Customizing Macular Structure-Function Maps for Individuals

Andrew Turpin[1], Siyuan Chen[1], Juan A. Sepulveda[2] and Allison M. McKendrick[2]

[1]Computing & Information Systems, [2]Optometry & Vision Sciences, The University of Melbourne, Australia

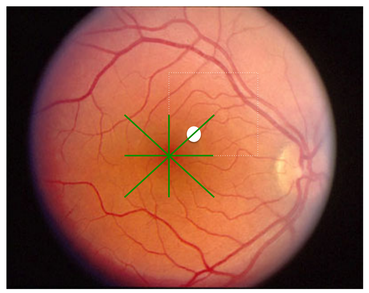
Program 632-B0145

THE UNIVERSITY OF MELBOURNE

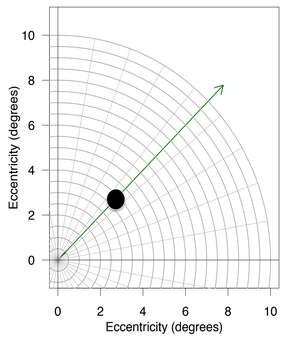
Purpose

To develop a model of Henle fibre length that is readily customizable to an individual based on their OCT images. By adjusting for an individual's Henle fibre length, it is anticipated that structural and functional measures of glaucomatous eyes will better correlate.

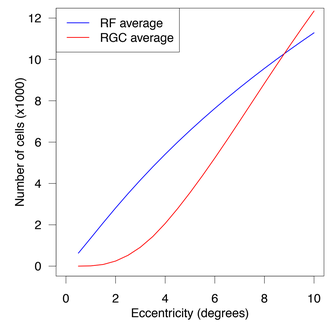
Methods



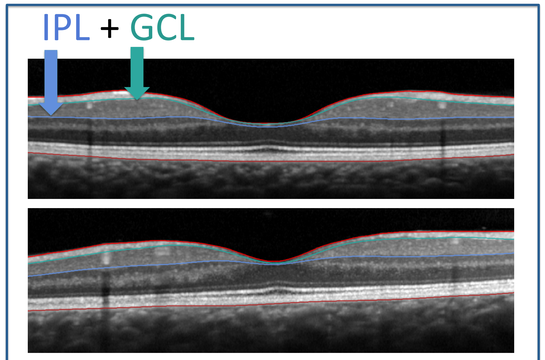
1. Choose a retinal location for which to compute the displacement of RGC bodies from that location.



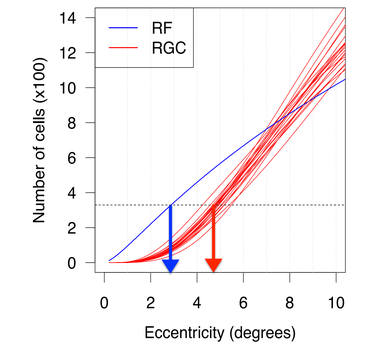
2. Compute the number of inputs to RGCs along a radial sector to the location using Equation 7 from Drasdo et al 2007. This is based on acuity (MAR) measurements and cell counts.



3. Compute the number of RGCs along the same sector using natural neighbor interpolation of cell density data from Curcio & Allen [1990].



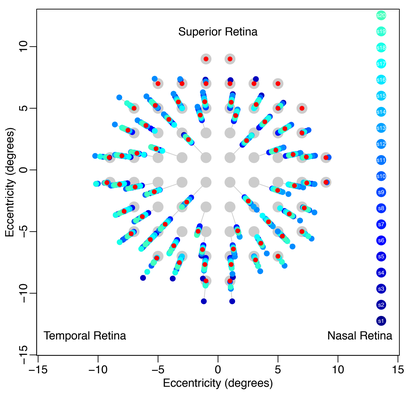
4. Using a segmented Spectralis OCT scan (Heidelberg Engineering) along the same radial, compute the ratio of RGC+ thickness (GCL+IPL) to the population average. Multiply the value in Step 3 by this ratio. We also experimented with using the ONL layer to customize the RF counts from Step 3.

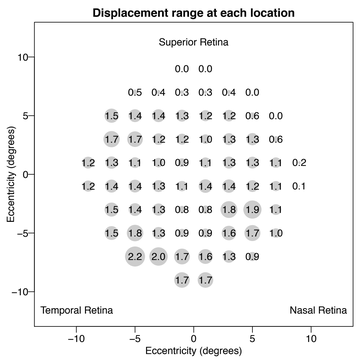


5. Read off the distance when the two counts are equal as the displacement of the RGC bodies from the retinal location. Here there is one red curve for each of the 20 subjects we tested.

Results

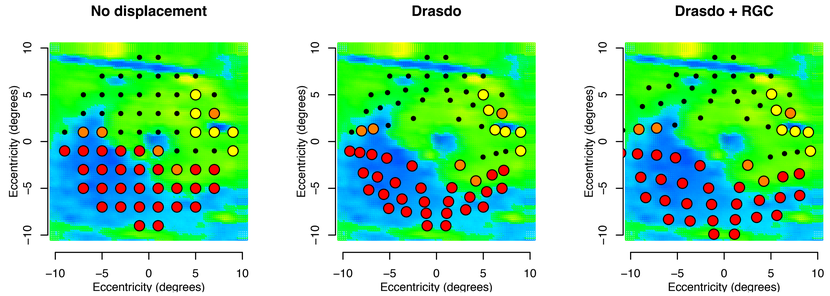
The figure below shows the displacements calculated for the 10-2 visual field pattern for 20 young, normal subjects (one blue dot each). The red dot shows the displacement predicted by Drasdo et al.





The figure above shows the range of displacements in degrees for the 20 subjects at each of the locations in the 10-2 visual field pattern.

The size of the grey bubble is proportional to the range shown as text.



The figure above shows an example of a total deviation probability plot using the 10-2 pattern for one patient superimposed on a macular cube scan (Spectralis) using no (left), population (middle) and custom (right) displacements. Red is p < 1%, orange p < 2%, yellow p < 5%.

Conclusions

Customizing the displacement of macular RGC bodies from their input receptive fields for an individual using our model yields large variation in estimated Henle fibre length.

Discussion

Using the ONL from the OCT images to further customize the approach by altering the RF curve in Step 3 did not work well (results not shown). It was difficult to segment ONL in the images, even manually, and it also contains Henle fibres [Curcio et al 2011], adding a confound to the whole counting approach.

It is not clear what proportion of the population would benefit from this customization approach, nor whether the range in displacement of one degree is enough to make a difference with the current precision of visual field and retinal thickness measurements.

It is not clear how the approach could be applied to patients with moderate or advanced glaucoma.

References

Curcio CA, Allen KA, J Comp Neurol, 1990: 300; 5-25
Drasdo N et al., Vision Research, 2007 47; 2901-2911
Curcio CA et al., IOVS, 2011: 52(7); 3943-3954

Support: Australian Research Council, Heidelberg Engineering

aturpin@unimelb.edu.au