The Optic Nerve Head In
Glaucoma
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Glaucoma
• Intraocular Pressure that is elevated to a level that causes dysfunction and loss of sensitivity of the optic nerve head in the form of:
  – Pathologic changes in the appearance of the optic nerve head
  – Subsequent characteristic visual field loss

Clinical Pearl #1742
Glaucoma is an optic neuropathy

Points To Live By
• 25% of G pxs NEVER have IOP >21mm
• 50% of G pxs have trough IOP < 21mm
• Glaucoma effects ONH in characteristic patterns
• ONH damage occurs well before VF changes appear
• Disk evaluation remains the most effective method of diagnosing glaucoma

Characteristics of Normal Disk
• Vertical dimension = 2mm
• Avg disk = 10-12 vessel widths
• Avg disk = middle spot size
• Avg C/D = .4/.4
• Cup size correlates with disk size
• Symmetry between 2 eyes

Characteristics of Normal Disk part 2
• Neuroretinal rim equal superiorly and inferiorly
• Temporal rim is thinnest
• ISNT Rule of Jonas
• Rim color – pink & symmetrical
• REMEMBER: C/D has a horizontal and vertical component
How To Estimate Disk Size

- Middle spot on 'scope
- Blood vessel method
- Litwak Method
  - 60D and slit lamp
  - Normal is 1.8 – 2.2mm
  - Affected by mag
  - Affected by RE
- RTA/HRT

Why do these pathologies occur?

- Pressure induced
- Ischemia
- Poor autoregulation
- Microcirculation dysfunction
- Glutamate toxicity

Normal Disk Variations

- Normal disk varies between .8mm2 – 6mm2
- Myopes have larger disks
- Hyperopes have smaller disks
- African-Americans have largest normal disks
- Size Does Matter!

Glaucmatous ONH Characteristics

- ONH asymmetry
- NFL dropout
- Neuroretinal rim defects
  - Focal notches
  - Loss of rim area
  - Sharp rim
- C/D ratio
- Lamina cribrosa
- Alpha & Beta zones

Pathologic Changes Due To Glaucoma

- Thinning of neuroretinal rim
- Deepening of optic cup
- NFL atrophy
- Increase cupping
- Splinter hemes
- PPA (Peripapillary atrophy)

Neuroretinal Rim

- What is it?
- ISNT Rule of Jonas
- In glaucoma the rim thins:
  - Sup/temp & inf/temp 1st
  - Temporal next
  - Nasal last remnant
- Can recede focally or globally
- Look at the donut, not the hole!
Recession of the rim
- Objective sign of clinical progression
- How do we notice this?
  - Serial photography
  - Increasing C/D
  - Thinner neuroretinal rim
  - Baring of circumlinear vessel
  - Focal notches

Nerve Fiber Layer Atrophy
- Focal, wedge or diffuse dropout
- Correlates with VF loss
- RTA or GDX

Nerve Fiber Layer Atrophy
- Bright/Dim/Bright Pattern
- Obscures view of underlying vessels
- How to best view?
  - Hi mag
  - Bright illumination
  - Red free filter

Estimating The C/D Ratio
- Our eyes allow a correct "estimate" to nearest 5%
- There is an interobservational accuracy of +/- 5%
- Be consistent in the way you grade this

RNFL Assessment: Red-Free Photography

C/D Ratio
- 2 dimensional
- Look at 4 quadrants
- Diffuse enlargement
- Focal changes
  - Notches
  - Optic pits
- Correlation to VF
Increase C/D
• Ophthalmoscopic manifestation of neuroretinal rim thinning
• Early sign of progression
• Verticalization
• Cup shape should not necessarily be the same as disk shape

Deepening of Optic Cup
• Visible laminar dots
• Size of pores important
• Correlation w/ VF
• Slope changes
• Bean potting
• Excavation is sign of progression

Peripapillary Atrophy and Glaucoma
• Zone alpha, zone beta
• More frequent in NTG & POAG than in normals or OHTN
• Correlation between degree of PPA and optic disk damage
• Correlation between location of atrophy and location of disk damage and corresponding VF loss

Zone alpha, zone beta
• The larger the area of atrophy:
  – Increased MD
  – Decreased MS
• Size correlates with:
  – Neuroretinal rim area
  – C/D
  – NFL thickness
  – VF loss
• Pathogenesis: ischemia of peripapillary choroidal circulation; vascular deficiency

Zone alpha, zone beta
• Zone alpha – RPE hypo- and hyperpigmentation
  – More peripheral
• Zone beta – adjacent to optic disk
  – Paler area
  – Visible sclera and large choroidal vessels
• Strong association with glaucoma

Zone Beta
• In G cases with beta zone atrophy:
  – Most likely pos’n sup/temp or inf/temp
  – Most thin areas of rim correspond with largest areas of beta zone
  – Localized beta zones correspond with focal VF defects
10 year retrospective study (Tezel)
- OHTN pxs who developed POAG had larger alpha & beta zones
- Had more frequent beta zones than OHTN
- Alpha zones were larger in G pxs than OHTN
- PPA enlarged with progression
- Enlargement of PPA was evident before disk or VF changes were seen

PPA – The Final Word
- Size Does Matter!- (of alpha zone)
- The mere presence of a beta zone is significant (but its size does not matter!)
- Progression of either may be the earliest sign of progression

Uchida Study
- Found direct ass’n between increased cupping, VF damage and size of PPA
- POAG – 45% have beta zones
  - Only 7% of normals have beta zones
- POAG – alpha zones are larger and progress over time

Arteriolar Narrowing
- Focal constriction of vessel
- Seen just off ONH
- ? Sign of progression?
- Usually seen after VF defect has occurred
  - Etiology – reduced demand for blood to that damaged, atrophic portion of retina/ONH

Relationship between PPA and VF (AJO 6/99)
- MD, CPSD of SWAP and standard were significantly worse in eyes with zone beta (any zone beta at all)
- Size of zone alpha correlated with MD of standard but not SWAP

Disk Hemorrhage in NTG
- AJO 6/00
- Is the presence of disk heme prognostic of VF progression?
  - 53% progressed if disk heme present (MD)
  - 81% progressed if disk heme present (pointwise VF definition)
- Recurrence is important
  - 67% did not progress if no recurrence
  - 27% did not progress if recurrence
  - Mean recurrence 12.2 mths later
Disk Hemorrhage In NTG (cont)

- Is the heme the etiology or the result?
  - Disk heme sign of progressive damage of NFL
  - Disk heme leads to deterioration of VF
  - Disk hemes are signs of active disease
- Disk hemes are the strongest risk factor for progression of VF (up to 20 fold increase)

Optic Nerve Head Imaging

- RTA
- HRT
- OCT
- GDx

- What role do these play?
- How often should they be done?

Disk hemorrhage

- 49.3% found inferotemporally
- 32.9% superotemporally
- Recurrences are likely at same location

Physiologic Cupping

- Is it a risk factor for glaucoma?
- Can a person w/ physiologic cupping develop glaucoma?
- Does it run in families?

How Does One Best

Examine The Optic Nerve Head?

Eric’s 3 Most Valuable Ophthalmoscopic Signs

- 1. Focal notches
- 2. Verticalization
- 3. NFL dropout
3 Most Valuable Indicators of Progression (MVPs)

• Enlargement of PPA
• Disk hemorrhage
• Focal recession of rim