Current Concepts in Glaucoma

Anthony B. Litwak, OD, FAAO
Program Director
OTCE

No Financial Disclosures

Is Glaucoma a Bad Disease?

Goals of Glaucoma Therapy
●Maximize the Patient's Quality of Life
●Patient Maintains Functional Vision to Meet the Requirements of Daily Activities
●Glaucoma Patients Do Not Become Symptomatic Until Late in their Disease Process
●Does Not Have to be a Zero Tolerance Policy to Visual Field Loss
-We Don't Stop Glaucoma Progression with Treatment, But We Can Slow It Down
●Not Every Person with Glaucoma Goes Blind (Rule of 10)
●Difficult to Predict the Rate of Glaucoma Damage and How Long the Patient Has To Live
●Blinding or Killing A Patient to Achieve a Desired Target Pressure is Not Good Practice

IOP
●Deemphasize that elevated IOP defines glaucoma
●Emphasize that elevated IOP is the most significant risk factor for developing glaucoma and the risk factor we can alter
●Higher the IOP the greater the risk
●Suggestion that the greater the diurnal variation of IOP, the greater the risk of developing glaucoma and progressing with glaucoma
●IOP is not a static measurement

IOP Varies More Than You Think
●Average diurnal variation for a glaucoma patient is 6 mm HG
●Mark sure you get baseline IOP readings before you start a patient on treatment
●3 readings is the minimum
●You can never rule out an IOP spike
–Personally I believe the highest IOP reading is more important than the average IOP reading
–Which patient concerns you more
●Patient #1 IOP 24, 24, 24 Patient #2 IOP 24, 18, 32

When Should We Treat?
●1. Does the patient have nerve damage?
–If yes then in most cases – TREAT
–If no, then access risk factors to determine the benefits of treatment vs observation
●Level of IOP
●CCT
●Age
●Race

●FOH

When to Treat Elevated IOP without Glaucoma Damage
●NO Glaucoma Damage
●Elevated IOP
●Refer to OHTS
–Greatest risk for developing glaucoma
●IOP 26 or above
●In conjunction with thinner CCT <555um
●OHTS lowered IOP by approximately 20% (Target Pressure)
–One or two meds

No Damage, But Elevated IOP
CCT and Ocular Hypertension

Treating When There is Damage
●Strong evidence (clinical trials) that lowering IOP slows down glaucoma progression
●Generally, we are going to treat patients that exhibit glaucoma damage
●Includes patients with elevated IOP (COAG) and non-elevated IOP (NTG)
●How to determine if damage is present

Glaucoma 101
- Glaucoma is a disease of the ganglion cell axons
- Damage occurs at the level of the lamina cribrosa
- Selective damage to the superior and inferior poles of the optic nerve
- Relative preservation of the temporal and nasal poles

Glaucoma Discriminates
- Glaucoma Often Asymmetrically Damages Between Above and Below and Between the Two Eyes
- Look for Notches in the Neuro-Retinal Rim Tissue
- Occurs in 30% of Glaucoma Patients
- Inferior Temporal Pole Most Common Site of Notching
- Associated With a Corresponding VF Defect

Compare Neuro-Retinal Rim Tissue Between Superior and Inferior
- Vertical Extension of Cupping Supra or Infra Temporal

Modified ISNT Rule
- Ignore the Nasal Rim Tissue
- Expected Ratios:

1.5-2.0x Inferior: 1.5-2.0x Superior: 1.0 Temporal

- Glaucoma Should Be Suspected When the Amount of Inferior or Superior Neuro-Retinal Rim Tissue Is Equal to or Less than the Temporal Rim Tissue

Disc Size Affects the ISNT Rule

- For Small Size Nerves

>2.0x Inferior: >2.0x Superior: 1.0 Temporal

- For Medium Size Nerves:

2.0x Inferior: 2.0x Superior: 1.0x Temporal

- For Large Size Nerves:

1.5x Inferior: 1.5x Superior: 1.0x Temporal

Does Size Really Matter?

- Is there a C/D ratio that defines glaucoma?
- Do You Think This Nerve Has Glaucoma?

A Big Cup Does Not Necessarily Mean Glaucoma

- There is No Demarcation Line Separating a Physiological Cup From a Glaucomatous Cup
- Physiological Cup Size Is Directly Related to Overall Disc Size
- Large Discs Will Have Large Physiologic Cups
- Small Discs Will Have Small Physiologic Cups
- Physiologic Disc and Cup Size Is Genetically Determined
- Physiologic Cup of .7 Or Greater Occurs in 2% of Normals
- A Small Disc With a Medium Size Cup Should Be As Suspicious As a Large Cup in a Medium Size Disc

How to Evaluate Disc Size

- Use a 60 D Lens at the Slit Lamp
- Make a Thin Vertical Beam
- Adjust Beam Height
- Read Disc Diameter off Scale on Slit Lamp
- Vertical Disc Diameter > 2.2 mm Is a Large Disc
- Vertical Disc Diameter < 1.8 mm Is a Small Disc

Expected Physiologic Cup Size
Based on Measured Vertical Disc Diameter
Using a 60 Diopter Lens At The Slit Lamp

	-2std	-1std	Mean	+1std	+2std
Vertical Height (mm)	1.6	1.8	2.0	2.2	2.4
Expected C/D ratio	0.0	0.2	0.4	0.6	0.8

OCT OPTIC DISC CUBE SCAN
The 6mm x 6mm cube is captured with 200 A-scans per B-scan, 200 B-scans.
Does the OCT Do It Better?

- Caveat #1
    - It is difficult to create a normal data base with a structure like the optic nerve that varies significantly in regards to size, shape and number of ganglion cell axons

Database

- 284 patients
- Image quality 6 or above
- Age 19-84
- Refractive range -12 to +8 diopters
- Ethnicity 43% Caucasian, 24% Asian, 18% African America, 12% Hispanic, 1% Indian

Factors That Affect Normative Database

- AGE
- RNFL and Neuro rim tissue slightly decreases with age
- The current software does account for age by comparing patients in similar age groups

Factors That Affect Normative Database

- DISC SIZE
- Disc Area range 1.06 – 3.38 mm^2 (ave 1.83 mm^2)
- Small - disc area < 1.63 mm^2
- Medium - disc area 1.63-1.97 mm^2
- Large – disc area > 1.97 mm^2

- Larger Discs will have larger c/d ratios
- Larger Discs generally have greater neuro rim tissue
- The current software does match disc size for optic nerve parameters but not RNFL
- Disc area <1.33 mm^2 or > 2.50 mm^2 is not compared to the normative database because there are too few in the database

Factors That Affect Normative Database

- Number of ganglion cell axons in the normal population varies considerably
- Rim area range in the normal data base 0.75-2.38 mm^2 (ave 1.31)
- We are born with different number of ganglion cell axons (700,000-1.5 million)
- No way to account for this in the database

Distribution of Normals

- White represents upper 5% of normal database
- Green represents middle 90% of normal database
- Yellow represents lower 5% of normal database
- Red represents lowest 1% of normal database
- Gray not compared to the normal database

Rim Area

Defines Disc at Bruch's Membrane End

Minimizes effect of peripapillary Atrophy on measurements
Optic Nerve Head Calculations
The disc edge is determined by the termination of Bruch's membrane.

Disc Area

- Disc Area range in normal database 1.06 – 3.38 mm2 (ave 1.83 mm2)
- Disc area < 1.8 mm2 is a small nerve
- Disc area 1.8 – 2.2 mm2 is a medium nerve
- Disc area > 2.2 mm2 is a large nerve
- Disc Area is always Gray color coded
- Larger Discs will have larger c/d ratios
- Larger Discs generally have greater neuro rim tissue
- The current software does compare disc area to the optic nerve parameters but not to RNFL parameters

The rim width around the circumference of the optic disc is then determined by measuring the shortest distance from the edge of Bruch's membrane to inner edge of neuro-retinal tissue in the optic nerve.

Rim Area

- Rim area range 0.75-2.38 mm^2 (ave 1.31) in normative data base
- We are born with different number of ganglion cell axons (700,000-1.5 million)
- No way to account for this in the database other than to average values
- Global measurement

- No way to account for how many ganglion cell axons a patient is born with
- Only tells us how much rim tissue is remaining
- Affected by blood vessels
- Floor is not zero, varies from .2 to.5
- A value under 1.00mm2 should get your attention

C/D Ratio

- Average and Vertical C/D ratio are reported
- Dependent on Disc Area
- Dependent on the number of ganglion cell axons in our retina
- C/D ratio will increase as ganglion cell axons are lost
- Vertical C/D ratio is probably more important than average C/D ratio

Cup Volume

- Partially Dependent on Disc Area
- Can increase as glaucoma excavation progresses
- Poorer Reproducibility compared to other optic nerve parameters
- **Thickness Profiles**
- Neuro-retinal Rim Thickness profile, OU
- Compared to normative data
- Pay attention to superior temporal and inferior temporal

NFL 101

- Patterns of Diffuse NFL Loss
- Focal NFL Defects

Caveat #2:

- There are structures (ie blood vessels, astrocytes and glial cells) that contribute to the measured RNFL by the OCT

RNFL Analysis
The 6mm x 6mm cube is captured with
200 A-scans per B-scan, 200 B-scans.

CALCULATION CIRCLE
Automatically centers the 1.73mm radius peripapillary calculation circle around the disc for precise placement and repeatable registration.
The RNFL thickness map shows the patterns and thickness of the nerve fiber layer.
The RNFL deviation map is overlaid on the OCT fundus image to illustrate precisely where RNFL thickness deviates from a normal range

Quantitative Optic Nerve and Nerve Fiber Layer Parameters
Average RNFL Thickness

- Represent the average thickness drawn along the 1.73 mm radius calculation circle around the optic nerve
- Measures the thickness of ganglion cell axons
- But along includes blood vessels, astrocytes and glial cells
- Global index (will miss focal loss)
- Normal range between 75-107 um

RNFL Symmetry

- Compares the entire TSINT of the RNFL between and right and left eye

RNFL Peripapillary Thickness profile, OU
- compared to normative data

Quadrant and Clock Hour RNFL Analysis

Should We Look Elsewhere for Glaucoma Damage other than the Optic Nerve?

- The ganglion cell complex (ILM – IPL)
- Ganglion Cell Analysis
- Measures thickness for the sum of the ganglion cell layer and inner plexiform layer (GCL + IPL layers) using data from the Macular 200 x 200 or 512 x 128 cube scan patterns.
- RNFL distribution in the macula depends on individual anatomy, while the GCL+IPL appears regular and elliptical for most normals. Thus, deviations from normal are more easily appreciated in the thickness map by the practitioner, and arcuate defects seen in the deviation map may be less likely to be due to anatomical variations.

Advantage of Ganglion Cell Analysis

- More reproducible measurement than peripapillary RNFL
- Less physiological variation compared to peripapillary RNFL
- Less major blood vessels to create pseudo-thickness measurements
- Better symmetry between superior and inferior and between eyes than peripapillary RNFL

Squeegee Sign

- Glaucoma initially damages the temporal side of the ganglion cell bodies in the macula
- Glaucoma asymmetrically damages between the superior and inferior ganglion cell bodies
- Squeegee Sign to the superior or inferior temporal ganglion cell bodies is the initial indication of glaucoma damage on the GCA.

OCT Clinical Pearls

- Normal data bases for optic nerve and RNFL are difficult to construct
- Blood vessels, astrocytes and glial cells can taint optic nerve and RNFL measurements
- Understand that GREEN does not always mean NORMAL and RED does not always mean ABNORMAL
- Glaucoma damages ganglion cell bodies in the macula (Look for Squeegee Sign)
- Symmetry is a beautiful thing, lack of symmetry should be cause for suspicion
- OCT can uncover glaucoma damage before visual field loss occurs

- OCT can add another technique to judge for glaucoma progression
- Beware of Blue Hurricanes and Red Tornados on the GCA
- Don't forget your clinical assessment of the optic nerve and RNFL
- The doctor should always correlate the data from the OCT printout with clinical data before making management or treatment decisions in glaucoma.

Visual Fields and Glaucoma Management

- Glaucoma Diagnosis
- Confirms Glaucoma Diagnosis
- Quantifies the Amount of Glaucoma Damage to Set Target Pressures
- Judge for Glaucoma Progression

Case SQ

- 63 yobm
- +HTN
- No complaints
- VA 20/20 OD and 20/20 OS
- PERRLA - APD
- CF FTFC OU
- SLE Unremarkable
- TA 24, 21, 26 OD and 20, 18, 23 OS
- CCT 586/588
- Gonio shows open angles OU
- DFE: See Photos

What Constitutes a Visual Field Defect?

- Glaucoma Hemifield Test
- Cluster Analysis
- Pattern Standard Deviation

Minimum Criteria for Diagnosing Glaucoma

- Two "Outside Normal Limits" Glaucoma Hemifield Tests Or
- A Cluster of Three or More Nonedge Points (30-2) in a Location Characteristic for Glaucoma, All of Which Are Depressed on the Pattern Deviation Plot a $P < 5\%$ Level and One of Which Is Depressed at a $P < 1\%$ Level on Two Consecutive Fields Or
- A Pattern Standard Deviation That Occurs in Less Than 5% of Normal Fields on Two Consecutive Fields

Clinical Pearls

- Correlate visual field to optic nerve and NFL
- Use visual fields to confirm optic nerve damage rather than diagnose glaucoma
- Look for pattern recognition of glaucomatous visual field defects, asymmetry and repeatability

Case EJ

- 52 yowm
- PMH: HTN, DM
- -POH
- + Strong family history of glaucoma
- Father and brother with glaucoma
- Referred by PC doc for Diabetic Screening

- **Case EJ**

- VA 20/20 OD 20/20 OS
- PERRLA –APD
- CF: FTFC OU
- SL See Slide
- TA 36 OD 28 OS
- Gonio shows open angles

- **Case EJ**

- CCT 604/600
- IOP 36, 32, 28 OD 28, 28, 22 OS

Clinical Pearls

- Correlate visual field to optic nerve and NFL
- Be skeptical when visual field loss does not match optic nerve
- Poor visual field tester
- Learning curve
- Other disease entities
- Use 24-2 Sita-Standard as default visual field test and Sita Fast for patients that have fatigue difficulties
- When you have a poor visual field tester, you should not use visual fields to diagnose or follow for progression

- **How much attention should we pay to reliability indexes?**

A Normal Visual Field Does Not Exclude Glaucoma

- Overlap of Receptor Sites in the Retina
- Lose 20-40% of Ganglion Cells Before You Get a 5-10dB Reduction on Automated Perimetry
- A Normal Visual Field Excludes Advanced Glaucoma, But Does Not Rule Out Glaucoma

- A Minority of Patients Will Show Innocuous Fields Despite Considerable Glaucoma Damage
- The Visual Field Will Eventually Catch Up to the Optic Nerve

Should We Be Performing More 10-2 Visual Fields?

- **24-2C Program**

- OCT GCA suggests central visual loss in glaucoma
- In a standard 24-2 program only 4 points are tested in the central eight degrees
- 24-2C program adds 10 additional testing points to the central 10 degrees of the 24-2 program for a total of 22 testing points
- Using the sita faster 24-2C program takes less testing time than standard 24-2 sita fast