Use of Diagnostic Imaging in Glaucoma

Michael Chaglasian, OD
Illinois Eye Institute
Illinois College of Optometry
mchaglas@ico.edu

Disclosure

- Michael Chaglasian has the following disclosures:
  1. Advisory Board / Honoraria:
     - Allergan, Alcon Labs, Carl Zeiss Meditec
  - The content of this presentation is in no manner influenced by any of the aforementioned parties or companies

Overview

- This introductory lecture will provide a step by step approach for several of the main OCT imaging systems that are currently available.

- Emphasis is placed on proper selection and correct interpretation of the various scan patterns for glaucoma and retinal disease.

- Numerous case examples are included.

Outline

Objectives:
1. Learn to accurately and efficiently assess an OCT printout on patients with glaucoma or retinal pathology.
2. Learn to identify artifacts that appear in OCT imaging.
3. Learn to compare OCT imaging with fundus photography.
4. To review clinical care guidelines for diagnosis and treatment based upon the OCT findings.
5. To understand the best practice utilization of OCT imaging for patients in conjunction with other exam procedures (ophthalmoscopy, visual fields).
6. To review techniques for the determination of disease progression based upon OCT.

Possible Indications for Performing OCT

- Elevated IOP > 21mm Hg
- C/D > .5 or Asymm. > 0.2
- Poor visual field test-takers
- Narrow anterior chamber angles
- High myopia
- Personal or family history of
  - diabetes
  - glaucoma
  - hypertension
  - field defects
- Suspicious Optic Nerves
  - Marcus Gunn pupil
  - Acquired color defect
  - poor confrontation fields
  - Disc pallor
- Unexplained decreased vision
- Drusen / AMD
- Numerous maculopathies and retinopathies
- And Many Others

Requirements of OCT Technology

- Validation / Accuracy / Improved Outcomes
  - Peer reviewed articles in the literature
    - Not sales/marketing hype

- Cost Effectiveness
  - Can be challenging.
    - Survey your patients for three months
    - Consider “added value” to your practice

- Ease of Use / Ease of Interpretation
OCT out performs Photography

- Conclusions:
  - For detection of a variety of retinal irregularities evaluated in the current study, volume OCT scanning was more sensitive than non-mydriatic retinal photography in our asymptomatic individuals.
  - OCT detected clinically relevant disease features, such as subretinal fluid, that were missed by FP, and had a lower ungradable image rate.
  - It is likely that OCT will be added to photography screening in the near future for choroidal disease.

OCT Coding / Billing 2013

- **92132**-
  - Used for cornea and narrow angle diagnoses
  - Some carriers/insurances are not covering

- **92133**-
  - Used for ALL Glaucoma and optic neuropathy diagnoses

- **92134**-
  - Used for ALL (approved) Retinal diagnoses
  - Mutually exclusive and cannot be billed on the same day as 92133. Can be billed with 92132.
  - None can billed on same day as fundus photos, 92250

OCT Coding / Billing 2014

- Must be based upon “Medical Necessity” and entering CC / reason for visit
  - Reason for diagnostic test?
  - Directly stated or easily implied
  - Will it effect diagnosis or treatment?
  - Always requires an “Order” and an Interpretation and Report

2013 Avg. Reimbursement:

- **$45-48**
  - Each of these new codes is considered unilateral or bilateral
  - Frequency varies with diagnosis
  - Obtain List of covered ICD-9 codes (Medicare LCD)

John Rumpakis, OD, MBA

“Here’s the bottom line:

Your patients’ medical insurance is not the same thing as your malpractice insurance.”

http://www.revoptom.com/content/d/coding___and___practice_management/c/36039/
**Optimize Revenue**

- The OCT model can help you improve your billing and coding.
- Help you build glaucoma and retina patients.
- According to Dr. John Rumpakis, a new glaucoma patient can require procedures valued up to $985 the first year.1

### FIRST YEAR GLAUCOMA PATIENT REVENUE

<table>
<thead>
<tr>
<th>VISIT #</th>
<th>TOTAL FEES PER VISIT</th>
<th>RUNNING TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST</td>
<td>$164</td>
<td>$164</td>
</tr>
<tr>
<td>SECOND</td>
<td>$288</td>
<td>$452</td>
</tr>
<tr>
<td>THIRD</td>
<td>$55</td>
<td>$731</td>
</tr>
<tr>
<td>FOURTH</td>
<td>$144</td>
<td>$875</td>
</tr>
<tr>
<td>SIXTH</td>
<td>$55</td>
<td>$930</td>
</tr>
<tr>
<td>SEVENTH</td>
<td>$55</td>
<td>$985</td>
</tr>
</tbody>
</table>


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### ADDITIONAL INCOME DUE TO IMPROVED CASE DETECTION

**One ROI Example:**

**OCT only 13.5 per month or 3.4 week for break-even**

<table>
<thead>
<tr>
<th>Procedures for each Glaucoma suspect and diagnosed, 2nd and 3rd visits2</th>
</tr>
</thead>
<tbody>
<tr>
<td>92014 Ophthalmological services, comprehensive medical examination</td>
</tr>
<tr>
<td>92250 Fundus Photography</td>
</tr>
<tr>
<td>92020 Gonioscopy</td>
</tr>
<tr>
<td>92083 Threshold Vascular Fields</td>
</tr>
<tr>
<td>76514 Comtal Pachymetry</td>
</tr>
<tr>
<td>92012 Ophthalmological services, intermediate</td>
</tr>
<tr>
<td>92132 Diagnostic Anterior Digital Imaging, - Spectralis</td>
</tr>
<tr>
<td>92133 Diagnostic Posterior ONH Digital Imaging, - Spectralis</td>
</tr>
</tbody>
</table>

Income generated by two follow-up visits of each glaucoma suspect $407.2

2. There is no guarantee that your Medicare carrier will pay for these procedures when performed on the same day. Please contact your local Medicare carrier to determine appropriate billing guidelines.

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**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

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**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)3

Use of Diagnostic Imaging in Glaucoma

**Time Domain OCT artifacts can be common**

<table>
<thead>
<tr>
<th></th>
<th>Stratus</th>
<th>SPECTRALIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Error in Stratus OCT Scans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral Domain OCT**

**Spectral Domain Comparison**

Typical SD OCT

SD OCT w/tracking & Noise Reduction

**Spectral Domain: Many Options**

Spectral Domain: Many Options

**Still Valuable: But Perhaps Limited Future**

(I am unaware of any timelines)

OptosOCT SLO

GDx

Optical Coherence Tomography

RS-3000 Advance NOT FDA Approved for US Sales

Michael Chaglasian, OD
Spectral Domain: Why??

- Enhanced reproducibility and registration.
- Objective quantitative data that supports standardization of care at an expert level.
- Pinpoint correlations in ocular structure and function, matching areas of abnormal tissue with attendant vision problems.

Cirrus™ HD-OCT

Cirrus HD OCT:
Optic Nerve Head Analysis

- This analysis:
  - Automatically identifies the optic disc and cup boundaries.
  - Is generated using the dense data in the Optic Disc 200x200 data cube and a proprietary ZEISS algorithm.
  - Is designed to precisely measure the neuro-retinal rim while accounting for tilted discs, disruptions to the RPE and other challenging pathology.

Printout

How to “Read” a Printout

- FIRST! Signal Strength
  - A KEY indicator of image quality
  - Should be 7/10 or higher on Cirrus
  - DO NOT interpret poor quality scan as “red” disease
- Well centered image
- No evidence of movement artifact
- Review Plots and Displays
  - Thickness Map and Deviation Map
  - Quadrant and Sector Plots
  - TSNIT and Optic Nerve B-Scan
Glaucoma – RNFL Thickness Analysis

- The RNFL thickness map shows the patterns and thickness of the nerve fiber layer within the 6mm x 6mm cube
  - Yellow and Red = Good / Normal
- The RNFL deviation map is overlaid on the OCT fundus image to illustrate precisely where RNFL thickness deviates from a normal range
  - Yellow and Red = Bad / Abnormal

Normative Data: Glaucoma

- Average RNFL Thickness
- RNFL Symmetry
- Rim Area
- Disc Area
- Average C/D Ratio
- Vertical C/D Ratio
- Cup Volume

Distribution of Normals:
Color coded indication of normative data comparison for RNFL and ONH:
- The thickest 5% fall in the white area.
- 90% of measurements fall in the green area.
- The thinnest 5% fall in the yellow area or below.
- The thinnest 1% fall in the red area.
- Measurements in red are considered outside normal limits.
- ONH values will be shown in gray when the disc area does not match with normative data.

Example Normative Data:
**Example Normative Data:**

<table>
<thead>
<tr>
<th>RNFL</th>
<th>ONH</th>
<th>Optic Disc Cube 200x200</th>
<th>OD</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average RNFL Thickness</td>
<td>70 μm</td>
<td>60 μm</td>
<td>60 μm</td>
<td>60 μm</td>
</tr>
<tr>
<td>Rose Angle</td>
<td>1.5°</td>
<td>1.2°</td>
<td>1.5°</td>
<td>1.2°</td>
</tr>
<tr>
<td>Size</td>
<td>10.5 mm</td>
<td>10.5 mm</td>
<td>10.5 mm</td>
<td>10.5 mm</td>
</tr>
<tr>
<td>Average C2D Ratio</td>
<td>0.33</td>
<td>0.35</td>
<td>0.33</td>
<td>0.35</td>
</tr>
<tr>
<td>Vertical C2D Ratio</td>
<td>0.43</td>
<td>0.45</td>
<td>0.43</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Cort thickness: 0.15 mm - 0.20 mm

**SD-OCT - Heidelberg Engineering**

SD-OCT Spectralis
40,000 scans per sec.

**Eye Tracking**

The reference image tracks eye movement, and the cross section is moved to match.

**Eye-Tracker Controls Scan Location in Real Time**

- Eye tracker recognizes eye movement and repositions scan pattern
- Data acquired during eye movement is discarded
- Stored data is free of motion artifacts

**Optovue: RTVue**

**Optovue**
iVue (Optovue)
- Retina, Glaucoma and Cornea scans and report
- Spectral-Domain OCT in a compact package
- 5 micron resolution
- 26,000 A-scans/sec
- Change & OU Analysis
- Ergonomic & Simple for fast workflow
- Convenient Scanner Head LCD Touchscreen

RTVue: RNFL and GCC

RTVue w/ GCC and RNFL

NEW: 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.

Cirrus: Ganglion Cell Analysis
- Data for both eyes (OU)
- Thickness Map —
  - shows thickness measurements of the GCL + IPL in the 6mm by 6mm cube and contains an elliptical annulus centered about the fovea.
- Deviation Maps —
  - shows a comparison of GCL + IPL thickness to normative data.
- Thickness table —
  - shows average and minimum thickness within the elliptical annulus.
The Ganglion Cell Complex (GCC) (iVue, RTVue) Inner retinal layers provide complete Ganglion cell assessment:
- Nerve fiber layer (g-cell axons)
- Ganglion cell layer (g-cell body)
- Inner plexiform layer (g-cell dendrites)

Posterior Pole Asymmetry Analysis
- A new SPECTRALIS software feature to help assess RNFL and GCL loss by mapping retinal thickness across the posterior pole
- Potential to detect earlier RNFL loss compared to RNFL thickness circle scans, fundus photos or visual fields

Glaucoma Case Study 1: Asymmetry of Ganglion Cell Analysis
- IOP 28 OD, Early VF Defect, Inferior RNFL defect

Posterior Pole Case Study 2
"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

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*Red Disease!*

**Glaucoma versus red disease: imaging and glaucoma diagnosis**

- Red disease can be difficult to distinguish from glaucoma.
- Wide variation of optic disc size in both normal and glaucoma patients.¹

¹ JB Jonas, Ger J Ophthalmology, 1992;1 (1); 41-4

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**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 patients¹
Use of Diagnostic Imaging in Glaucoma 2014

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Use of Diagnostic Imaging in Glaucoma

Diagnostic Testing for Glaucoma

1. A method for detecting abnormality and also documenting optic nerve structure should be part of routine clinical management of glaucoma.
2. According to limited evidence available sensitivity and specificity of imaging instruments for detection of glaucoma are comparable to that of expert
3. Digital imaging is recommended as a clinical tool to enhance and facilitate the assessment of the optic disc and retinal nerve fiber layer in the management of glaucoma.

Optic Disc Size

Small discs with glaucoma may have small cups

Large discs have large cups in healthy eyes

Size of cup varies with size of disc

Small discs: avg vertical diameter <1.5 mm
Large discs: avg vertical diameter >2.2 mm

Large Disc / Large Cup

Optic Disc Photos

Subtle disc change

No disc change x 30 years (without treatment)

The Global Glaucoma Network
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

Current Practice “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

Glaucoma Madness

• Plethora of information
  • Nothing Definitive in Early Stages
    • Nothing Stable
    • ONH – IOP/C/D Ratio
    • Pachymetry
    • Gonio – family history
    • Ethnicity – Stereo Photos
    • Pallor – Rim Area
    • Asymmetry-Blood Flow
    • Visual Fields

FRUSTRATION
Use of Diagnostic Imaging in Glaucoma

Increasing Prevalence of Glaucoma

Increasing Prevalence: African American

Increasing Prevalence: Hispanic

CASE EE

IOP 21-24 mmHg
CCT 545

Disc Photos

Visual Fields

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Use of Diagnostic Imaging in Glaucoma

Combined Report

CASE MZ

IOP in high teens

CCT= 560

Disc Photos

Visual Fields
CASE CM

38 yo
GAT = 22 OD 25 OS

Visual Fields
CASE SR

65 yo
GAT = 19 OD, 18 OS
CCT = 505

Visual Fields
Glaucoma Suspect: IOP~ 23mmHg
Detecting Structural Progression of Glaucoma

A Key Component of Glaucoma Management

Two important questions every glaucoma practitioner has:
- Is my patient getting worse?
  - How can I tell for certain?
  - Variability in perimetric testing
  - Challenges of ONH serial assessment

Newer Question:
- What is the rate of progression?
- Can we quantify this?

Different Rates of Progression

Variability in Progression Rates

Progression Measurement: Older Options

GDx SLP Stratus OCT

Still Valuable: But Perhaps Limited Future
(I am unaware of any timelines)
HRT: Topographic Change Analysis Report

Case Example:
Progression Left Eye?
Visual Field is Stable

Cirrus GPA Progression Report

Cirrus OCT GPA Analysis

How to Evaluate Progression?

• Event Analysis:
  – Progression is defined when the difference between baseline and follow up is greater than test-retest

• Trend Analysis:
  – Progression is defined when there is a significant negative slope of a regression line, which is performed on a particular parameter

Cirrus RNFL “Event” Analysis

• Two baseline exams are required
• Yellow Coded: Change greater than test-retest variability.
• Red: Confirmed on follow up.
Patterns of Progression

- Initial Appearance of Defect
- Widening of Defect
- Deepening of Defect

Leung et al. Ophthalmol 2012

Appearance of Defect

Leung et al. Ophthalmol 2012

Widening of Defect

Leung et al. Ophthalmol 2012

Deepening of Defect

Leung et al. Ophthalmol 2012

Cirrus RNFL/ONH Trend Analysis

Four Parameters: Average, Superior, Inferior RNFL; Average C/D Ratio

Trend Analysis:

- Regression Line is drawn to determine rate of change for all the data that has been collected over time.
- Less variability with Structural/OCT testing compared to Functional/Visual Field testing.

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

Cirrus GPA Analysis
**Cirrus GPA: Trend Analysis**

- Average RNFL Thickness values are plotted for each exam.
- Yellow marker denotes change from both baseline exams.
- Red marker denotes change sustained over consecutive visits.
- Rate and significance of change are shown in text.

**Cirrus GPA™ Analysis RNFL Summary**

- Legend summarizes GPA analyses and indicates with a check mark if there is possible or likely loss of RNFL.
- RNFL Thickness Map Progression (best for focal change)
- RNFL Thickness Profiles Progression (best for broader focal change)
- Average RNFL Thickness Progression (best for diffuse change)
Limitations to OCT Progression

- Age Related RNFL and Macular Thinning:
  - Is not accounted for in the analysis
  - ~0.52 µm/year and ~0.25 µm/year
  - thus, not all negative slope is disease related and may not be related to glaucoma progression

- Review all clinical findings, do not base management decisions on OCT alone
  - Avoid “Red Disease”

CASE VM

48 yo
Several Year History of OHTN
CCT ~ 575µ
Negative Family History
Monitored q3-4m without Treatment

Disc Photos
Case EG

- 67 yo, AA male, Retired school teacher
- Good health, no medications
- + Family History of glaucoma
- OHTN/Early Glaucoma
- CCT= 565, 555
- Pre-Tx IOP ~ 30 mmHg OD, OS
- With PGA:
  - Always 20-23 mmHg x 5+yrs
  - Good Compliance
Use of Diagnostic Imaging in Glaucoma

ONH Photos

Current and Initial

Progression?

Cirrus GPA: Stable OD and OS

Page 2 Data

GPA Visual Fields
Case EW

- 73 yo, “Snowbird”
- Pseudophakic OU
- PreTx GAT:
  - 34 mmHg and 24 mmHg
- Currently:
  - 22 and 18 mmHg on a PGA
Detection of Progression using both Structure and Function

- Structural tests not necessarily better than functional tests in early disease
- Both imaging and visual function tests should be used to monitor OHT and early glaucoma
- Earliest detection/progression will vary amongst patients

Take Home Message:

- RNFL and ONH Progression Analysis on OCTs is now at a higher level.
  - Macular/Ganglion Cell Scans may be included in the future
- Structural Progression Analysis will become a regular part of the best practice patterns for glaucoma.