

Eye Center, Eye Bank Preserve “Windows on the World”

It's the oldest and by far the most common transplant procedure, with the shortest recipient waiting lists.

Yet it's also probably the most overlooked – except, of course, by the roughly 40,000 people in the U.S. who get new donor corneas every year.



Eye Center's Richard Davidson, MD, shows a model of the eye. The cornea is curved structure under his index finger.

The first corneal transplant dates back to 1905, when Austrian ophthalmologist Eduard Zirm successfully performed it in a city that is now part of the Czech Republic. That predates the first solid-organ transplant – a kidney – by about half a century.

Today, the Eye Center at University of Colorado Hospital performs between 100 and 120 corneal transplants each year, says Richard Davidson, MD, associate professor of Ophthalmology at the University of Colorado School of Medicine.

As might be expected, with more than 100 years of practice, ophthalmologists, including those at the Eye Center, have steadily

honed their corneal transplant techniques as well as the outcomes for patients. For example, instead of the whole cornea, they now sometimes use only small portions for transplant.

Smaller, thinner. And the portions are getting smaller and thinner. For patients undergoing a “partial corneal transplant,” Davidson and Eye Center colleagues Michael Taravella, MD, and Darren Gregory, MD, are now slicing the cornea twice, a procedure they've trialed internally on four patients.

“We've been able to get the grafts consistently thinner,” Davidson says. “Thinner grafts mean better vision.” The thinner the graft, moreover, the less donor tissue is required. That, in turn, may lessen the likelihood that the body will reject the new arrival.

Davidson is also medical director for the Rocky Mountain Lions Eye Bank, which procures donor corneas used in procedures throughout the state, region, nation and the world.



A cornea in the Rocky Mountain Lions Eye Bank awaits transplant. The view is from the back of the five-layer cornea; the white material is part of the sclera.

Plentiful supply. The Eye Bank harvests corneas from about 1,800 donors a year, notes Davidson, more than enough to meet demand. That stands in stark contrast to the long waiting lists for solid organs. “The beauty is we can almost always get a cornea when we need one,” he says.

Nearly all patients who book a corneal transplant surgery will get one, he adds. One key reason: putting a donor together with a recipient does not require blood matching because the cornea contains no blood vessels.

Priority goes to recipients in Colorado and Wyoming. "But we place others around the country and the world," Davidson adds. "Many corneas go to Korea, Saudi Arabia and Mexico."

Indeed, a prominent feature in one room of the Eye Bank, located right next door to the Eye Center in the Rocky Mountain Lions Eye Institute, is a large bank of digital clocks showing the current times in Denver; Mexico City; Riyadh, Saudi Arabia; Dublin, Ireland; and Tokyo.



Digital clocks in the Eye Bank show times from around the world. At any moment, donor corneas might be needed in any of these places.

Beneath the clocks, an erasable white board shows the status of donor corneas in the process of moving "from the field to the facility," says John Lohmeier, quality assurance manager for the Eye Bank.

"We dispatch staff to where the body is for chart review and recovery," he explains. "Techs remove the corneas and bring them here for evaluation and testing." That process includes an extensive serology panel, primarily to screen for HIV and hepatitis, and a social history of the donor to check for infectious disease.

As little as possible goes to waste, Lohmeier adds. Eyes that aren't suitable for transplant go to study and research, so long as the donor's next of kin or loved one gives permission.

Cleaning windows. It's all part of an effort to save a portion of the eye frequently referred to as the "window on the world." The five-layer cornea refracts light, allowing an individual to focus clearly on objects. Just a half-millimeter thick and transparent, it curves to cover the front of the eye and extends to the edge of the sclera, the white part.

The cornea's normal curvature is roughly like that of a basketball, Davidson says. But in some individuals, the smooth curve assumes a cone shape. The condition, keratoconus, distorts vision. Ophthalmologists often prescribe hard contact lenses to flatten the cone and reshape the cornea; a newer variety fits entirely over the cornea and sclera (*see sidebar*). However, the point of the cone may become so sharp that contacts can no longer correct vision.

Keratoconus usually affects only one eye severely, although it is present in both eyes, Davidson says. The cause is unknown, although there "could be a genetic component," he adds. Trauma, bacterial infections and scarring can also damage the cornea and distort vision.

Cutting two ways. The Eye Center performs two types of corneal transplants, both, typically, in outpatient procedures that include intravenous sedation and anesthesia.



John Lohmeier of the Eye Bank checks a white board that displays status of donor corneas.

In a full-thickness procedure, surgeons measure the patient's cornea, then remove all of it using an instrument called a trephine that functions like a "cookie cutter." They replace it with a matched-size donor cornea, which they suture into place with nylon Davidson says is about a third the thickness of a human hair.

In 40 to 45 percent of cases, the Eye Center uses a newer procedure, "descemet's stripping automated endothelial keratoplasty" (or DSAEK), in which they take a portion of a donor cornea to replace only damaged tissue at the back of the cornea.

"We cut the donor cornea as thin as possible," Davidson explains, "and transplant it." Because the DSAEK procedure requires only two small sutures to close the incision, he adds, patients can recover in three or four months. Full-thickness procedures, by contrast, may require a year for recovery. Ophthalmologists believe DSAEK also reduces the risk of rejection.

While most patients benefit from corneal surgery, many will still require contact lenses or subsequent later refractive surgery.

"It's not a quick fix," Davidson emphasizes, adding, "the suturing is the most difficult part." No matter how careful the work, he explains, suturing can create "different tensions" on the cornea, causing subtle irregularities in its shape and complicating visual rehabilitation.

"It's the biggest struggle," he says. "The 'holy grail' is to find an adhesive that keeps the cornea in place without any irregularities."

He counsels patients to be patient. "I tell them to look out five years. At five years, 95-plus percent will see well with the same cornea."

UCH Staffer Fights Family History with Transplant



Reenie Zaccardi (left), with optical technician Jitka Havlicek in the Eye Center. Zaccardi had the cornea in her right eye transplanted by UCH ophthalmologist Michael Taravella in 1991.

The idea of a corneal transplant was less daunting to Reenie Zaccardi than it probably would be to most of us.

Zaccardi, the hospital's director of Ambulatory Services, has long suffered from the keratoconus (*see story above*) that plagued her father. He had both corneas transplanted in the mid-60s with "good success," she says. Her older

sister also successfully underwent the procedure, in one eye, a decade before Zaccardi. A nephew has the disease but has so far avoided a transplant.

It was Zaccardi's turn in 1991, when UCH ophthalmologist Michael Taravella, MD, transplanted the cornea in her right eye. The sight-saving cornea, she says, came from a 50-year-old who died in a car wreck. "I give thanks for it every night," she says. "I've had no problems."

She can also be thankful her recovery was easier than her father's. "Back then, patients had to lie flat on their back for 30 days after transplant surgery," she relates.

Other than a numbing shot below the eye, Zaccardi says, her outpatient procedure involved no pain. She wore a hard patch at bed time to protect the eye; her body absorbed the tiny sutures that held the new cornea in place.

Like her father and many other patients with keratoconus, Zaccardi's condition affects both eyes. "I'll probably need another transplant," she says. In the meantime, however, she's aided by new contacts, called sclera lenses, that fit over her entire eye and help to reshape the cornea.

"The old contacts were too small and moved when you blinked," she explains. "These don't move."

She's grateful for the technology and the providers that saved her sight. "Vision is intricate. It's not like replacing one joint with another. This group of physicians at the Eye Center is the cream of the crop."