New technique detects microscopic diabetes-related eye damage

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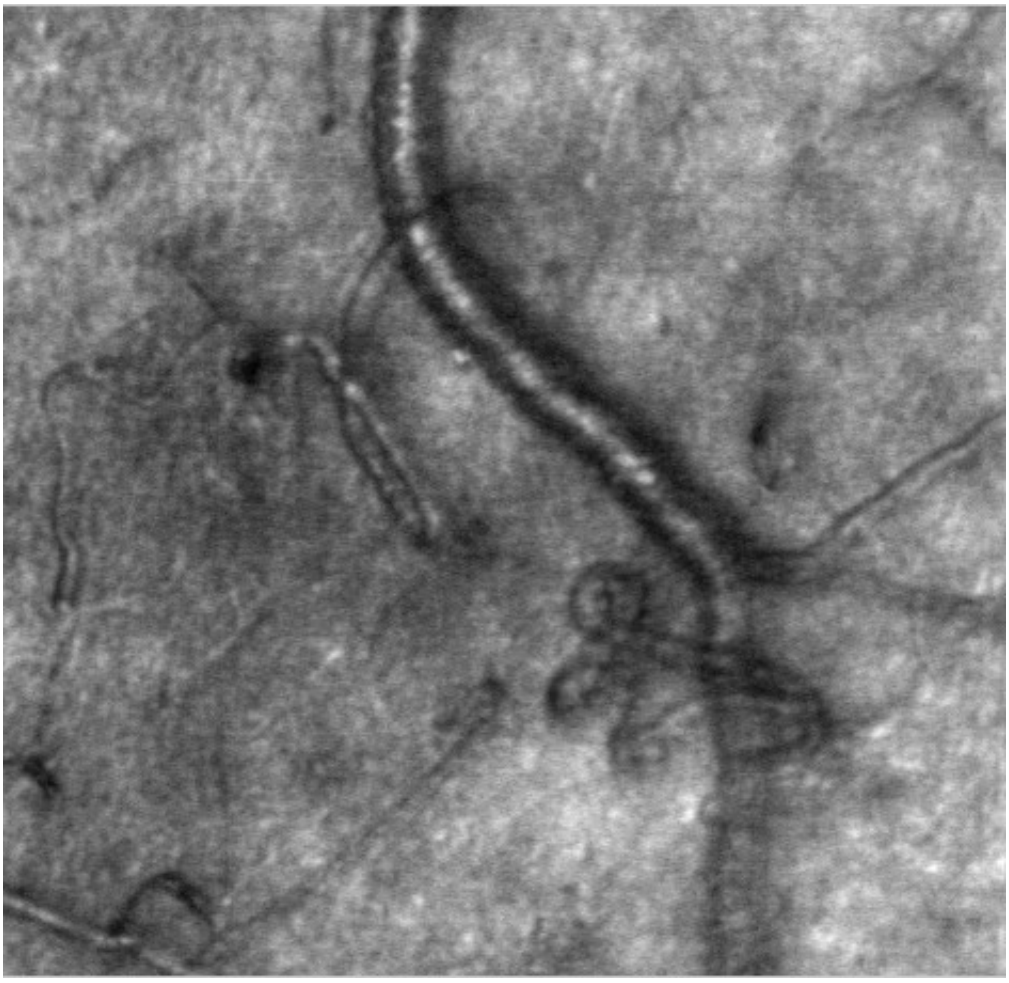

This is a retinal capillary with multiple loops. The blood cannot travel directly to nourish the retinal cells. Credit: The Burns Lab

Indiana University researchers have detected new early-warning signs of the potential loss of sight associated with diabetes. This discovery could have far-reaching implications for the diagnosis and treatment of diabetic retinopathy, potentially impacting the care of over 25 million Americans.

"We had not expected to see such striking changes to the retinas at such early stages," said Ann Elsner, professor and associate dean in the IU School of Optometry and lead author of the study. "We set out to study the early signs, in volunteer research subjects whose eyes were not thought to have very advanced disease. There was damage spread widely across the retina, including changes to blood vessels that were not thought to occur until the more advanced disease states."

These important early-warning signs were invisible to existing diagnostic techniques, requiring new technology based on adaptive optics. Stephen Burns, professor and associate dean at the IU School of Optometry, designed and built an instrument that used small mirrors with tiny moveable segments to reflect light into the eye to overcome the optical imperfections of each person's eye.

"It is shocking to see that there can be large areas of retina with insufficient blood circulation," he said. "The consequence for individual patients is that some have far more advanced damage to their retinas than others with the same duration of diabetes."

Because these changes had not been observable in prior studies, it is not known whether improved control of blood sugar or a change in medications might stop or even reverse the damage. Further research can help determine who has the most severe damage and whether the changes can be reversed.

The study, "In vivo adaptive optics microvascular imaging in diabetic

patients without clinically severe diabetic retinopathy," was published in the journal *Biomedical Optics Express*.

Diabetes has long been known to damage the retina, the irreplaceable network of nerve cells that capture light and give the first signal in the process of seeing. This damage to the retina, known as diabetic retinopathy, is the leading cause of vision loss in the U.S. for individuals under the age of 75.

The changes to the subjects in the study included corkscrew-shaped capillaries. The capillaries were not just a little thicker, and therefore distorted, but instead the blood vessel walls had to grow in length to make these loops. This is visible only at microscopic levels, making it difficult to determine who has the more advanced disease among patients, because these eyes look similar when viewed with the typical instruments found in the clinic. Yet, some of these patients already have sight-threatening complications.

Diabetes also is known to result in a variety of types of damage to capillaries, the body's smallest blood vessels. The more commonly known changes, such as microaneurysms along the capillaries, were also present in the study, but seen in much greater detail. In addition to the corkscrew appearance and microaneurysms, along with the hemorrhages in the later stages of the disease, there is also a thickening of the walls of blood vessels. This is thought to be associated with poor blood flow or failure to properly regulate blood flow.

In the study, patients with diabetes had significantly thicker blood vessel walls than found in controls of similar ages, even for relatively small diameter blood vessels. The capillaries varied in width in the diabetic patients, with some capillaries closed so that they no longer transported blood within the retina. On average, though, the capillaries that still had flowing blood were broader for the patients with diabetes. These diabetic

patients had been thought to have fairly mild symptoms. In fact, the transport of oxygen and glucose to the retina is already compromised.

Previous diagnostic techniques have been unable to uncover several of these changes in living patients. Simply magnifying the image of the retina is not sufficient. The view through the imperfect optics of the human eye has to be corrected.

The instrument designed by Burns takes advantage of adaptive optics to obtain a sharp image, and also minimized optical errors throughout the instrument. Using this approach, the tiny capillaries in the eye appear quite large on a computer screen. These blood vessels are shown in a video format, allowing careful focus and observation of blood cells moving through the blood vessels. After imaging each patient's eye, highly magnified retinal images are then pieced together with software, providing still images or videos.

More information: The study is available at http://www.opticsinfobase.org/boe/abstract.cfm?uri=boe-5-3-961.

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