Optical Coherence Tomography (OCT) for Glaucoma

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Imaging for Glaucoma: New Stuff

- Spectral Domain OCT
  - Zeiss: Cirrus
  - Optovue: RTVue 100 / iVue
- Structure and Function
- Progression Analysis
  - HRT and Spectral Domain
- Cases

Case

- 50 yo
- No significant history
- Slit Lamp is normal
- GAT= 22 OD and 24 mmHg OS
- Pach= 570 / 572 μ

Assessment:
- Slightly elevated IOP
- Avg CCT
- Thin NRR / Asymmetric CD ratio
- Unreliable VFs
- Definite OCT Abnormality

PLAN:
- Treatment PGA

Is this enough information to make the best assessment and treatment plan for the patient?
CASE JH

- 51 yo
- Large cupping
- Negative Family History
- GAT = 24 mmHg OD; 25 OS
- CCT = 515/525 µ

Photos

SAP Visual Fields

Risk Calculator

Case OB

Suspect to POAG
Case OB

- 53 yo, woman,
- GAT: ~ 23 – 25 mmHg
- CCT: ~ 568 µ
- Neg Family history glaucoma
- + hypertension
5 years later

Serial VFs 1

Serial VFs 2

Serial VFs 3

Initial 3 years later

Cirrus OCT
Challenges of Glaucoma

- The structural changes in early glaucoma can be difficult to distinguish
  - Wide variation of optic disc size in both normal and glaucoma patients

Optic Disc Size

- Size of cup varies with size of disc
- Large discs have large cups in healthy eyes

Identify small and large optic discs

- Small: avg vertical diameter < 1.5 mm
- Large: avg vertical diameter > 2.2 mm
### Optic Disc Size

Small discs with glaucoma may have small cups

### Current Standard

- **Obtain Baseline Photographs**
  - Stereo is preferred
  - *Screen-Vu Stereo Viewer™*
    - www.berezin.com
  - Read, Review, and Document in record
  - Repeat periodically, or when change is suspected

### Stereo Viewing

### Fundus Cameras

### Photos

Photo 2005 vs 2010
How do you view all of this?
Zeiss Forum: Combined Report

Image Management Systems
- Topcon
  - EyeRoute
- OIS
  - Symphony Web
- EHR Systems
  - Generally don’t offer as much functionality

Clinical Strategy for Glaucoma
- Earlier identification
  - of glaucoma suspects
- Earlier diagnosis
  - of glaucoma using the most sensitive, specific, objective, and reproducible tools available.
- Progression Analysis
  - Who is getting worse? What is the rate of progression?
- Tools to individualize treatment
  - to maintain quality of life while minimizing costs of treatment.

At first, OCT was slow
- First OCT images taken by Huang and Schuman over night in James Fujimoto’s laboratory, MIT

OCT – Time Domain Stratus
Strengths
- Provides Cross Sectional images
- Useful to calculate RNFL thickness
- Cross section scans useful for retinal pathologies
- Database comparisons

Weaknesses
- Slow scan speed (400 A-scans / second)
- Limited data for glaucoma, 768 pixel (A-scan) ring for RNFL
- Limited data for retina, 6 radial lines with 128 A scans (pixels) each
- Macula maps 97% interpolated
- No progression analysis
- Location of scan ring affects RNFL results
- Prone to motion artifacts because of slow scan speed
- Poor optic disc measurements

Time Domain OCT susceptible to eye movements
- 768 pixels (A-scans) captured in 1.92 seconds is slower than eye movements
- Stabilizing the retina reveals true scan path (white circles)

Benefits of Spectral Domain

- Higher resolution
- Fewer moving parts – faster scan acquisition
- Acquisition of a cube of data
- Better visualization of tissue/pathology
- Slightly better penetration of light
- Better registration
- 3D analysis

Spectral Domain: Many Options

Cirrus™ HD-OCT

Model 4000
Model 400 (no LSO)

Optic Nerve Head Analysis

- The new Cirrus™ HD-OCT Optic Nerve Head Analysis software from Carl Zeiss provides automated identification of the optic disc and cup boundaries.

Optic Nerve Head Calculations

- The disc edge is determined by the termination of Bruch’s membrane. This is validated in the literature. The rim width around the circumference of the optic disc is then determined by...
Case YD

• 55 yo C, F, Seeking second opinion
• History of being treated for glaucoma
  – Currently on PGA and beta blocker
  – Was recommended to have laser trabeculoplasty
• No insurance currently
• IOP= 17 mmHg
  – Reports PreTx IOP around 21mmHg
• CCT= 555µ

Case GS

• 55 yo C, F, Seeking second opinion
• History of being treated for glaucoma
  – Currently on PGA and beta blocker
  – Was recommended to have laser trabeculoplasty
• No insurance currently
• IOP= 17 mmHg
  – Reports PreTx IOP around 21mmHg
• CCT= 555µ
Several Years Later:
OCT for Glaucoma

**Optovue: RTVue 100**

- Retina
- Glaucoma
- Anterior Chamber

**Optovue: iVue**

**Glaucoma: Macular Ganglion Cell Mapping**

- RTVue FD-OCT
- 25,000 A-scan per second
- 5 micron axial resolution
- Ganglion Cell Complex (GCC)
- 7 mm scan area
- 14,944 A-scans, 9.98 sec

**Ganglion Cell Complex (GCC)**

**CASE DD**

**Optovue: iVue**
Case EG

- 67 yo, AA male, Retired school teacher
- Good health, no medications
- + Family History of glaucoma
- OHTN/Early Glaucoma
- CCT= 567, 571
- Pre- Tx IOP ~ 30 mmHg OD, OS
- With PGA:
  - Always 20-23 mmHg x 5+yrs
  - Good Compliance

Photos (initial)

SAP  VFs

SWAP VFss
Photos (5 yrs later)

Left Eye: Can you see a change?
CASE MT

- 60 year old patient
- 10 ten history of POAG
- Poor visual field test taker
- IOP ~ 20/21 mmHg on PGA

- ?Progression?

Detecting Structural Progression of Glaucoma

A Key Component of Glaucoma Management
Two key questions every glaucoma practitioner has:

- Is my patient getting worse?
- How can I tell for certain?

“Measuring the rate of progression is, however, challenging because it is hard to differentiate a true change from that due to a variation in testing.”

- Ted Garway-Heath
  - Roundtable Meeting December 17, 2005,
  - Rome, Italy

What is Glaucomatous Structural Change?

- Retrospective study of disc photos taken over 15 years on 259 patients with glaucoma
- 29 Eyes showed progressive enlargement of the cup:
  - Vertical extension: 17%
  - Horizontal extension: 3%
  - Generalized Expansion: 79%

  - Likely the hardest to see ophthalmoscopically

Pederson, Arch Ophthal 1980

Focal Neuroretinal Rim Narrowing

Baseline

Follow-up

Courtesy of David S. Greenfield, MD.

Progression Detection:

Summary

- Registration of Images is Key
  - Good-quality data and careful use of testing frequency are important
  - Need to differentiate patients who progress quickly:
    - more frequent testing required
    - Event vs. Trend Analysis
  - Combine Structure and Function

- Answer = Spectral Domain OCT

Cirrus HD-OCT GPA Analysis

Guided Progression Analysis

Image Progression Map

- Two baseline exams are required
- Third exam is compared to the two baseline exams
- Sub pixel map demonstrates change from baseline
- Yellow pixels denote change from both baseline exams
- Third and fourth exams are compared to both baselines. Change identified in three of the four comparisons is indicated by red pixels. Yellow pixels denote change from both baselines

Change refers to statistically significant change, defined as change that exceeds the known variability of a given pixel based on population studies

Cirrus HD-OCT GPA Analysis

TSNIT Progression Graph

- TSNIT values from each exam are shown
- Significant difference is colorized yellow or red
- Yellow denotes change from both baseline exams
- Red denotes change from 3 of 4 comparisons

Summary Parameter Trend Analysis

- Rate and significance of change shown in text
- RNFL thickness values for overall Average, Superior Average, and Inferior Average are plotted for each exam
- Yellow marker denotes change from both baseline exams
- Red marker denotes change from 3 of 4 comparisons
- Confidence intervals are shown as a gray band

- Legend summarizes GPA analyses and indicates with a check mark if there is possible or likely loss of RNFL
Case GJ

- PreTx IOP: 38/39 mmHg
- CCT = 575 µ
- Angles Open
- No PDS or XFS

Photos 2005

HVF 2006

Treated

IOP in mid twenties on PGA alone

GPA 2008

Cirrus OCT 2008 and 2009
Case GJ

- OHTN / Early POAG left
- Stable though unreliable visual fields
- Consistent early RNFL loss, R>L
- ? How aggressive to treat?
Case

- 45 yo
- No significant history
- Slit Lamp is normal
- GAT = 27 OD and 24 mmHg OS
- Pach = 569 / 572 μ
  - RC

Photos

Left VFs Right

CASE EW (snowbird)

- 70 yo, W, M
- Hx of Phaco/IOL x 2 yrs
  - never completed follow up
- SLE: quiet, No C/F, IOL in position
- IOP 34 OD; 21 OS
- Gonioscopy: open w/o PAS
CASE EW A and P

Assessment:
Glaucoma OD
Significant GCC loss with minimal VF loss

PLAN:
Start PGA qhs OD only trial may add OS

Imaging Doesn't Always Work:

Case AK

- 52 yo, W, F, from Poland
- Good Health, no medications
- High Myope
- Told she has glaucoma
- IOP = 12 OD, 13 OS
- Pachs = 590
- Currently taking 2% dorzolamide TID OU
  - Multiple topical side effects
What are practitioners’ most common misunderstandings of imaging technology?

“The thought that these devices can diagnose glaucoma in the absence of corroborating clinical evidence is, in my opinion, the most common (and potentially dangerous) misunderstanding. The limited normative databases against which scans are compared can never cover the remarkably varied appearance and structure of the optic nerve we encounter in normal individuals.”

James Brandt, MD