Eye implant could lead to better glaucoma treatment

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For the 2.2 million Americans battling glaucoma, the main course of action for staving off blindness involves weekly visits to eye specialists, who monitor—and control—increasing pressure within the eye.

Now, a tiny eye implant developed at Stanford could enable patients to take more frequent readings from the comfort of home. Daily or hourly measurements of eye pressure could help doctors tailor more effective treatment plans.

"For me, the charm of this is the simplicity of the device," said Stephen Quake, PHD, professor of bioengineering and of applied physics. "Glaucoma is a substantial issue in human health. It's critical to catch things before they go off the rails because once you go off, you can go blind. If patients could monitor themselves frequently, you might see an improvement in treatments."

A paper describing the device was published online Aug. 24 in *Nature Medicine*. Quake, who is also the Lee Otterson Professor in the School of Engineering, and ophthalmologist Yossi Mandel, MD, PhD, MHA, of Bar-Ilan University in Israel are the senior authors of the paper. The lead author is Ismail Araci, PhD, a postdoctoral scholar in Quake's lab.

Internal optic pressure is the main risk factor associated with glaucoma, which is characterized by a continuous loss of specific retina cells and degradation of the optic nerve fiber. The mechanism linking IOP and the damage is not clear, but in most patients IOP levels correlate with the

rate of damage.

Meauring the pressure

The only treatment for glaucoma is to reduce IOP to normal or below-normal levels. (This is usually done with medication or surgery.) The patient's IOP must be measured repeatedly until the levels stabilize. The problem, though, is that the measurements do not always tell the whole story.

Like blood pressure, IOP can vary day to day and hour to hour; it can be affected by other medications, body posture or even a necktie that is knotted too tightly. If patients are tested on a low IOP day, the test can give a false impression of the severity of the disease and affect their treatment in a way that can ultimately lead to worse vision.

The new implant consists of a small tube: One end is open to the fluids that fill the eye; the other end is capped with a small bulb filled with gas. As the IOP increases, intraocular fluid is pushed into the tube, and the gas pushes back against this flow.

As IOP fluctuates, the meniscus—the barrier between the fluid and the gas—moves back and forth in the tube. Patients could use a custom smartphone app or a wearable technology, such as Google Glass, to snap a photo of the instrument at any time, providing a critical wealth of data that could steer treatment. In one previous study, researchers found that 24-hour IOP monitoring resulted in a change in treatment in up to 80 percent of patients.

The implant is currently designed to fit inside a standard intraocular lens prosthetic, which glaucoma patients often get when they have cataract surgery. The scientists are investigating ways to implant it on its own.

No optical distortion

Remarkably, the implant won't distort vision. When subjected to the vision test used by the U.S. Air Force, the device caused nearly no optical distortion, the researchers said.

Before testing the device in humans, however, the scientists said they need to re-engineer it with materials that will increase its life inside the human eye. Given the implant's simple design, they expect this will be relatively achievable.

"I believe that only a few years are needed before clinical trials can be conducted," said Mandel, head of the Ophthalmic Science and Engineering Laboratory at Bar-Ilan University.

Baolong Su, a former technician in Quake's lab who is now an undergraduate student at UCLA, is also a co-author of the paper.

Stanford University has applied for a patent on the IOP-sensor technology.

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