3-D snapshots of eyes reveal details of age-related blindness

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To get a better look at the abnormalities that cause age-related macular degeneration (AMD), the leading cause of vision loss in Americans and Europeans over 50, the research groups of James Fujimoto at the Massachusetts Institute of Technology (MIT) and collaborators Jay Duker of the Tufts University School of Medicine, and Joel Schuman of the University of Pittsburgh School of Medicine have created ultra-detailed 3-D images of the eyes of more than 2,000 people from different ethnic groups, 400 of whom have AMD. Selected electronic data, published in the special Interactive Science Publishing (ISP) issue of *Optics Express*, the Optical Society's (OSA) open-access journal, may pave the way for new diagnostic software useful for developing new treatments.

AMD is a condition in which the macula -- the region of highest visual acuity in the retina -- stops functioning properly. AMD causes blurred vision and, in advanced cases, a large blind spot in the center of one's vision.

Optical coherence tomography (OCT) has become a standard tool for assessing AMD and other eye diseases. An OCT instrument shoots beams of infrared light into the retina, where they are reflected to greater or lesser extent by different structures within the eye. By measuring the echo time delays of reflected light, an ophthalmologist can have a cross-sectional or three-dimensional view of the retina's layers. This high-resolution, three-dimensional image reveals abnormalities that can be used to track disease progression and response

to treatment.

Fujimoto's team uses an OCT machine with a resolution two times higher than commercial OCTs. In this study, they imaged the retinas of 400 people suffering from different stages of macular degeneration. Their profiles range from a 54-year-old man with mild AMD and 20/20 vision, to a 77-year-old woman with advanced AMD who can just barely count fingers from a distance of four feet. Each person's eye was scanned in 180 different slices and stitched together to form a 3-D image of the eye.

Most of the patients suffer from "dry" AMD, the milder and more common form of the disease. The hallmark of this condition is drusens, small yellowish clumps that build up between the layers of retina. These masses tend to progress with time, eventually disrupting the structure of the retina.

Ultra-high resolution OCT reveals the detailed structure of these changes with a resolution that enables individual layers of the retina to be visualized. "This would be hard to resolve with the standard resolution of a typical commercially available OCT instrument, which cannot see ultra-thin layers," says co-author Yueli Chen of MIT.

Scans of other patients' eyes show a more advanced "wet" form of AMD, in which abnormal blood vessels grow in between the layers of the retina. 3-D OCT provides a more accurate estimate of the volume of fluids leaked by these faulty vessels, which damages the photoreceptors in the eye and leads to blindness.

The MIT group is publishing the electronic data in these 3-D images in order to make it available to the image processing community to develop computer programs that can quickly and automatically detect the details and severity of the disease -- by counting the number of drusens, for

example, or quantifying the volume of fluid leaked into the eye by faulty blood vessels. Developing these programs will be difficult because of the sheer quantity of data contained in each data set says Fujimoto -- but it is important because quantitative measurements can be used to track disease progression and help establish correlations between the severity of vision loss and changes in the architecture of the eye.

Researchers say this could provide a faster and more efficient way for drug makers to develop and evaluate new treatments in clinical trials. No treatment currently exists for dry AMD, and treatments for the wet form -- including lasers that burn the blood vessels and drugs that inhibit the growth of new vessels -- can only slow, not stop, vision loss.

More information: "Three-dimensional ultrahigh resolution optical coherence tomography imaging of age-related macular degeneration," Yueli Chen et al, Optics Express, Vol. 17 Issue 5, pp.4046-60, March 2, 2009.

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