I. OCT in glaucoma: interpretation, progression, and management

A. Goals
   1. Discuss analysis of optic nerve OCTs
   2. Review strengths and weaknesses of OCT for glaucoma management
   3. Review recent research about OCT related to diagnosis and progression
   4. Provide tips for improved use of OCT in clinical practice

II. OCT Overview

A. Available OCTs
   1. Zeiss Cirrus, Heidelberg Spectralis, Zeiss Stratus, RTVue, etc

B. Spectral domain vs. time domain
   1. Similarities/differences in databases
      a) Progression between instruments?
   2. SD-OCT advantages:
      a) Higher resolution, decreased scanning time
      b) Better repeatability of RNFL measurements
      c) More data – peripapillary scans with RNFL thickness maps, macular GC analysis, etc
      d) Better for diagnosis and progression
      e) Interpretation and influential Factors

III. Influential Factors?

A. Normative databases
   1. Stratus
   2. Cirrus
   3. Spectralis
   4. RTVue

B. Average RNFL Thickness measurements
   1. Stratus: 99-100um in Caucasian/Japanese
   2. Spectralis: 89-97.3um +/- 9.6 to 15.87um
   3. Cirrus: 84-94um +/- 13.68um
   4. RTVue: 107.9 +/- 10um
   5. Topcon: 102um
   6. Range: approx. 90-108um

C. Red-Green Disease

D. Scan Quality
   1. Media, PVD, and eye movement effects

E. ONH size/Disc area
   1. Larger ONH means OCT scan is closer to ONH
      a) RNFL thickness decreases as measurement diameter increases
      b) Overestimates RNFL in some studies but not others

F. Disc area measurements
G. PPA
1. Present in 15% of normals but 62-84% of glaucoma patients
2. Disc size variations between instruments

H. Artifacts
1. ERM

I. Axial length
1. Some studies found no correlation with axial length and RNFL thickness (Hirasawa 2010)
2. Others show total RNFL thickness decreases with increased axial length (2.2 um/1mm in Stratus)

J. ONH distance to foveola
1. High myopia: RNFL bundles converge causing abnormalities (Leung 2012)
2. Temporal or nasal deviated RNFL plot can over diagnose glaucoma

K. Other Factors
1. Rx: RNFL thinner by 1.2um/diopter of myopia
2. Race: RNFL decreases from Hispanics>Asians>African Americans>Caucasians

L. Case examples to illustrate points throughout the presentation

IV. Glaucoma Diagnosis

A. Utility of OCT in glaucoma
1. RNFL loss precedes VF loss by 6 years in 60% of eyes (Sommer 1991)
2. In OHTS, HRT showed glaucomatous change 8 years before VF defects
3. 17% RNFL loss before VF detection (Wollstein 2012)

B. Glaucoma Detection
1. Both TD and SD have high sensitivity and specificity for glaucoma when >1 clock hour is <5% level (red)
2. Both TD and SD may be inadequate in detecting preperimetric RNFL defects
3. Cirrus can discriminate mild glaucoma from normal based on ONH parameters

C. Useful parameters
1. RNFL measurements
2. ONH measurements

D. Interocular symmetry
1. Increasing age is not associated with increased RNFL asymmetry
   a) >9 um difference may be indicative of early glaucoma
2. Spectralis: 6.6x greater asymmetry in glaucoma vs. normal
3. Difference of 6um for RNFL global average had high sensitivity and specificity to detect POAG
4. Macular asymmetry has also proven sensitive and specific (Sullivan-Mee)

V. Glaucoma Progression

A. Progression considerations
1. Variable nature of glaucoma
2. Event-based vs. trend-based analyses
3. Changing technology – longitudinal f/u
4. Instrument variability
5. No consensus on limit of RNFL thinning that equals progression; no reference standard

B. Progression: Various methods
1. Average RNFL thickness may be better than sector analysis with lower inter-test variation
2. Significant negative trend in average RNFL thickness with time?
3. >1 clock hr at the <5% level?
4. 1 clock hr at <5% and overall ‘borderline’ or ‘outside normal’?

C. Reliability and reproducibility
1. Inter-visit repeatability is good for most SD-OCT
2. Signal strength – 7 or greater desired
3. Dilation – may not effect repeatability
4. Variability vs. progression?

D. Variability vs. Progression
1. Stratus: ~4-10um per quadrant
2. Cirrus: >4-6um between visits is suspicious
3. Spectralis: 5-14um intra- and inter-visit variation
4. Variability:
   a) Average RNFL: ~5um
   b) By quadrant: ~8um
   c) By clock hour: ~10-12um

E. Case examples to illustrate points throughout the presentation

VI. Types of RNFL change

A. Patterns of RNFL loss on OCT
1. Inferotemporal is most common in glaucoma
2. Other optic neuropathies can cause RNFL thinning, but patterns are different
3. Age related thinning is most common superior and inferior

B. Types of RNFL changes (Leung 2012 – Cirrus with GPA)
1. Widening of RNFL defect (85.7%)
   a) Angular width of defects can be a useful alternative for RNFL average thickness
2. Deepening of RNFL defect
3. Development of new RNFL defect (17.9%)

C. Age-Related RNFL Loss
1. Average rate: -0.10 to -0.52um /yr (1.5-2mm/decade)
2. Influenced by baseline thickness
   a) Greater baseline thickness = faster rate of change
3. No significant change in nasal and temporal quadrants with age
4. Rates between normal and glaucoma pts vary

D. Rates of progression

E. Correlation between RNFL changes and VF defects
1. Low agreement for progression on both VF and OCT; 0.9 to 46.4% (Leung 2011, 2012)
2. OCT accuracy is effected by severity of glaucoma

F. GPA for OCT
   1. Cirrus: GPA available for OCT or HVF or combined analysis for both
   2. Faster rate of RNFL loss in patients with thicker baseline RNFL

VII. Macular OCT

A. Macular OCT
   1. Useful in advanced glaucoma
      a) Papillomacular bundle preservation
   2. Macular OCT may be better for progression in moderate and severe glaucoma
   3. May have a purpose in early glaucoma detection too

B. Ganglion cell analysis
   1. Macular RGC complex is 1-7 cells thick: RNFL, GCL and IPL
      a) Contains 50% of retinal RGCs
   2. RGC counts performed better than average RNFL thickness for separating glaucomatous eyes with early/minimal VF loss from healthy eyes

VIII. Adjunct and future technology

A. Enhanced depth imaging (EDI)
B. Swept source OCT (SS-OCT)
C. SD-OCT integrated with adaptive optics (AO-OCT)
D. Polarization-sensitive SD-OCT
E. Micro-OCT and ultra-high res OCT

IX. Conclusions

A. OCT is great technology but it isn’t perfect
   1. Validated for glaucoma diagnosis/screening and has been shown to be highly repeatable
   2. Can’t detect disc hemes, pallor, etc
   3. Correlate HVF and OCT findings

B. Evaluate scan data and not just colors
   1. Confounding factors, artifacts, instrument capabilities, etc
   2. Keep in mind normal database limits

C. Progression can be judged many ways and they do not always agree
   1. No set standard for OCT progression

D. Research studies vs. monitoring changes in individual patients
E. Repeat OCTs and correlate with other findings before making treatment decisions
X. References


