# Detecting progression of early glaucoma using alternative methods with optical coherence tomography

COLUMBIA
COLUMBIA UNIVERSITY
DEPARTMENT OF OPHTHALMOLOGY

Sun, Ashley[1]; Tsamis, Emmanouil[1]; Li, Xinhui[1]; Tsang, Katherine[1]; Al-Aswad, Lama[2] ; Blumberg, Dana[2]; Cioffi, George[2]; Liebmann, Jeffrey M.[2]; Moraes, Carlos G.[2]; Hood, Donald C.[1, 2]

[1]Columbia University. New York, NY; [2]Columbia University Irving Medical Center. New York, NY;

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## PURPOSE

To compare quantitative methods for detecting progression of early glaucoma using swept source optical coherence tomography (ssOCT) widefield scans based on summary metrics and manual region-of-interest (ROI) evaluations.

## METHODS

**Participants:**

- 81 eyes from 81 patients from the Macular Assessment Progression Study[1]: mean age of 59.3±16.8 yrs [range: 18 to 84].
- 52 eyes were diagnosed as patients (glaucomatous or suspects; GL) by a referring physician and 29 were healthy controls (HC).

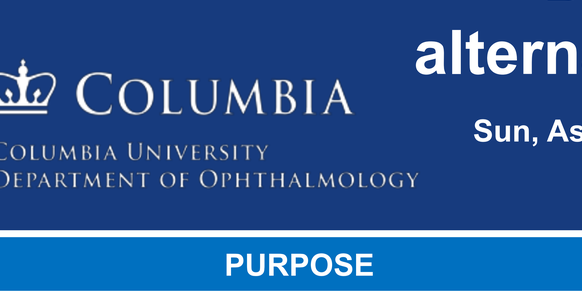
**Optical Coherence Tomography:**

- Each eye had three (Topcon Atlantis) ssOCT scans. The first was a baseline scan (V1), followed by a second, short-term scan (V2), taken 0.89±0.83 months from baseline. A third, long-term scan (V3), was taken 21.0±5.7 months from baseline.
- Each scan had a Hood wide-field report including a B-scan, RNFL thickness plot, and RNFL probability scans (Fig 1).[2]

**Assessment of Progression:**

- Metrics method: average global (G), temporal (T), superior vulnerability zone (SVZ), and inferior vulnerability zone (IVZ)[3] circumpapillary retinal nerve fiber layer (cpRNFL) thicknesses values were obtained from all three scans.
- ROI method[4,5]: abnormal regions of thinning on cpRNFL plots were manually marked to indicate local defects on the RNFL thickness plot on the wide-field report (Fig 1), aided by information from B-scans and RNFL probability scans.
- Thickness of constant ROI: The ROI marked on V3 was applied to V1 and V2, and average thickness was calculated for each scan separately.

Fig 1.



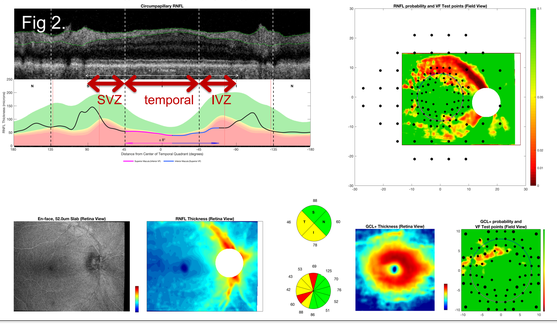
**Statistical Analysis:**

- V1 and V2 measurements defined the upper 95% and lower 5% limits of short-term variability for each method (Quantile Regression – see black and red lines on Fig 5).
- Metric measurements from V3 scans were compared against V1 and V2. Progressors were identified by those eyes which fell below the 5% limit in both comparisons (V1-V3 and V2-V3).

**Post-Hoc Analysis:**

- Qualitative method (flicker method)[6]: the likelihood of progression on a scale of 0-100 was assessed by an OCT expert after viewing all three scans (Fig 2), with 100 being definitely progression and 0 being no progression.

Fig 2.




## RESULTS

### Post-Hoc Analysis

6 eyes showed progression according to the OCT expert – 5 Definitely Progressors (>90%) and 1 Probable (65%).

- 2 of these 6 eyes were missed by both summary metrics and ROI (Fig 3). Note clear change in RNFL probability and thickness plots
- 2 eyes were identified by both summary metrics and ROI (Fig 4).
- 2 eyes were identified by one method only – 1 from the IVZ metric and 1 from the ROI.

Fig 3. Two examples of progression confirmed by post-hoc analysis, but not by any summary metric or ROI.

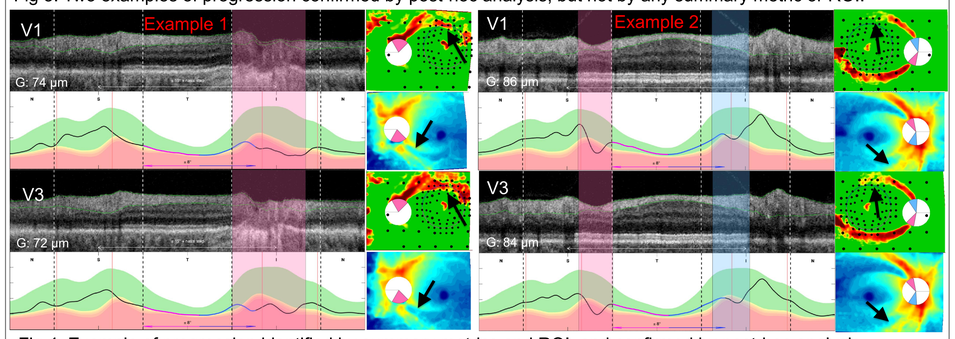
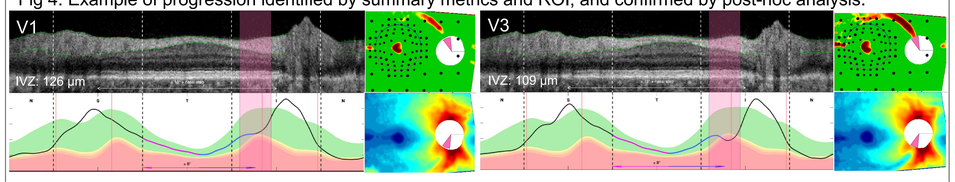



Fig 4. Example of progression identified by summary metrics and ROI, and confirmed by post-hoc analysis.




### Summary Metrics Assessment

- 19 eyes showed statistically significant progression for at least one metric – Fig 5 shows the G metric with its 13 progressors highlighted by the red points.
- 2 of those 19 were HCs – i.e. “false positives” (Fig 6).
- Upon post-hoc analysis, 3 of 19 eyes were confirmed by the OCT expert (Fig 7).
- 14 eyes were not confirmed as ”true” progressors by the OCT expert.
  - 5 eyes within uncertainty (grade between 40-60).
  - 9 eyes probably and definitely healthy (grade < 40).

Fig 5. Quantile Regression Plot of V1-V3 of G metric.

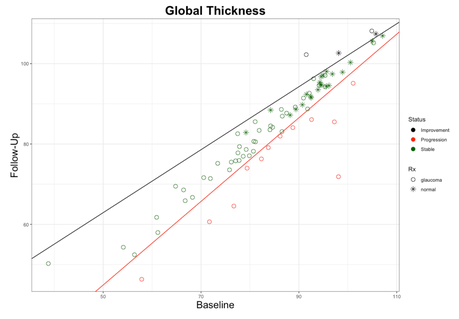



Fig 6. “False positive” (HC) according to summary metrics.

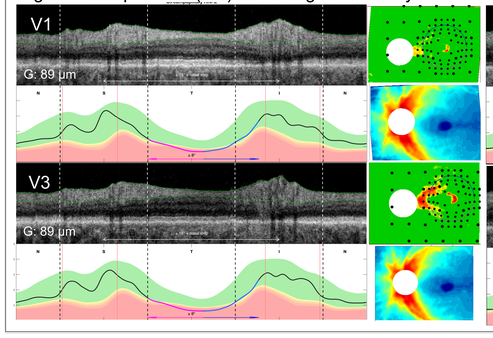
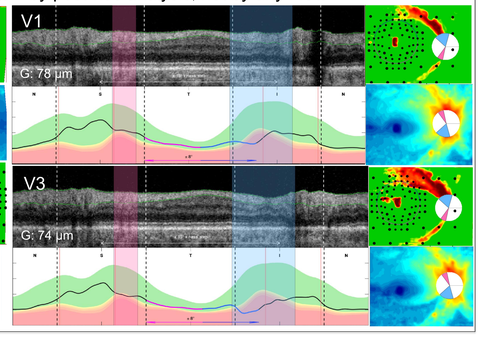


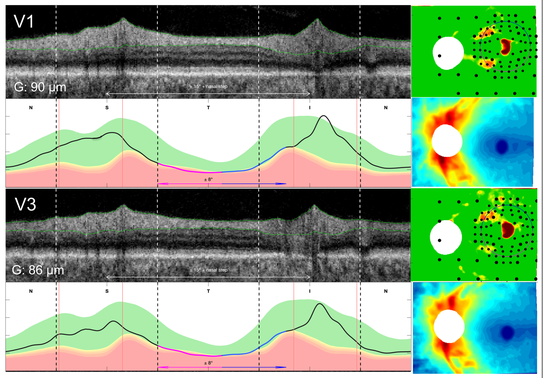

Fig 7. Progression indicated by metrics and confirmed by post-hoc analysis, not by any ROI.




## RESULTS

- Of the 9 eyes graded < 40%, 7 had segmentation errors (mostly due to low contrast – Fig 8), 1 had motion artifacts, and 1 had wrong disc centering.

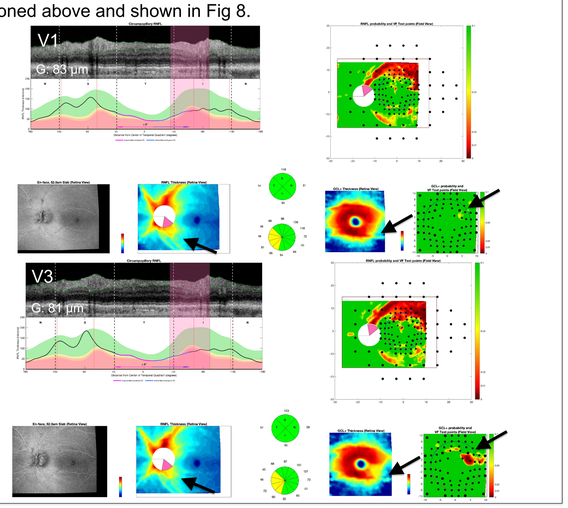
Fig 8. Example of segmentation errors due to contrast and blood vessel location.




### Manual Region-of-Interest (ROI) Assessment

- 12 eyes showed progression in the manual marking of the ROI, none of which were HC.
- Upon post-hoc analysis, 3 eyes were confirmed; one of which was missed by the metrics (Fig 9).
- 9 eyes were not confirmed as ”true” progressors by the OCT expert.
  - 6 eyes within uncertainty (grade between 40-60).
  - 3 eyes probably and definitely healthy (grade < 40).
- All 3 of these eyes graded < 40 were identified by summary metrics too. Hence, reasons for these “false positives” are similar to those mentioned above and shown in Fig 8.

Fig 9. Progression indicated by ROI and confirmed by post-hoc analysis, but not by any summary metric.




## CONCLUSION

- A manual ROI method can identify similar numbers of “true progressors” compared to a summary metrics method, while reducing the number of “false positives.”
- Nonetheless, issues such as segmentation errors and motion artifacts can falsely label eyes as progressing on both methods.
- Therefore, a qualitative, post-hoc analysis is needed to confirm progression in early glaucoma identified by summary metrics and/or ROI methods.

## REFERENCES & SUPPORT

**References:**
1. ClincialTrials.gov Identifier: NCT02547740, 2. Hood DC et al. TVST, 2016; 3. Hood DC. PRER, 2017; 4. Hood et al. JAMA Ophthalmol. 2015; 5. Wu Z et al. TVST. 2018; 6. Wu Z et al. TVST. 2018.

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