Clinical Evaluation of the ONH & RNFL in Glaucoma
Beat the OCT!

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Clinical Key Point

• The diagnosis of glaucoma depends on detecting glaucomatous damage and analyzing the risk of developing damage. All means available should be used to achieve these.
• But the single most important factor in recognizing and differentiating glaucomatous damage is the clinical ONH/RNFL evaluation.

The Clinical Significance

• Critical to glaucoma diagnosis – look for glaucomatous pattern of ONH damage
• Helps you interpret the OCT findings
• Helps you avoid diagnosing glaucoma based on red (p<1%) on OCT printout – “red disease”
• Allows you to detect glaucoma clues that OCT is not designed to detect
• Helps you rule out non-glaucomatous optic neuropathies which can look like glaucoma on OCT

KEY CONCEPTS IN THE CLINICAL ONH/RNFL EVALUATION

• RNFL loss and VF loss are NOT very specific for glaucoma
  – Must have the ONH evaluation
• The pattern of glaucomatous ONH damage (cupping, later pallor inside the cup but no pallor outside of the cup) is very specific to glaucoma
• Pallor of rim strongly suggests a nonglaucomatous cause

Glaucoma versus red disease: imaging and glaucoma diagnosis

Gabriel T. Chong and Richard K. Lee

Recent findings
As imaging modalities have become more sophisticated and are validated in research studies, clinicians have come to rely upon data from these imaging devices to aid in differentiating between normal and glaucomatous states of the ONH and RNFL — typically by examining if the data are green or red, suggesting normal or abnormal. However, normative databases can sometimes be flawed relative to atypical ONH or RNFL morphologies and imaging can provide artifacts which do not represent true ocular disease but secondary to limitations of imaging technology.

Summary
Ophthalmic imaging is an important adjunct to clinical diagnosis but the results from imaging devices need to be assessed critically relative to artifacts of imaging and the limitations of the technology and its normative databases.

ONH/RNFL FINDINGS THAT IMAGING IS NOT DESIGNED TO DETECT

- Pallor of the ONH rim tissue
- Drance heme
- Parapapillary atrophy

Clinical Key Point

The best way to determine whether glaucomatous-looking RNFL loss or glaucomatous-looking VF loss is truly due to glaucoma is a clinical ONH/RNFL evaluation

IC

56 y/o Am +FHx of glau GAT:21/24
Glaucoma??
Superior arcuate RNFL wedge defect + sup temp rim is thin + sup paramacular RGC dropout respecting the temp horizontal raphe

Cirrus GCA
(Ganglion Cell Analysis)
Glaucoma??
Superior arcuate RNFL wedge defect + sup temp rim is thin + sup paramacular RGC dropout respecting the temp horizontal raphe

RTVue
RNFL + GCC
Glaucoma??
Superior arcuate RNFL wedge defect + large amount of sup paramacular RGC dropout respecting the temp horizontal raphe OS normal

Which imaging instrument is designed to pick these up?
**Clinical ONH Evaluation in IC Case**

**Key Points**
- Key finding for IC in OD: ONH pallor of the superior temporal rim
- Pallor is loss of the pink color of rim tissue which is outside of the cup = optic atrophy
- May have pallor and subsequently cupping; check the rim tissue outside of the cup

**How to Best Recognize Pallor**
- To recognize pallor its best to examine the ONH at a **lower** mag in order to perceive the color difference
- Low mag (5x) slit lamp funduscopy (Volk lens) or BIO or fundus photos

**IC HFA 24-2 OD Reliable??**

Fixation:
- Gaze Tracker: Good
- BS Monitor: Good
- FN: 25%

Interpretation:
- Lens rim artifact but central 24º is normal

**IC HFA 24-2 OS Reliable??**

Fixation:
- Perimetrist: “Not good”
- Gaze Tracker: Good
- BS Monitor: Fair
- FN: 40%

Interpretation:
- 360º lens rim artifact but central 24º is normal
- Possible SN step but doubtful
Is it real or is it “red disease”? 
55 y/o w f 
Glau suspect referred by local OD for imaging, 
CCT, stereo ONH photos due to increasing cups 
over past 4 years. IOPs have been in mid to 
high teens for several yrs. 
PMHx: Good health 
Family hx: No glau 
BCVAs: OD: 20/20- OS: 20/20 
GAT: 18/17 12:20 pm 
CCT: OD: 591 OS: 594 

HRT OU 
Report 
1/2/13 
Image quality: 
OD SD=9 
(excellent) 
OS SD =15 
(very good) 
MRA shows 
normal ONH 
in all 
sectors OU 

Cirrus 
1/2/2013 
ONH/RNFL 
scan 
Signal strength: 9/10 
OU 
Is this data 
reliable?? 
Does it 
suggest 
glaucoma? Is 
there RNFL 
loss OS?? 

TF – What is going on? 
• Major clues: 
  – OS ONH much smaller than OD in 1st scan 
  – All OS ONH, cupping, RNFL parameters are 
    shaded gray because OS ONH size is not 
    within the Cirrus database 
• Strategy: Clinical ONH/RNFL evaluation 
  – Clinical ONH & RNFL evaluation – do you 
    see ONH hypoplasia? 
  – Do you see RNFL loss/absence? 
• Bottom line: Scan for OS is not reliable – 
  algorithm for recognition of ONH edge 
  failed 

Repeat 
scan 
ONH/RNFL 
scan on the same day 
Is this data 
reliable?? 
Does it 
suggest 
glaucoma?
**Clinical Key Point**

*The but ...*

- However, there are MANY cases that cannot be determined on a single evaluation and are best monitored for glaucomatous progression.
- Progression analysis with imaging is improving and in the near future (now?) will outperform a clinical evaluation in identifying glaucoma progression in many cases.

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**ONH EVALUATION FOR CUPPING Technique and Strategy**

- Best technique → slit lamp/fundus lens
  - Stereo, med mag, fine slit beam
- Evaluate contour (3-D concept)
  - Cup is defined by CONTOUR, not color
  - Cupping (excavation) of neural rim is highly specific to early glaucoma
  - In early glaucoma there will be no pallor inside or outside of the cupping/excavation

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**ONH EVALUATION**

*Keys to Judging Contour & the Edge of the Cup*

- Vessel deflection
  - Use smaller/medium vessels, not large vessels
- Use narrow slit beam
  - There are many cases where there are no vessels that can be used
- Stereopsis – optimal at higher mag

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**WHY USE CONTOUR TO DEFINE CUP?**

- Vessel deflection
- Inside of cup is just as pink as the rim tissue

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**ONHs that Make Differentiation from Glaucoma Very Difficult!**

- Some obliquely inserted ONHs
- Tilted discs
- Drusen of the ONH
- Small ONH
  - Hypoplasia of ONH - small ONH due to lack of RGC development
  - Crowded discs
- Megalopapilla – large ONH

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**TILTED DISCS OU**
ONH DRUSEN
Buried and not so buried drusen

ONH HYPOPLASIA OS>OD
Generalized OU, segmental hypoplasia inferior temporal OS

CT
OS
11-12-04
30-2
SITA Std

Two subsequent Synemed VFs showed more missed points into the sup nasal step area of the central VF – progression!

CT
OS
11-17-98
Synemed
Central 30

Peripheral nasal step + small central nasal step

Peripheral sup arcuate + sup nasal step

Central nasal step
**Clinical Key Points**

- Congenital ONH anomalies can be extremely difficult to differentiate from glaucomatous damage. Why? Because it is difficult to differentiate damage from congenital anomaly.
- With congenitally anomalous ONHs in a glaucoma suspect it is often best to image (OCT), get ONH/RNFL photos, get baseline threshold VFs and follow for progression.
- Glaucoma will progress!

**SYSTEMATIC ONH EVALUATION**

- Check ONH size
- Evaluate rim tissue color
- Evaluate rim width & C/D
- Evaluate for parapapillary atrophy (PPA) & Drance heme
- Evaluate the RNFL

**IT IS WISE TO CHECK ONH SIZE FIRST!**

- ONH size largely dictates cup size and C/D
  - Large ONHs get large cups & large C/Ds
  - Small ONHs get small cups & small C/Ds
- Caution: Some small ONHs are hypoplastic
  - These very often have RNFL defects like glaucoma but not progressive loss

**CAUTIONS ON CUP SIZE DECISIONS**

- Large ONHs get large cups – be very careful to NOT overdiagnose glaucoma in large ONHs
- Small ONHs get small cups – be very careful to NOT underdiagnose glaucoma in small ONHs. A very small ONH with a small cup may have glaucoma
- Ethnicity and average ONH size:
  - African-American > Asian > Hispanic > Caucasian
**SYSTEMATIC ONH EVALUATION**

**ONH SIZE**
- Cup size related to ONH size
  - Larger ONH → larger cup and C/D
- Wide variation in ONH sizes
- Major factors:
  - Race/ethnicity
  - Refractive error
- *Always check ONH size before checking rim width & C/D*

**SYSTEMATIC ONH EVALUATION**

**Neural Rim Tissue**
- Portion of the ONH outside of the cup
- Most important ONH feature in glaucoma
- Factors to consider:
  - **Width**: Should follow ISNT rule
    - I slightly thicker than S > N. Temp is very variable
  - **Color**: Pink in glaucoma
    - I=S and N>S or I; temp rim color is highly variable
    - Color/pallor is most critical in nonglaucomatous
  - **Contour**: Most critical rim tissue feature in glaucoma; use slit beam

**Clinical Key Point**
- To help rule out an acquired nonglaucomatous optic neuropathy (optic atrophy) look very carefully for pallor of the rim outside of the cup
- Other strategies:
  - Evaluate the pattern of VF loss, if any
  - Evaluate the pattern of RNFL loss
  - Check for color vision loss. Glaucoma causes B-Y loss, rare in ON disease
  - Visual acuity loss - not typical of glaucoma
  - Neuroimaging

**VERY IMPORTANT**

**Pallor and Cupping**
- Cupping (contour) change precedes pallor in glaucoma
- Pallor of rim outside of cup is nonglaucomatous OA

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35 y/o male
History of headaches x 4 months; getting more frequent and more painful. Might be related to computer work; 14+ hours/day on computer. PCP sent him for eye exam.

VAs: 20/20 OD, OS
Pupils: 2+ light reflexes OU but 4+ near reflexes, no APD.
EOMs: full
NCT: 22/24 3:30 PM
FDT: Repeated x 2
44 y/o white male
BCVA: 20/20 OD, OS  GAT: 25/26 9:40 am
Color vision: normal on HRR plates

**Glaucomatous, nonglaucomatous or both?????**

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**SYSTEMATIC ONH EVALUATION**

- Check ONH size
- Evaluate rim tissue color
- Evaluate rim tissue width & C/D
  - C/D considerations
- Evaluate for parapapillary atrophy (PPA) and Drance heme
- Evaluate RNFL

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**SYSTEMATIC ONH EVALUATION**

**C/D Considerations**

- ↓ rim tissue width causes ↑ cup/disc ratio so rim tissue width is MUCH more important than C/D
- Judge cup by contour not by color
- ~ 2% of normals have C/D ≥ .7
- Best to draw even if photos are taken

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**SYSTEMATIC ONH EVALUATION**

- Check ONH size
- Evaluate rim tissue color
- Evaluate rim tissue width & C/D
- Evaluate for parapapillary atrophy (PPA) and Drance heme
- Evaluate the RNFL

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**SYSTEMATIC ONH EVALUATION**

**PARAPAPILLARY ATROPHY**

Two Components

- Zone beta
  - Closer to ONH
  - Large choroidal vessels visible
  - Important in glaucoma
- Zone alpha
  - More peripheral to zone beta
  - Irregular pigmentation
GLAUCOMATOUS ONH

Focal ↓ Rim Tissue Width (“Notch”)

- Inferior > superior
- Often preceded by Drance heme
- Results in eventual focal RNFL defect and focal VF loss
- More common in small ONH?

LOCATION OF FOCAL RIM TISSUE LOSS vs STAGE OF GLAUCOMA

- Early glaucoma – mainly inf temp rim and sup temp rim
- Moderate glaucoma – temp rim unfolds
- Advanced glaucoma – nasal rim

This pattern of rim tissue damage corresponds to the typical sequence of VF damage in glaucoma.

Focal ↓ in Rim Tissue Width Color Changes Within the Notch

- Pink
- Less pink - “tinted hollow”
- Grey - “shadow sign”
- Laminar dot sign

Glaucomatous cupping

Pink inside of cup & pink rim tissue

Superior edge of cup

Note cupping almost to inf disc margin inferiorly

Deep, steep notch to disc margin inferiorly But still pink within the notch!
**Advanced (deep, steep bordered) cupping inferiorly with loss of color within the cup but no laminar dots yet**

**SAUCERIZATION**
- Saucer-like cupping pattern with 2 or 3 levels of cupping
- Can be extremely subtle
- Determination of contour is critical
  - Don’t use color to define the cup margin; it can be very deceptiv
- Important: From the disc margin moving toward the center of the cup the first downward deflection of the RNFL or a vessel or your slit beam represents the cup edge!

**INFERIOR SAUCERIZATION**
Note the pink color within the cup

**Drance Hemorrhage**
(Splinter heme/flame heme on ONH)
- Flame heme on ONH margin
- Very common but transient (lasts < 2-6 weeks)
- Precedes ONH damage/VF loss by years!
- Recent retrospective analyses of large multicenter randomized clinical trials brings into question the significance of Drance heme in glaucoma

**Drance heme examples**

**Drance Heme**
Retrospective Look at Findings in Large, Randomized Clinical Trials
- **OHTS**
  - Most (87%) with heme did not convert to glaucoma in average of 96 months Budenz D et al. Ophthalmology 2011.
- **EMGT**
  - Hemes predicted progression but treatment did not prevent progression
  - Equal occurrence in treated and not treated patients
- **NTGS**
  - Hemes predicted progression but treatment did not affect clinical course
Drance Heme - Ddx

- LTG, COAG
  - More common in those with large beta zone PPA
- Anticoagulant or meds/herbal meds with anticoagulant effects
  - Aspirin, ginkgo biloba, fish oil capsules etc.
- Bleeding disorders
- DM, HBP retinopathy
- Anemia
- Migraine
- PVD or peripapillary vitreal traction
- AION
- Disc drusen
- Disc edema
- Random occurrence <0.2%

DRANCE HEME
Management considerations

- If already a glaucoma suspect then Drance heme suggests that the patient is progressing → treat????
- If already treated → perhaps something is wrong:
  - Check compliance
  - Diurnal, supine IOP evaluation (is IOP spiking?)
  - Target IOP (is it low enough?)

Clinical Key Point

- Recent findings bring into question the relationship of Drance hemes to glaucoma.
- May be best to monitor patients who have a Drance heme rather than change their management.

WV Summary to 10/30/2013

- 88 y/o w f
- POAG treated since 1996; at SCCO since 2006
- Long time Timolol 0.5% bid but reduced to qd (upon arising) 4/2006
- Large shallow cups but stable since 2006
- CCT: OD: 480  OS: 490
- GAT: 12 to 16 at all visits
- HFA 24-2: no VF loss, no progression
- HRT: Large cups but no progression
- RTVue: Normal RNFL, ERM OU with VMT

WV 10/30/2013

- NCT: 12, 11, 13/13, 13, 13  2:00 pm
- HRT: No progression by TCA analysis but inf temp RNFL defect present OS
- RTVue: No RNFL or GCC loss OU
- ONH: see photos
- Tonopen – sitting: OD: 15.1  OS: 16.3
- Tonopen – reclined: OD: 19  OS: 20.2

WV 10/13/2013, 10/30/2013
Inf temp flame heme OU, inf RNFL defect OS
**WV**
What should we do with OU Drance hemes?

- Nothing
- Go back to **BID 0.25% Timolol**
- Add a PG to the Timolol
- Substitute a PG
- SLT to flatten the diurnal IOP curve

**RNFL LOSS - SIGNIFICANCE**

- Can precede corresponding VF loss by up to 8 yrs.
- Can be used to predict presence and location/type of VF loss
  - Diffuse RNFL loss → generalized depression of VF, if any VF loss present at all
  - Focal RNFL loss → focal VF loss in the corresponding area of VF, if any VF loss present

**LOCALIZED RNFL LOSS TYPES**

- Slit defects
  - Narrow, greater than width of retinal vessel
  - If single no VF loss
- Wedge defects
  - Coalesced slit defects – wider
  - More likely to show VF defect

**Normal RNFL or not?**

- 2 RNFL defects – sup slit defect + inf wedge

**NOT NORMAL!**
3 narrow wedge defects inferiorly

What 3 signs suggestive of glaucomatous damage are present?

CAUTION!!!
RNFL loss and VF loss are NOT very specific for glaucoma → many possible causes other than glaucoma
The ONH changes are much more specific to glaucoma; use ONH to confirm glaucoma as cause.

HS 28 y/o with history of eye trauma in OS.
GAT: 22/22 VFs: Inf arcuate scotoma OD
Glaucoma???

What is the cause of the inf arcuate scotoma?
OS – same ONH problem as OD but also a choroidal rupture inferiorly.

Does imaging really help in the differentiation of the cause?

23 y/o wm
History of MVA – head trauma
OD – normal
OS – sup & inf arcuate RNFL loss

TM

23 y/o wm
Hx of MVA – head trauma
Sup & inf arcuate RNFL defect OS; normal OD

ONH PROGRESSION
Which is better imaging or clinical evaluation?

* Use all techniques available to you:
  - Clinical evaluation
  - ONH/RNFL photos - stereo photos better than monocular photos
  - Imaging
* Progression may be detected first on any of these; correlate to the others & to the VF
* Imaging appears to be capable of detecting very small changes in the ONH & will prove to be very good at identifying and tracking progression

DM ONH OS Stereopair
DM HRT TCA
Note inf temp rim loss in early 2011

Consistent, progressive inf rim loss OS on last 4 exams that was not detected clinically

Questions?
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