Optometrists make custom contact lenses for long-underserved patients

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This is an acuity chart degraded by aberrations measured in a keratoconic eye. Credit: None

While the majority of patients with common vision problems can find glasses or contact lenses fairly easily, others who suffer from diseases of the eye that affect the focus of light have more limited options and may simply have to learn to live with poor vision.

At the University of Houston's College of Optometry, a team of researchers has set out to address the latter population's long-underserved needs by developing custom contact lenses.

"The lenses we make are made for you. It's like putting a fingerprint in the optics. It would not work for another individual with the same disease. It's a custom fit, a designer lens," said Dr. Jason Marsack, an assistant professor of optometry.

Supported by a grant of $1.25 million from the National Eye Institute, Marsack's team aims to give patients with elevated amounts of what are known as "higher-order aberrations" the quality of life long enjoyed by those with common vision problems, such as nearsightedness, farsightedness and astigmatism. The grant will help translate the results the team has realized in laboratory trials into products that will be available for widespread clinical use.

"Every eye has aberrations that cannot be corrected with glasses," explained Dr. Raymond A. Applegate, a professor of optometry, but, in the normal eye, most of the time they're not particularly limiting.

The lenses the team is making not only incorporate sphere and cylinder, which are commonly corrected in glasses and contact lenses, but they also correct an entire other family of aberrations, which are induced by disease, trauma or surgical interventions, Marsack said.

To the naked eye, the lenses don't look all that different from the soft contact lenses that are distributed en masse, but each one is actually unique.

"One of the issues with getting a contact lens out of a clinic is you that have to work within the parameters of the manufacturers. Let's say with astigmatism, an aberration commonly corrected with contacts, the graded steps that you can put in the lens are finite, meaning that you cannot put whatever you want in the lens," Marsack said.

For the most part, he said, those steps are there because people do well with them, and they don't sacrifice quality of life.

"But, we don't want those restrictions. We want to put whatever astigmatism we want at whatever orientation."

Applegate explained that although rigid contact lenses, or gas-permeable ones, are used to correct higher-order aberrations in highly aberrated eyes by masking a significant portion of the aberrations, soft lenses are preferred by patients about 3-to-1, because of comfort and wear time.

"The major problem with the rigid gas-permeable lens is the patient often has to pick the portion of the day that they're going to have reasonable vision," Applegate said.

The key to creating a custom soft lens, he said, is making the surface that corrects the optical errors of the eye and having it remain properly aligned during wear.

"You can imagine that you have a surface with bumps and hills on it, and they're on the order of microns. If there are bumps and hills, light will go every which way. Instead of a clean focus, it's a very blurry focus," Applegate said. "The correcting bumps and hills of the contact lens have to register perfectly with the bumps and hills on the eye.

"First, we have to manufacture this lens. The success of this lens depends on registering it on the eye. It can only translate left and right on the order of one-tenth of a millimeter, and it can't rotate more than a couple of degrees."

A large part of Marsack's latest grant is dedicated to solving lens-stabilization problems.

"It's important to know how it's going to rotate, so that, when you put the correction on it, you'll know how it'll perform," Marsack said. "It needs to move so that it's physiologically acceptable. But, you need know how it's going to move. Unpredictable movement is no good, because it's going to limit the effectiveness of the correction."

In patients with the eye disease keratoconus, Marsack said, the cornea thins and bulges forward, reducing its ability to focus light.

"Let's say at night you're on the road, and you're looking at a stoplight. That light, for the most part, is fairly well formed. Keratoconus subjects who have highly aberrated eyes may perceive that same spot with a huge flare shooting through it; the stoplight simply is not well focused by the optics of the eye, which leads to blur," Marsack said.

In later stages of the disease, a corneal transplant may be a keratoconus patient's only chance for acceptable vision if he or she can't tolerate wearing rigid contact lenses, said Marsack.

Patients involved in earlier stages of the study already have had dramatic results with their custom lenses.

"We had one patient who went to the window, and there's a set of power lines out in the distance. He is amazed at his ability to resolve the power lines," Marsack said.

Applegate said he was not surprised by that patient's reaction and that he believes demand for custom lenses likely is widespread.

Ultimately, Applegate said, the team would like to see custom lenses become the standard of care, and he emphasizes that the College of Optometry is uniquely positioned to determine how best to serve the needs of patients with highly aberrated optics.

"We're not only recruiting our patients from the University Eye Institute downstairs and quantifying the optical properties we need. We're also building and evaluating the lenses," Marsack said.

Applegate is optimistic their research will help determine a set of best practices and drive down costs.

"Could we fit 60 percent by making a batch of lenses that look like this?" Marsack asked, holding up a freshly cut lens. "That would reduce costs significantly. We have incredible computing power nowadays. We're tying the measurements instruments directly into the lathe instruments, and that feeds right down to the clinic. It's all tied together."

Source: University of Houston (news : web)

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