

# Detecting Progression of Preserved Areas of Retinal Nerve Fiber Layer in Advanced Glaucoma using Optical Coherence Tomography

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## INTRODUCTION & PURPOSE

- It is commonly assumed that optical coherence tomography (OCT) cannot be used for following eyes with advanced glaucoma [e.g., eyes with 24-2 visual field (VF) with mean deviation (MD)  $\leq -12$  dB].<sup>1</sup>
- However, we recently argued that if there are points on the 10-2 or 24-2 VF  $\geq -8$  dB, then there will be preserved regions on the OCT.<sup>2,3</sup>
- To assess the feasibility of using OCT to follow eyes with advanced glaucoma, local regions of preserved circumpapillary retinal nerve fiber layer (cpRNFL) were identified, followed and compared to summary measures.

## METHODS

### Participants:

- 33 eyes from 27 patients had a mean age of  $65.1 \pm 14.1$  yrs [range: 19.1 to 80.3].

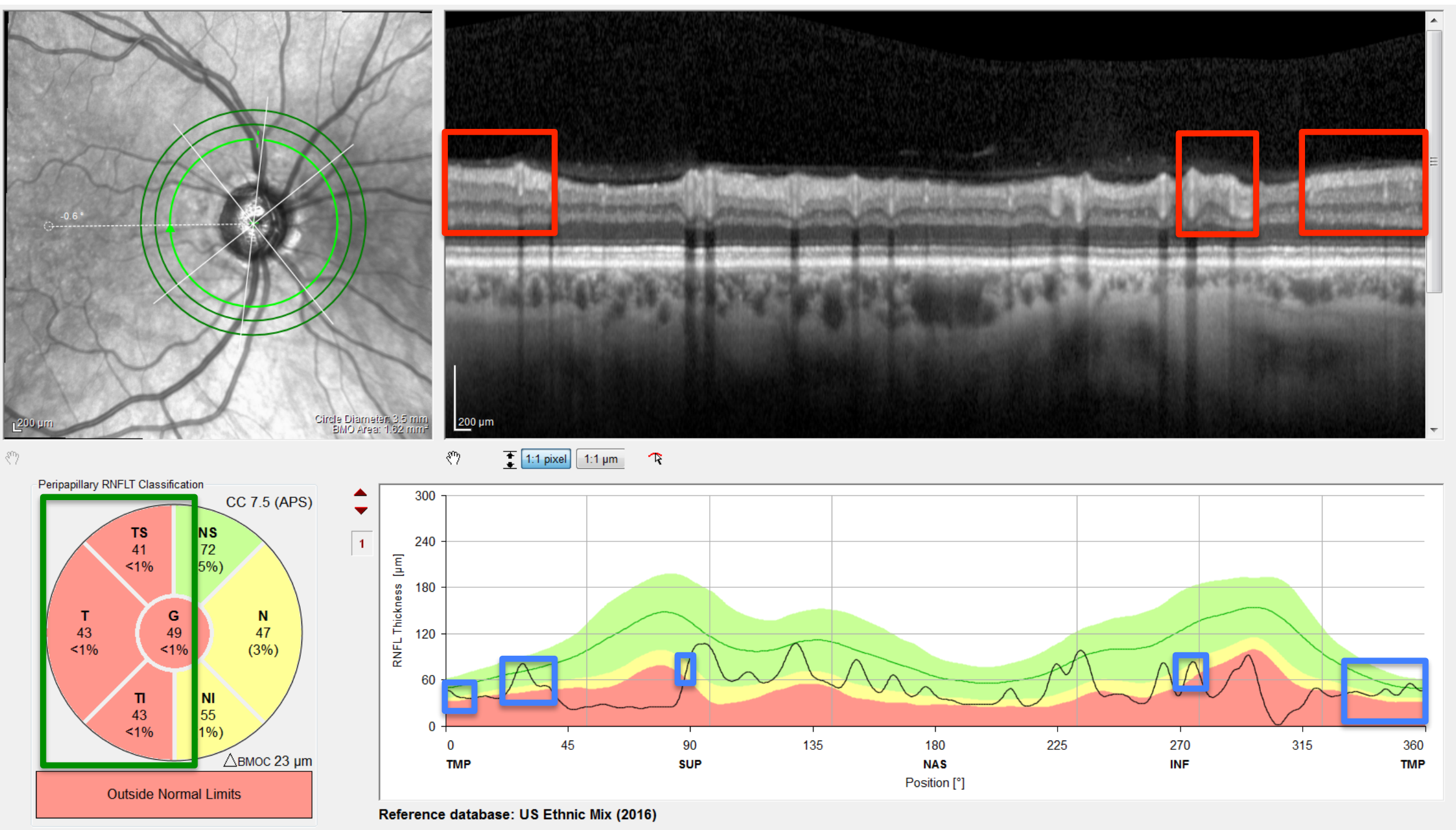
### Visual Fields:

- 30 eyes had two 24-2 (stimulus size III) VFs before or up to 6 months after the first scan date with an average MD  $\leq -12$  dB.
- 3 eyes had only one 24-2 VF before the scan date with MD  $\leq -25$ .

### Optical Coherence Tomography:

- Each eye had two OCT scans  $1.8 \pm 0.7$  yrs apart [0.8 to 3.0] with an averaged 3.5 mm diameter circle of the optic disc as part of the Glaucoma Module Premium protocol (Spectralis, Heidelberg Eng). See example of report in figure 1.
- Automatic segmentation of RNFL boundaries was manually corrected in 34 of 66 scans.

Figure 1



### Assessment of Progression:

- Summary metrics in temporal half of disc (green box in fig. 1).
- Regions of interest (ROIs)<sup>4</sup> marked manually (mROI) for local areas of preserved cpRNFL on the circle B-scans without segmentation (red boxes) and automatically (aROI) based on areas above the 1%<sup>ile</sup> of normative values on cpRNFL thickness plots<sup>5</sup> (blue boxes) within the temporal half.
- Width, thickness and area of ROIs were calculated based on the original and adjusted segmentation data.

### Statistical Analysis:

- The above parameters were compared between visits with ANOVA and linear mixed effect model regression.

## RESULTS

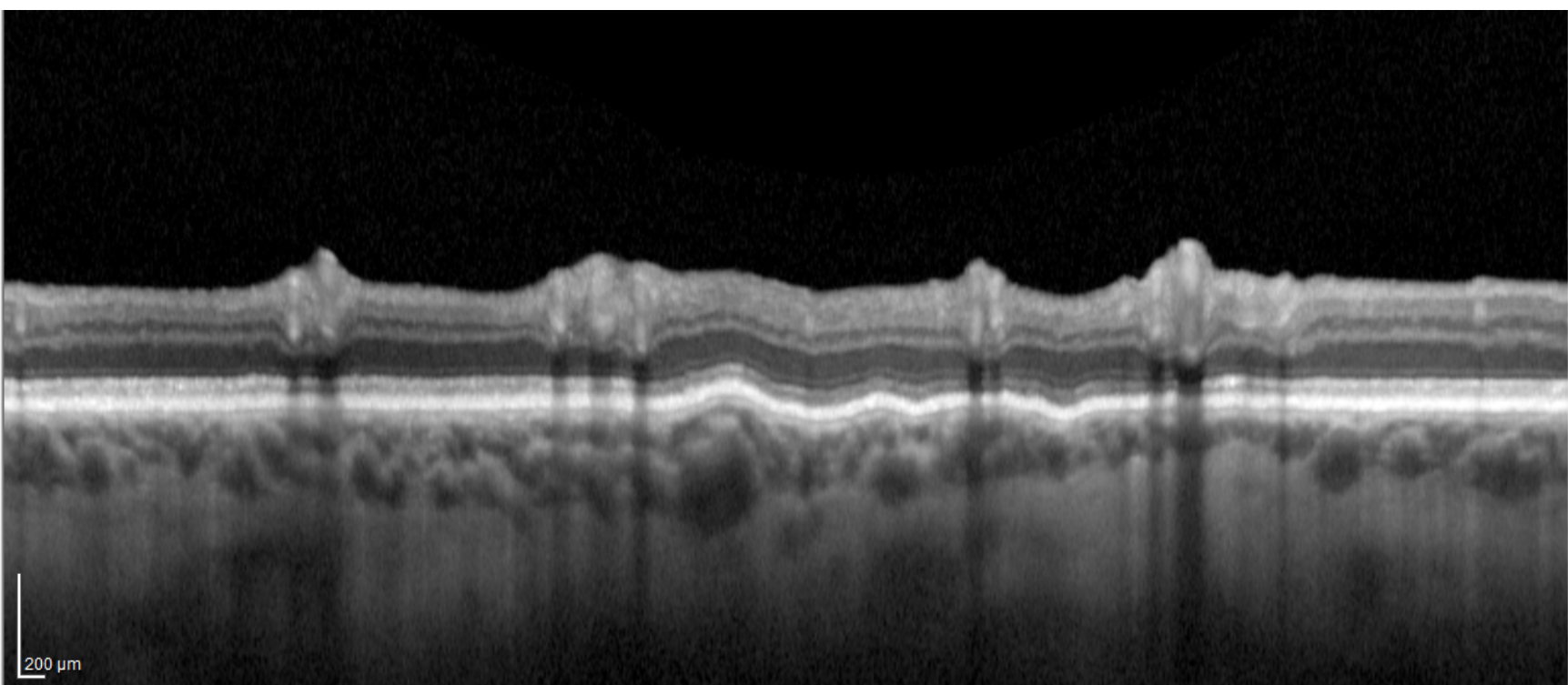
### Examples of Preserved and Non-Preserved Regions

#### For the 33 eyes in this study:

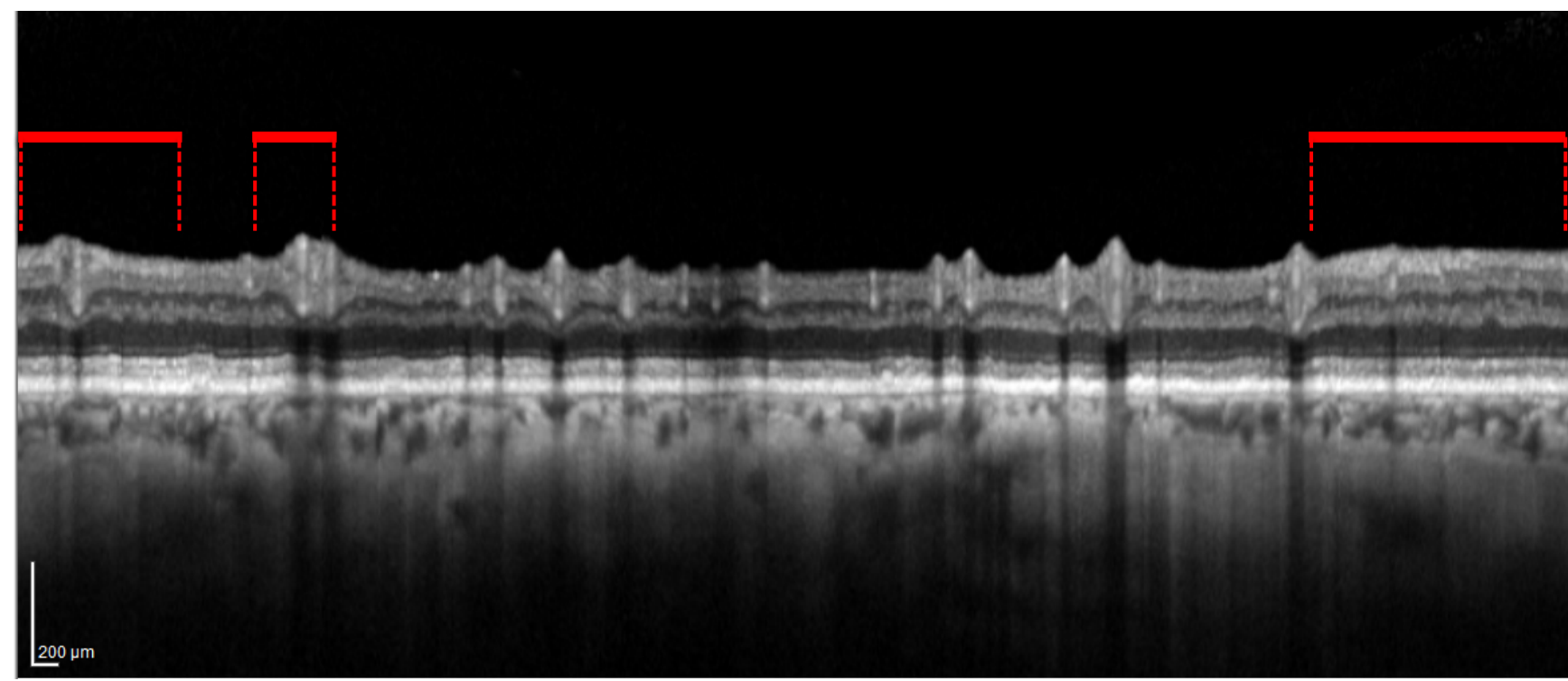
- 31 eyes had preserved regions of RNFL in the temporal half of the disc that could be followed for progression.
- Figure 2 shows (a) an eye with preserved RNFL in the entire temporal half; (b) no preserved RNFL in the temporal half; (c) large portions of preserved RNFL; and (d) small portions of preserved RNFL.

Figure 2

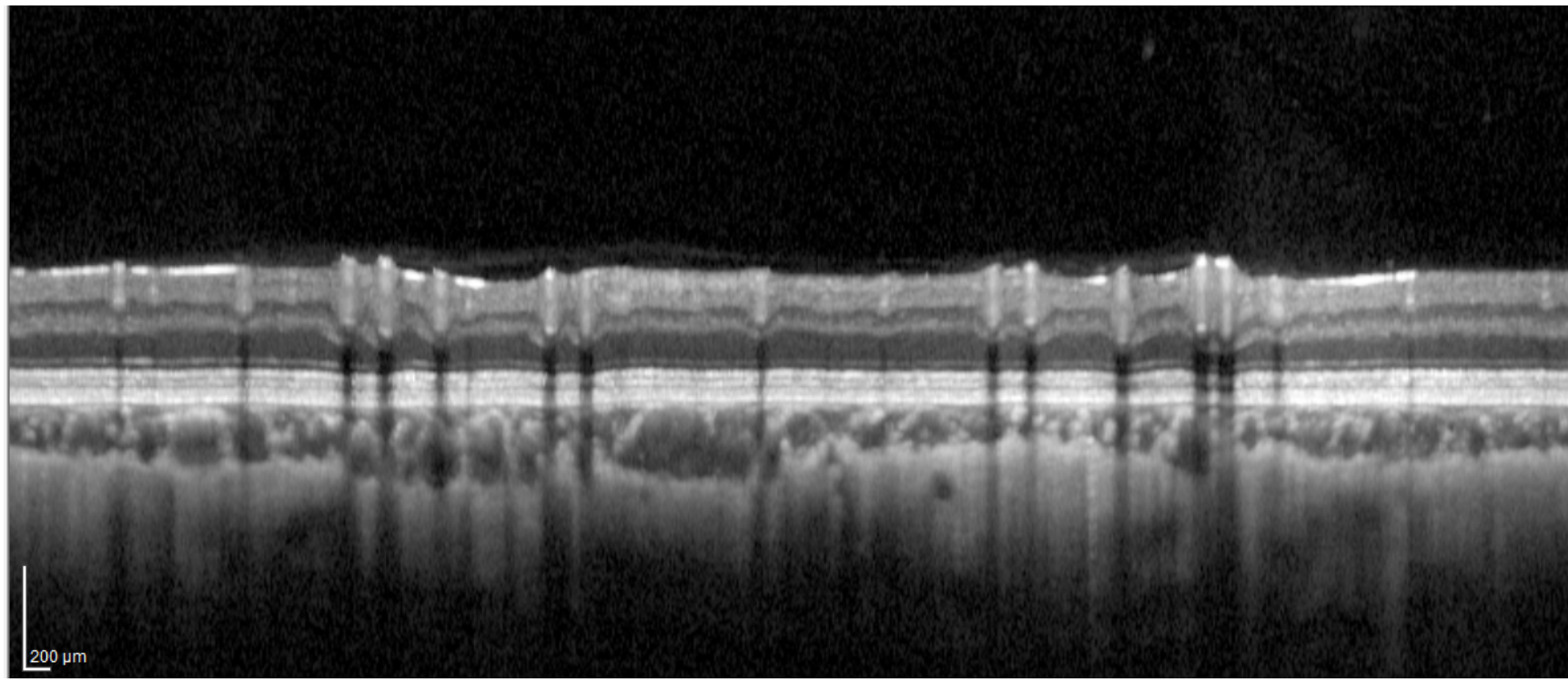
a. Entire temporal region preserved



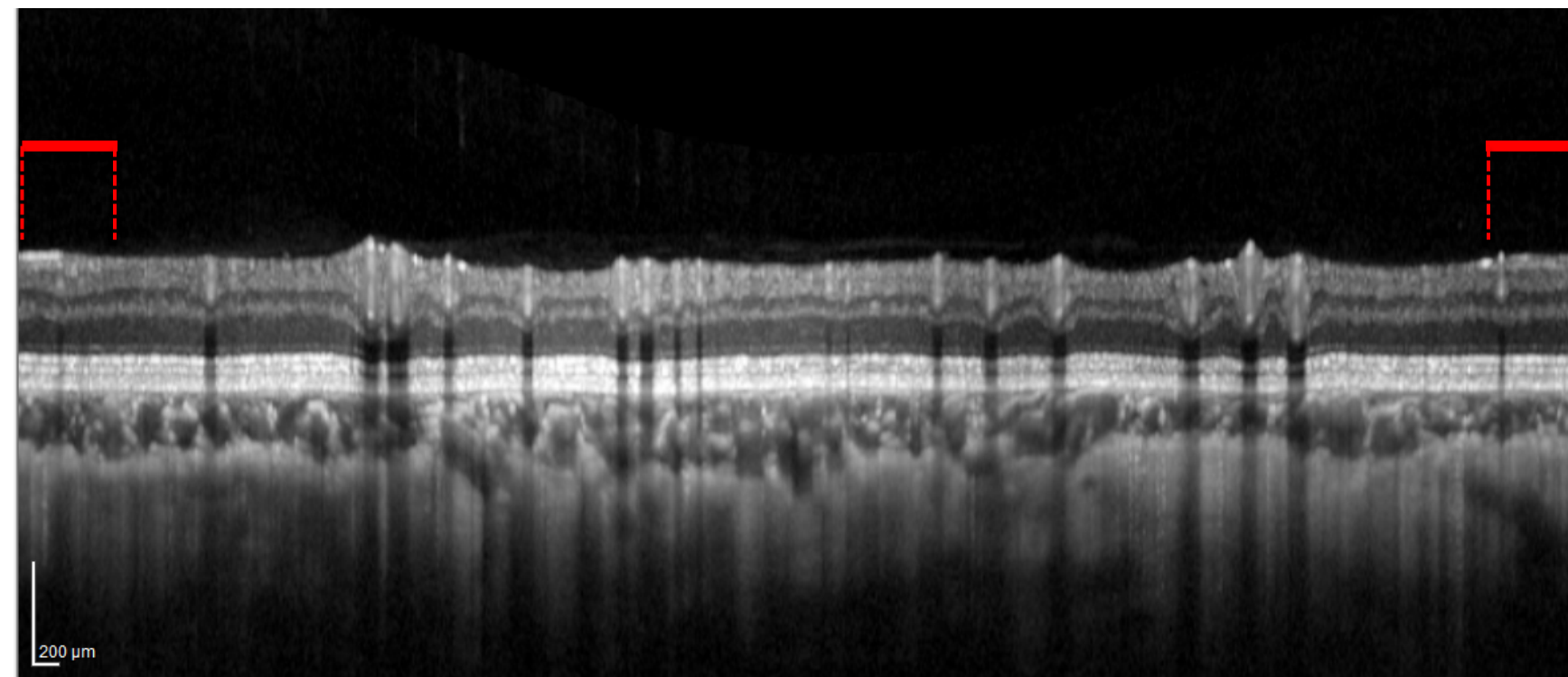
c. Large portions preserved



b. No preserved RNFL



d. Small portions preserved



### Linear Mixed Effect Analysis and Significance

- One-way ANOVA did not show significant differences from baseline to follow-up for any parameters
- Using linear mixed effects, none of the four summary metrics showed significant changes between visits with the automated segmentation (Table 1) but did reach significance after correction of segmentation (Table 2).
- Before correcting for segmentation errors, all ROI parameters, except aROI width, were able to identify significant changes between visits (see Table 1).
- After correcting segmentation errors in 34 of 66 scans, all measures reached statistical significance for change between visits (see Table 1).

Table 1: Change in measurements from time 1 to time 2

	Uncorrected Segmentation		Segmentation Corrected as Necessary	
	Mean $\pm$ SD ( $\mu$ m)	p-value	Mean $\pm$ SD ( $\mu$ m)	p-value
G	-1.8 $\pm$ 7.1	0.16	-2.7 $\pm$ 5.2	* <0.01
T	-1.8 $\pm$ 7.3	0.17	-1.8 $\pm$ 4.6	* 0.03
TS	-2.6 $\pm$ 10.0	0.15	-2.9 $\pm$ 7.4	* 0.03
TI	-1.8 $\pm$ 10.8	0.35	-3.8 $\pm$ 8.0	* <0.01
mROIw	-307 $\pm$ 706	* 0.02	-307 $\pm$ 706	* 0.02
mROI t	-3.5 $\pm$ 7.2	* <0.01	-3.8 $\pm$ 6.5	* <0.01
aROIw	-220 $\pm$ 685	0.07	-281 $\pm$ 510	* <0.01
aROI t	-4.4 $\pm$ 8.9	* <0.01	-4.6 $\pm$ 5.9	* <0.01

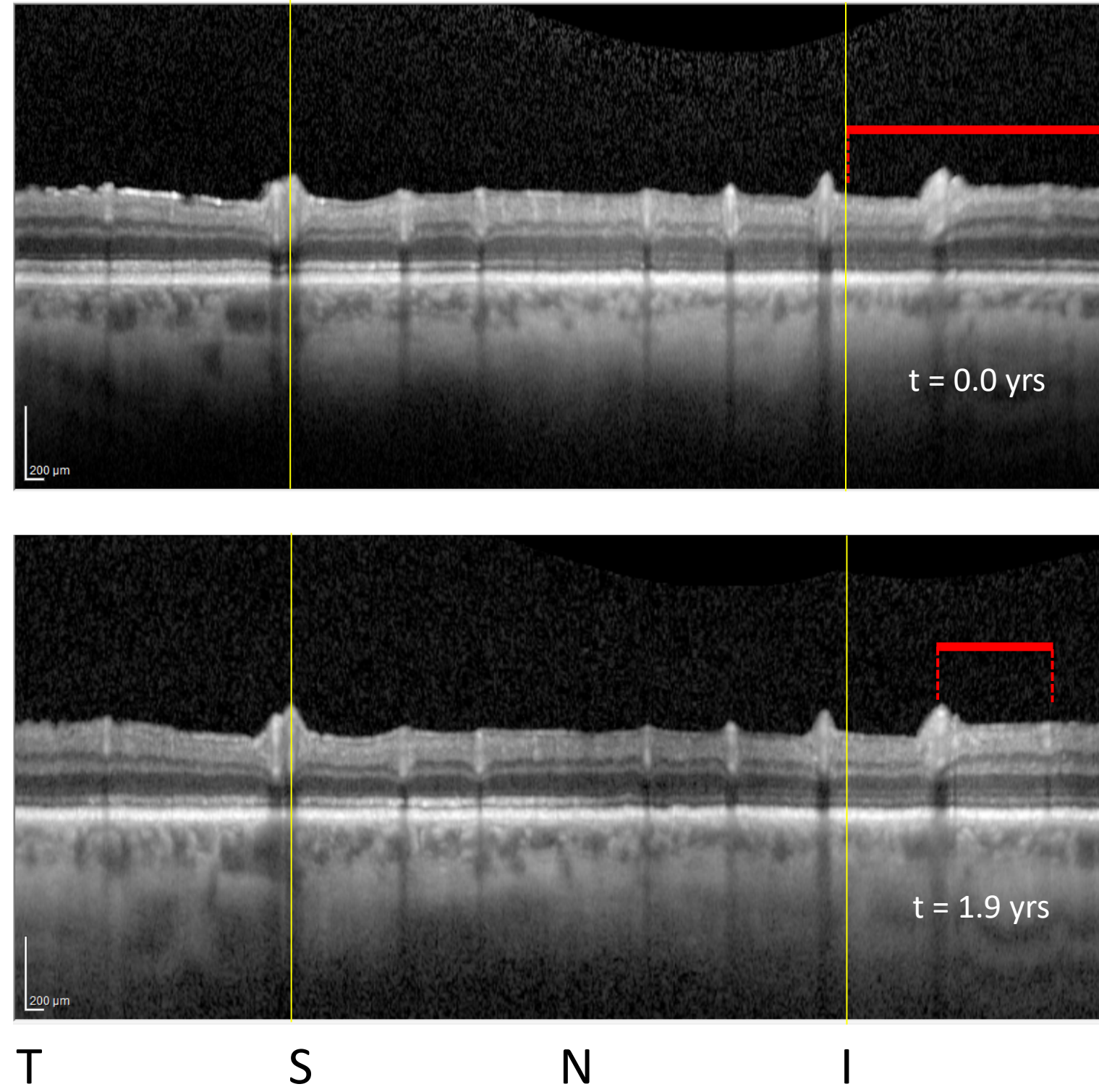
G: Global; T: Temporal; TS: Temporal superior; TI: Temporal inferior; mROI: manual region of interest; aROI: automatic ROI; w: width; t: thickness; \*: Significant p-value

## RESULTS

### Changes in Width

- 21 of 31 eyes with preserved regions showed decreases in mROI width and 24 of 33 showed decreases in aROI width.

Figure 3: change in width



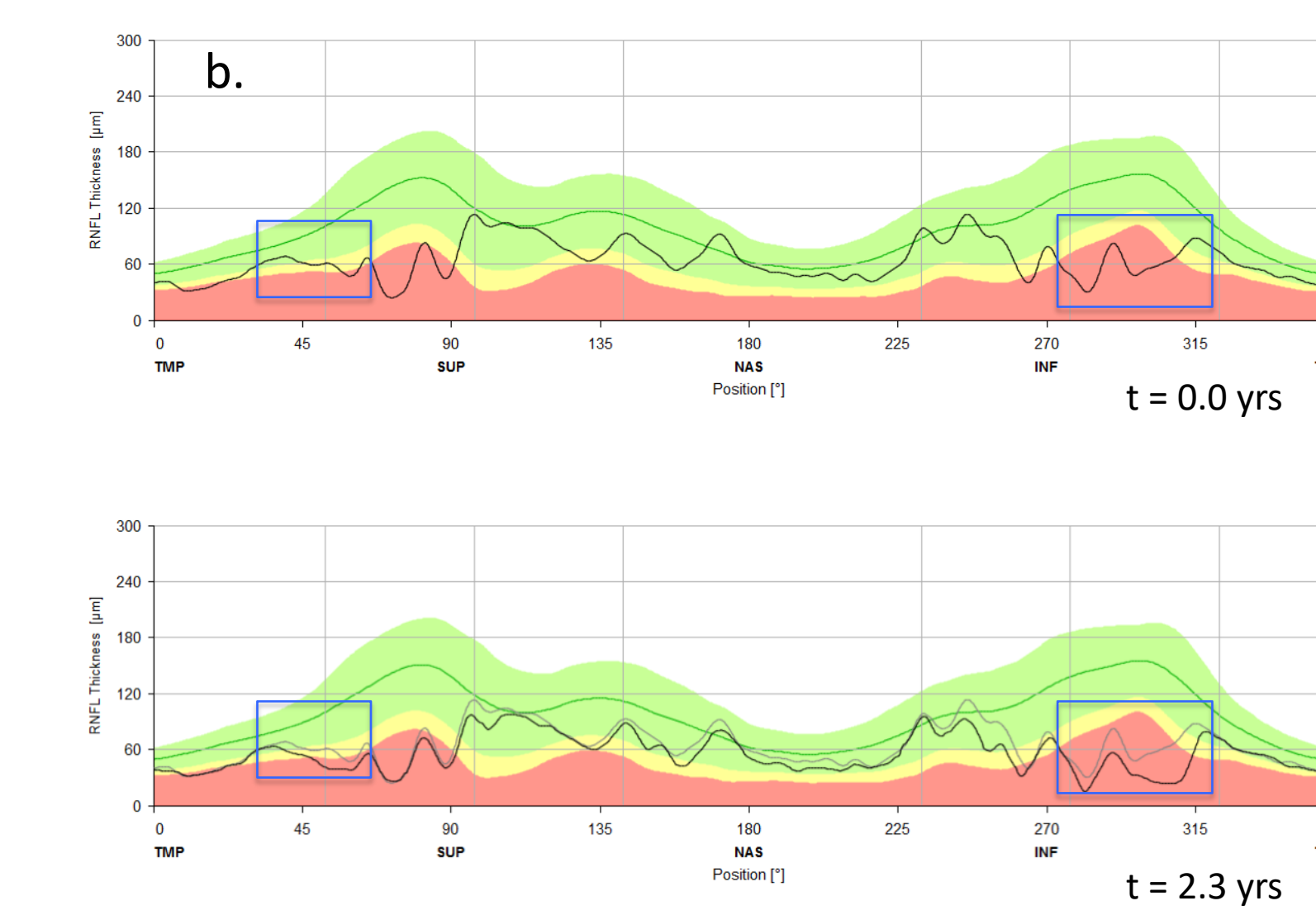
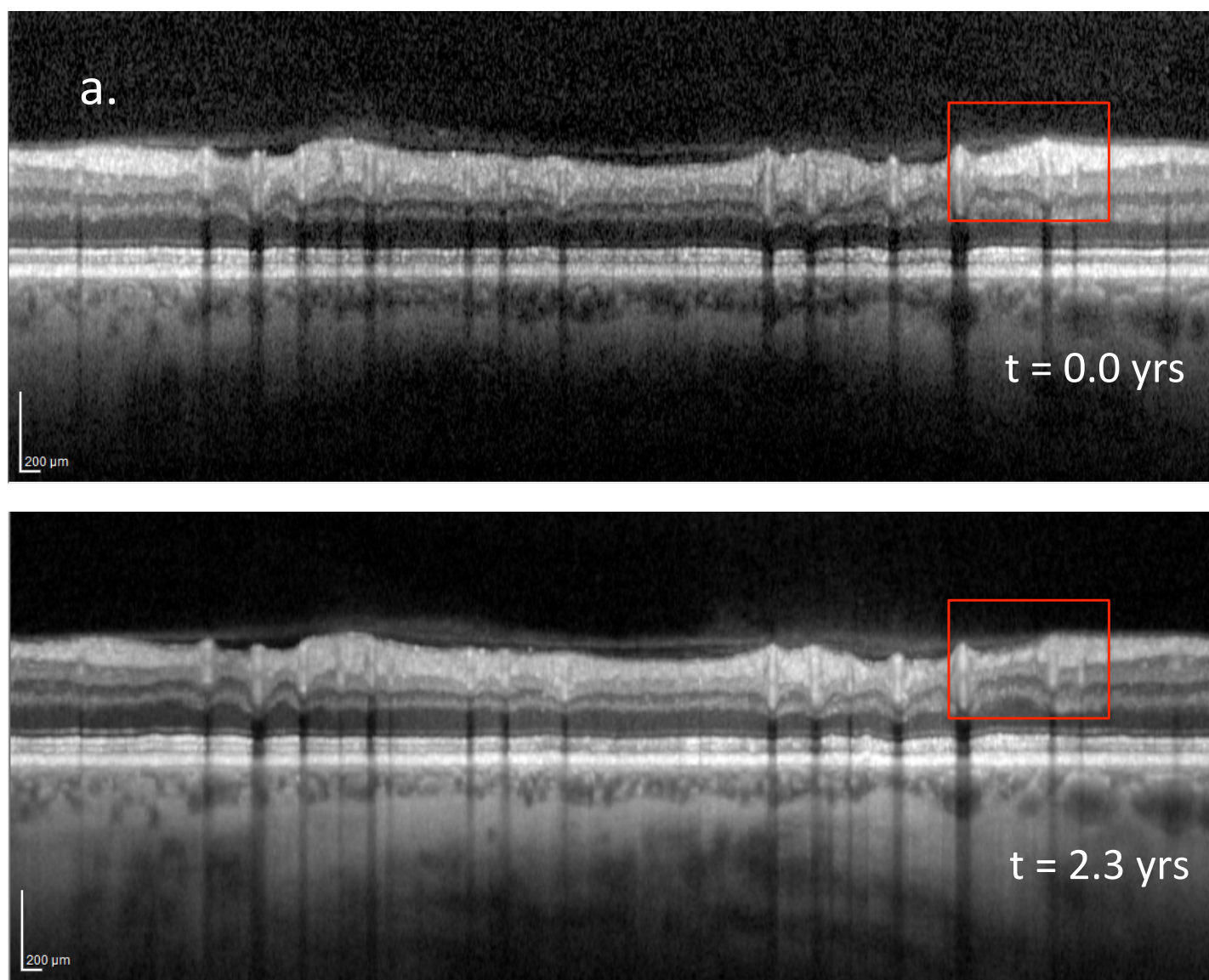
- Fig. 3 shows two circle scans 1.9 yrs apart with red lines highlighting changes in the mROI, yellow lines indicating the boundaries of the temporal half.

### Changes in Thickness

- Fig. 4 shows an eye with circle scans 2.3 years apart with changes of thickness seen within the red boxes for (a) mROI thickness and (b) aROI thickness.

- 21 of 31 eyes with preserved regions showing decreases in mROI thickness and 30 of 33 showing decreases in aROI thickness. For the G, T, TS, and TI sectors, there were decreases in 21, 16, 20, and 21 eyes respectively.

Figure 4: change in thickness



## CONCLUSIONS

- OCT circle scans can be used to follow progression in eyes with advanced glaucoma if local regions of preserved cpRNFL are measured via either manual or automated ROI methods.<sup>4,5</sup>
- On the other hand, summary metrics did not perform well, though performed better after correction of segmentation.
- It is important to carefully inspect the B-scan, look for segmentation errors and continue to utilize OCT scans in these advanced eyes.

## REFERENCES & SUPPORT

### References:

1. Abe RY et al. IOVS. 2016; 57(9): Oct421-428.; 2. Lee S et al. Ophthalmol Glauc. 2019; 3. Hood DC and DeMoraes CG. J Glaucoma. 2018 Aug;27(8):657-664; 4. Hood DC et al. JAMA Ophthalmol. 2015; 133: 1438; 5. Wu Z et al. TVST. 2018;7(1):19

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