



Dr. Jimmy Lee of the Yale Eye Center with an exploded view of the inside of an eye with a cornea attached. He is one of the few surgeons who can transplant an artificial cornea into the eye of a patient. The cornea is like a windshield that protects the rest of the eye. When it stops working, surgeons can transplant part of a cornea from a cadaver. However, if the cornea is too badly damaged from an injury, disease or infection, then the patient may require an artificial cornea.

Peter Hvizdak/Register

TRANSPLANTS
DONE FOR
MORE THAN
A CENTURY,
BUT ARTIFICIAL
CORNEAS
NOW AN
OPTION

CORNEAL CORRECTION

By Abram Katz
Register Science Editor

CORNEAS ARE the clear, curved, covers over the eyes' irises and lenses. They are like windshields of the eyes, offering protection and preventing what's outside from coming in.

Corneas provide about two-thirds of the eye's focusing power, and generally aren't noticeable until something bad happens: a scratch, infection, trauma or problem that turns them opaque.

Sometimes, a cornea can be damaged so severely that it must be replaced. In fact, a cornea was the first tissue transplanted. That happened in 1905.

Part of the ease in transplantation lies in the cornea's structure, said Dr. Jimmy K. Lee, director of Cornea and Refractive Surgery at the Yale University School of Medicine.

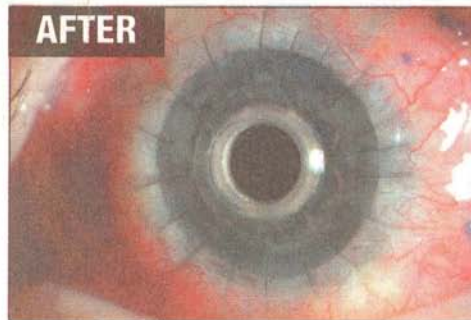
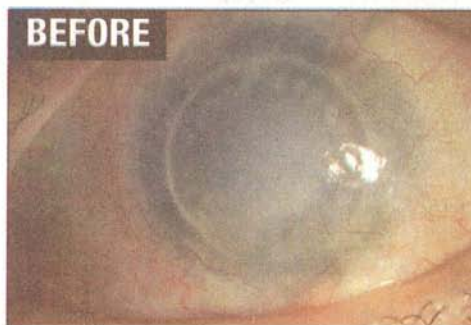
After all, the cornea contains no blood vessels. Almost all donor corneas are harvested from cadavers. Tissue typing is not a concern, because the immune system usually has no access to the organ.

However, if the initial transplant must be redone for some reason, the next transplants are successively less apt to be successful, Lee said. Consequently, sometimes the best option is to use the newly developed artificial cornea. Lee is one of a few surgeons who implant artificial corneas. He uses a three-part model developed at Harvard University.

A normal cornea is composed of layers of protein, akin to the pages of a book. It is about the thickness of 10 human hairs placed side by side. The part of the cornea facing the world, called the epithelium, receives oxygen directly from the air and nutrients from tears, spread every few seconds by the eyelids.

The inner side of the cornea is called the endothelium. It consists of cells that pump liquid from the aqueous humor, the fluid in the front chamber of the eye, into the rest of the cornea.

The cornea is composed of very compact stacks of collagen proteins. The proteins require water to render the cornea transparent, Lee said. If the endothelial pumps do not function properly, or are damaged, the cornea dries out and becomes cloudy and, eventually, opaque. The outer periphery of the cornea is lined with stem cells that can repair damage.



The number of stem cells dwindles with each implant.

Corneas can be injured in several ways. They include infections, ulcers, perforation and scarring; blunt trauma and lacerations; and degeneration and dystrophies. Endothelial pumps can also fail.

Any of these problems can reduce or eliminate transparency, leaving the eye sightless.

"In the past, regardless of the problem, doctors would perform a full thickness transplant," Lee said.

The damaged cornea was carefully cut out, and a clear cornea sutured in its place. Complications could include astigmatism, meaning the cornea is not perfectly curved. The transplant could also be marred by infection, or bleeding.

More recently, surgeons realized they could replace only the damaged layers of the cornea, leaving most of the tissue intact, Lee said.

Most of the 40,000 cornea transplants done in the United States annually are to replace an endothelium that is not working, Lee said.

Lee performs this procedure by gently scraping away the layer of cells that comprises the damaged endothelium. The endothelium from a donor cornea is slipped into place, and held in position by an injected bubble of air.

Corneas that are severely scarred by chemical burns, disease, or some other trauma must be replaced with an artificial cornea, Lee said.

The model he uses costs about \$3,000 and consists of three parts and a ring of healthy donor cornea. The front section is made of transparent polymer. It screws into a back plate and locking ring. Before the first two parts are connected, the ring of cornea is centered around the threads of the front part. The cornea provides an anchor for sutures.

The artificial cornea provides a transparent round window about an eighth of an inch in diameter. This provides a field of view almost as wide as a normal cornea.

After the unit is sutured into place, it can become infected, or the foreign material may be rejected. This means the patient must use antibiotic drops and be followed by the surgeon for several months.

Often, the eye is affected by other diseases or conditions that may not be apparent until the opaque cornea is removed, Lee said. For example, a retina may be detached, making the cornea transplant superfluous.

Sometimes, the retina has been damaged by glaucoma. When the cornea is replaced, the field of view is still restricted, but useful sight is restored.

Worldwide, about 10 million people are blinded by corneal scarring, which could be treated with an artificial cornea, Lee said.

Harvard has produced only about 1,500 artificial cornea implants and only a handful of doctors have sufficient experience to use them, Lee said.

Abram Katz can be reached at akatz@nhregister.com or 789-5719.