

WORKING KNOWLEDGE

LASER EYE SURGERY

Clear Favorite

Since excimer laser eye surgery was approved by the U.S. Food and Drug Administration in 1995, it has soared in popularity. Last year more than 1.5 million nearsighted, farsighted or astigmatic people underwent the procedure to eliminate the need to wear eyeglasses or contact lenses.

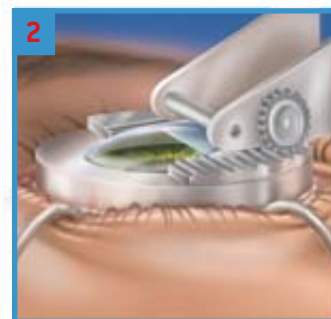
Several laser-correction schemes exist, but laser-assisted in situ keratomileusis (Lasik) is by far the frontrunner. The procedure reshapes the cornea by vaporizing cells so that light focuses onto the retina properly. Up to 8 percent of patients develop minor complications, among them poorer night vision and visual distractions such as glare or halos, which may disappear after a few months or can be improved with a second treatment. Less than 1 percent develop severe conditions such as infection or scarring.

Fully corrected vision may not last forever, though. Ophthalmologists have only 10 years of data. Most of the early patients “appear to retain their full correction, but a few began to regress after eight or five or even three years,” says Douglas D. Koch, an ophthalmology professor at the Baylor College of Medicine. Regression is usually mild and caused by natural changes in the eye. In most cases, a laser fix can be repeated, but each surgery thins the cornea, which should not be trimmed to less than 250 microns. Any thinner, Koch says, and the cornea may develop an irregular curvature because it cannot support itself.

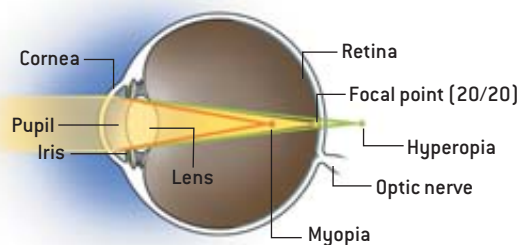
Competition has pushed prices down to \$1,000 per eye. Cheaper discount providers have sprung up, but ophthalmology associations worry that patients might be misled or receive poor care. (The FDA offers advice at www.fda.gov/cdrh/lasik) Other procedures include photorefractive keratectomy (PRK) and laser epithelial keratomileusis (Lasek), which avoid certain Lasik side effects such as dry eyes but may involve more initial discomfort and recuperation time.

The latest advance is wavefront-guided Lasik. It allows a surgeon to ablate specific points on each person’s eye instead of implementing a generalized fix, as is done with standard Lasik. Wavefront technology has been shown to provide better vision than regular Lasik, but it can increase the cost by \$400 or more for each eye treated.

—Mark Fischetti



LASIK SURGERY begins with anesthetic drops that numb the eye. A surgeon then places registration marks on the cornea (1). A suction ring immobilizes and pressurizes the eye so it can be cut cleanly by a motorized blade (2) that slices into the cornea, creating a flap about eight millimeters in diameter and 0.15 millimeter thick. (In a new procedure, a laser makes the cut.) The flap is pulled back, exposing the stroma. A laser vaporizes cells to a certain depth (3), reshaping the cornea in 60 seconds or less. The laser emits pulses of 193-nanometer ultraviolet light to ablate cells to an accuracy of 0.25 micron. The surgeon repositions the flap (4), which rebonds naturally.



CLEAR VISION occurs when the cornea focuses light rays exactly on the retina. In myopia (nearsightedness), the cornea is too steep or the eyeball is too long; although diverging rays coming from close objects converge at the retina, parallel rays from distant objects converge too early. Vaporizing the center of the cornea to flatten it fixes the problem. In hyperopia (farsightedness), the cornea is too flat or the eyeball is too short; parallel rays from distant objects focus behind the retina, and diverging rays from near objects are even farther behind. Vaporizing a ring of cells gives the cornea the needed, steeper slope.

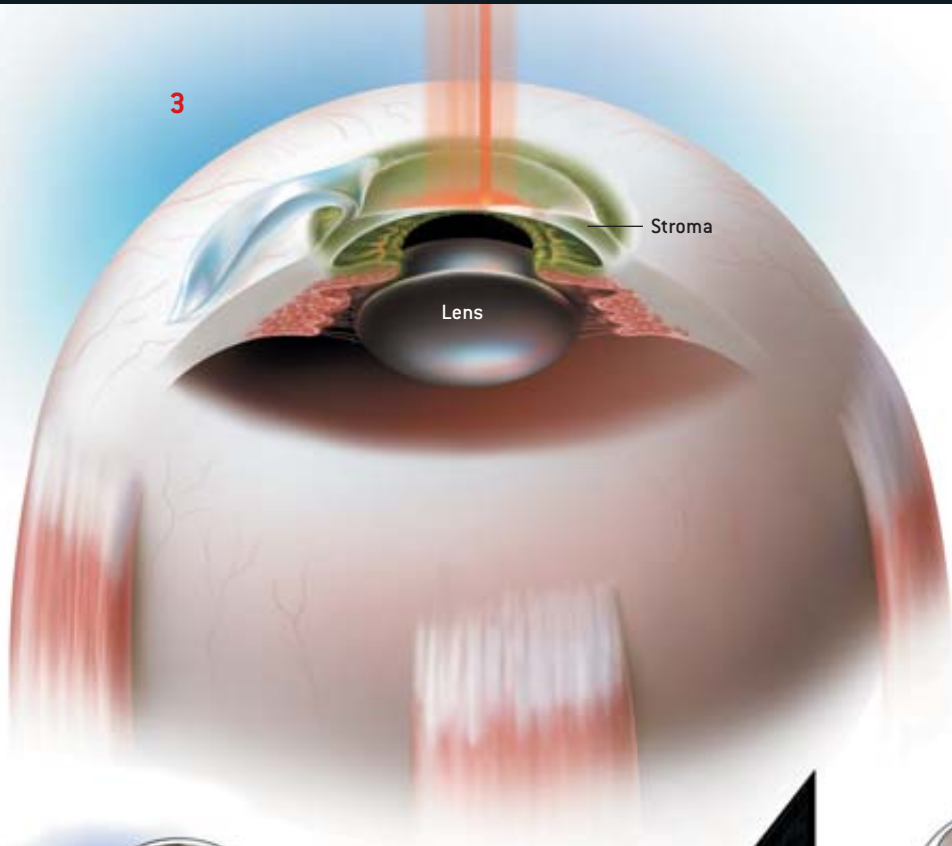
CONNIE FUNKHOUSER/BALEK Precision Graphics

- > **BETTER ONE:** Eye doctors determine prescriptions with the subjective, decades-old process of sliding different glass lenses in front of a patient's eyes and asking if a chart of letters looks "better with lens one or better with lens two." Laser wavefront sensors approved to guide Lasik surgery are being adapted for more objective measurement. They sample numerous points on the eye, leading to diagnoses that are 50 times as accurate.
- > **SUPER-VISION:** Good vision is labeled 20/20—a person sees objects 20 feet away as they should appear (at 20/40, the person must stand at 20 feet to see what normal eyes see at 40 feet). But the density of light-sensing cones in the retina would allow 20/8 vision (more than twice as sharp) if every cornea aberration could be eliminated.

Advanced wavefront-guided lasers recently approved could approach that goal. "They are finding distortions we didn't know existed," says Daniel Durrie, director of refractive surgery at Durrie Vision in Overland Park, Kan., "and they can tell surgical lasers how to correct them." Super-vision might be possible—unless the procedure creates unforeseen distractions such as distorted color perception.

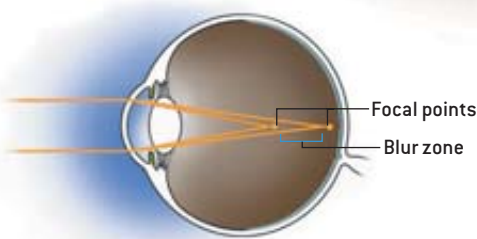
- > **HELLO, READING GLASSES:** Tiny muscles push and pull the eye's crystalline lens to bring objects into focus. As people age, the lens loses elasticity, making it difficult to zoom in on small objects close at hand. By age 45 virtually everyone has this degradation, which stabilizes in another 10 to 20 years when the lens simply loses all flex. The condition is called presbyopia—"old eye." It cannot be prevented.

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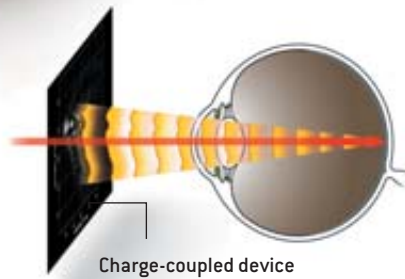
Stroma

Lens

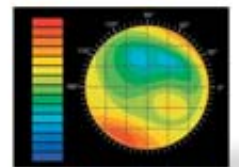


Focal points

Blur zone



Charge-coupled device



ASTIGMATISM (blurry vision) results when the cornea has uneven regions of curvature, which focus rays at multiple points. Smoothing the surface helps to bend rays uniformly.

WAVEFRONT-GUIDED Lasik surgery bounces a laser beam off the retina and senses the reflections on a charge-coupled device. Software maps the distorted rays caused by ocular aberrations (such as blue region, right) as small as 0.05 micron and directs the laser to vaporize specific points on the stroma to compensate for each error. In regular Lasik, the surgeon measures the cornea with traditional instruments and the laser ablates a standard, symmetric region to provide a good but generalized correction.

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