness values as some borderline values may fall in one color spectrum vs another
  - Significantly thicker on color map but not on heat map
  - Heat maps offer a more continuous spectrum of colors that will not lead to such misleading assessments

GCL Thickness Printout
- Ganglion cell layer thickness maps and average thickness values using ETDRS grid

Basic Protocol: Recommended Report 1
- Clinical utility: Allows for diagnostic assessment of ONH, RNFL and Macula
- Report features:
  - MRW & RNFL Garway-Heath Sector and global analysis (compared with the reference database and color-coded based on classification)
  - MRW & RNFL thickness profiles based on 48 data points for MRW and 768 data points for RNFL
  - Overall classification indicators for MRW and RNFL thickness values (Outside of Normal Limits, Borderline, Within Normal Limits)
  - “Average Thickness” graph
  - “Hemisphere Asymmetry” graph. For this graph, a difference of 30 µm results in a black cell indicating a significant difference

Basic Protocol: Recommended Report 2
- Name of report: “RNFL Change Report”
- Clinical utility: Allows for assessment of change over time
- Report features:
  - RNFL thickness progression graph indicating RNFL thickness at each time point with color-coding indicating progression over the whole range of the thickness graph

Basic Protocol: Report 3 (If Needed)
- If report 1 is inconclusive
- Name of report: “RNFL Single Exam Report OU”
- Clinical utility: Allows for diagnostic assessment of asymmetry of RNFL between eyes, which can be an indicator of glaucoma since RNFL thickness asymmetry is a hallmark of glaucoma.
- Report features:
  - RNFL Garway-Heath sector and global analysis (compared with the reference database and color-coded based on classification)
  - RNFL thickness profiles based on 768 data points
  - Overall classification indicators (Outside of Normal Limits, Borderline, Within Normal Limits)
  - Quadrant and sector difference analysis between eyes
  - Thickness profile with both eyes plotted on the same graph
Basic Protocol: Report 4 (If Needed)
- Clinical utility: Allows for diagnostic assessment of asymmetry of macular thickness between eyes, which can be an indicator of glaucoma since asymmetrical loss of macular thickness is a hallmark of glaucoma.
- Report features:
  - IRcSLO of the macula with thickness map and posterior pole grid
  - "Average Thickness" graph
  - "Hemisphere Asymmetry" graph. A difference of 30 µm results in a black cell
  - "OD - OS Asymmetry" and "OS - OD Asymmetry" graphs. Each cell represents the difference between average thickness in the respective cell of OD grid and the average thickness in the corresponding cell of OD grid. A difference of 30 µm results in a black cell indicating a significant difference

Comprehensive Protocol: Recommended Report 1
- Scans acquired: ONH-RC, P40H, P40V
- Clinical utility: Allows for diagnostic assessment of ONH, RNFL, and Macula
- Clinical utility: Same as Basic Protocol Report 1

Comprehensive Protocol: Recommended Report 2
- Scans acquired: ONH-RC, P40H, P40V
- Name of report: "Thickness Map Single Exam Report OL"
- Clinical utility: Allows for detailed glaucoma-related assessment of macula via evaluation of the distribution of RGC soma (GCL thickness)
- Report features:
  - IRcSLO of the macula with GCL thickness map and grid of choice (1,2,3mm ETDRS, 15° PMB grid, 20° PMB grid overlays)
  - GCL "Average Thickness" graph associated with grid of choice

Comprehensive Protocol: Report 3-5
- Reports 3,4 and 5 of "Comprehensive Protocol" → same as reports 2,3 and 4 of "Basic Protocol"

Is Perimetry Still Important?
- Optic nerve/RNFL changes are NOT always the first clinical signs of glaucoma
- From 30-40% of the time, VF were first changes noticed in when one converted to glaucoma in OHTS
- EMGT demonstrated early field loss as first signs almost exclusively

Large Clinical Trials
- In 3 large clinical trials perimetric damage preceded optic nerve damage in 35% to 86% of patients

Goals of Selective Perimetry Testing

- Isolate and evaluate specific visual mechanisms
- Reveal early pathologic changes to visual system
- Evaluate specific subgroups of ganglion cells with specific response properties
- Motion, flicker, color, contrast

Selective Perimetry

- Primary Use
  - Provide evidence that person has progressed from suspect/ocular hypertension to having glaucomatous damage
- Indicted in
  - Ocular Hypertension
  - Glaucoma Suspects/Suspicious Optic Nerves
  - No sign of loss on White-on-White Visual Fields

FDF targets M-cells

- The magnocellular (M-cell) pathway is one of the three main neural pathways from the retina to the primary visual cortex.
- FDF targets the M-cells which are sensitive to high frequency and high contrast stimuli
- Selective Damage or Selective Testing?
  - M-cells may be the first to sustain damage in glaucoma
  - There are fewer M-cells so selective testing can find defect to all cells earlier

Flicker Defined Form (FDF)

- Phase 1 + Phase 2 = Illusory “Edge” or Contour

References:
Optic Nerve Abnormality Without Visual Field Loss on SAP

The Questions in Clinical Practice

1. Does the patient have a situation that needs to be monitored without medication or with medication?
   - In other words, do they have glaucoma? What is your diagnosis? Do they need to be medicated?
2. Are they STABLE?

Structure and Function

- Assists in answering #1
  - But this is a clinician-based decision, best evaluated in the examination room
  - C/D?
  - Risks?
- Is imperative in repeatedly answering #2

63 year old female

- Referred for glaucoma evaluation
- No family history
- CD 5 x 6 OD 6 x 7 OS
- IOP 20 OD 22 OS
- CCT 539 OD 544 OS
- Anterior segment normal.

Fields:

63 year old female
63 year old female

- Presents with suspect nerves OD and OS
- IOP 19 OD, 18 OS
- C/D 65 x 7 OD, 7 x 75 OS
- Thin IT rims OU
- No family history
- CCT 546 OD, 540 OD

64 year old new patient

- Assessment:
  - Suspect OD
  - OAG OS
- Plan:
  - Monitor OD
  - Medicate OS
  - Target IOP?
82 year old caucasian female

- Travatan Z HS OU x 6 years
- IOP average 17 mmHg OD 16 mmHg OS
- Pretreatment IOP mid 20’s
- CCT 530 OD 533 OS
- C/D 6 x 65 OD 65 x 65 OS

82 year old caucasian female

- All indices stable over 6 year period
- Patient develops disc hemorrhage OS Sept 2010
- Therapy change warranted???

82 year old caucasian female

- Hemorrhage develops September 2010
- Structural changes seen and confirmed, within 6 months
- Additional therapy instituted OS at confirmation of structural change on HRT 3

82 year old caucasian female

- No functional change/damage noted
82 year old caucasian female

- Summary:
- Damage may occur in NRR, NFL or arcuate macula, and may or may not involve VF

Structure Function Summary

- Some changes occur first to the structure of the:
  - Disc
  - NRR
  - RNFL
  - Arcuate macular fibers
- Some changes first affect fields
- Continued evaluation of both structure and function is imperative in monitoring change over time

Thank You