

Comparing Retinal Vasculature Using Adaptive Optics, Commercial Retinal Cameras and Entoptic Imaging

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Abstract



The alarming rise in diabetic retinopathy, a disease that afflicts the retinal vasculature causing microaneurysms and the leakage of blood from capillaries, has generated a renewed importance for routinely observing the retinal

microvasculature. When looking into the eye, however, these vessels are blurred by the ocular aberrations of the eye and are of poor contrast due to weak tissue reflections. A leading technique that effectively bypasses these obstacles is entoptic imaging, but it depends on the patient to describe what they see severely limiting its effectiveness in a clinical setting. As an objective non-invasive alternative, we have developed a retina camera that corrects the aberrations of the eye using a technique coined adaptive optics that is highly sensitive to weak reflections. To assess the utility of this camera for detecting capillaries, images within the foveal center were collected on several subjects and compared to entoptic drawings obtained on the same eyes. Results indicate strong correlation between images and drawings, and provide supporting evidence for the clinical benefit of an AO retina camera.

Methods

Commercial Retinal Camera



Topcon TRC - 50EX

- Subjects are placed in machine
- Images are captured with camera
- ~20° field of view possible
- Red free filter is used to enhance vasculature contrast

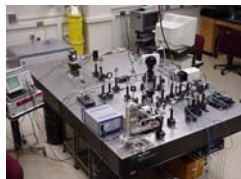
Entoptic Imaging



Entoptic Imaging Machine

- Subjects are placed in machine
- Movable light source allows subjects to see shadows of their vasculature
- Subject then draws these shadow patterns

AO Corrected Camera

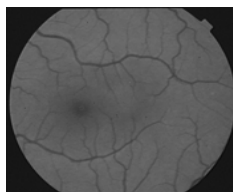


Miller Lab AO System

- Subject fixates on light source
- Light is reflected to Shack-Hartmann wave front sensor
- Scientific camera is focused
- Collection of images
- Images are registered

Results

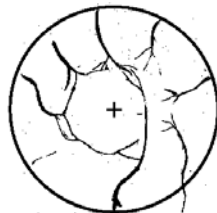
Commercial Retinal Camera



Subject DM's CRC Image

- ~20° field of view
- Large vessels clearly recorded
- Few capillary structures apparent

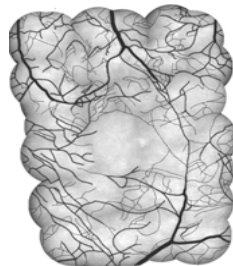
Entoptic Imaging



Subject DM's EI Image

- Field of view unknown
- Limited amount of capillary bed sketched
- Subject had difficulty sketching all the shadow patterns observed

AO Corrected Camera



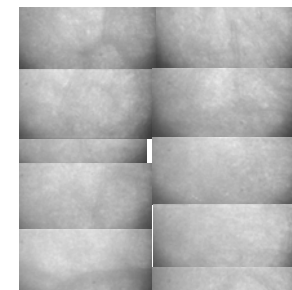
Subject DM's AO CC Image

- 3.5 ° x 3.0 ° field of view
- Full detailed vasculature tracing possible
- Capillaries traced in avascular zone
- Vasculature corresponding to commercial retinal camera and entoptic imaging are observed

Future Projects

With the registration of smaller and finer detailed capillaries it became harder to determine if we correctly recorded capillary structures or not. One method to eliminate this Ambiguity would be to observe Actual blood flow through the structure. Only structures that exhibit blood flow can then be correctly labeled as capillaries.

By building mosaic maps of retinal vasculature and layering very close exposers of each map together a Looped image could be produced to help us determine actual blood flow. These mosaic maps would give us a more complete understanding of a living human retina. This work would further enable us to gain a better insight into how a healthy versus a diseased retinas appear and function in clinical settings.



Subject CC's Mosaic Map
2.0° x 2.8 ° field of view

Conclusions

- Commercial retinal cameras do not provide detailed capillary structure images
- Entoptic images provide limited capillary structure images that are solely dependent on patient interpretation
- AO corrected cameras provide the most detailed images of capillary structures

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