

# LIGHT for SIGHT

## Lasers Beginning to Solve Vision Problems

by Margie Patlak

**A**lthough it happened more than a year ago, 68-year-old Ervin Chudnow of West Palm Beach, Fla., still marvels at how a laser gave him back good eyesight.

Several years after having a cataract removed from his left eye, Chudnow began having problems with hazy vision. "It was like looking through a window with soap on it," he says. His sight became so poor he had difficulty with daily tasks such as driving and reading the paper.

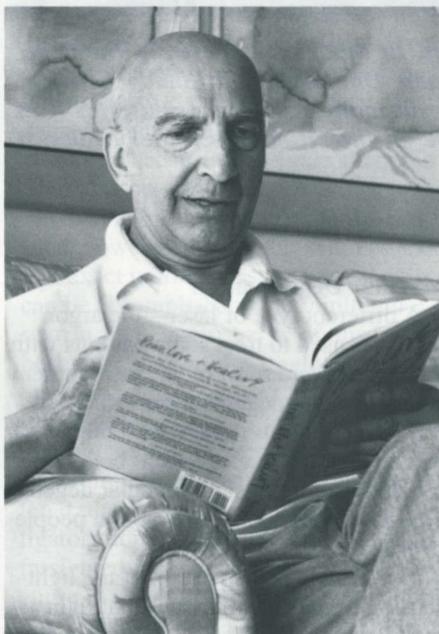
Chudnow went to see his ophthalmologist, who used about a dozen one-billionth-of-a-second blasts of infrared laser light to puncture the clouded membrane lining the back of the lens of his eye that was obscuring his vision.

"I went in there nearly blind in one eye, and after the half-hour walk home, I could see perfectly again," Chudnow recalls.

Many people tell dramatic tales of how lasers restored their sight. A versatile tool, lasers are commonly used to treat a variety of eye disorders such as retinal tears and glaucoma. In the not-too-distant future, moreover, a few zaps of laser light might bring back 20/20 vision to those who are nearsighted, farsighted, or have problems with astigmatism.

"Someday lasers may be routinely used to treat most things wrong with the eye," says Richard Weiblinger, a senior scientist in the Food and Drug Administration's ophthalmic devices division.

FDA's Center for Devices and Radiological Health regulates medical lasers to ensure they are safe and effective. Although surgical lasers must comply with stringent FDA safety standards, like any other surgical procedure, laser eye surgery is not completely without risk.



**Reading is no problem now for Ervin Chudnow of West Palm Beach, Fla., whose eyesight was restored by laser surgery.**

A laser (an acronym for "light amplification by stimulated emission of radiation") is a simple device that usually combines electricity, a series of mirrors, and a crystal or gas to generate an extremely intense and narrow beam of a single type of light, such as infrared or ultraviolet. (Sunlight, in contrast, is composed of a jumble of different colors, spread out in different directions.)

The laser's usefulness in ophthalmology stems from the precision and ease with which it can be used to reach tissues deep within the eye. Unlike the smallest scalpel used in surgery, which makes cuts as wide as the tip of a pin and crushes neighboring tissue, a "laser scal-

pel" can slice as thin as the width of a cell without damaging surrounding cells. This precision allows eye doctors to target diseased blood vessels, for example, while sparing healthy ones, and fosters a speedy recovery with little resulting scar tissue.

Even minor amounts of scar tissue can pose major impediments to sight by blocking the pathway of light entering the eye. That pathway is what makes the laser so useful in treating patients with eye disorders; the pupil acts as a natural window through which laser beams can enter to mend tissues deep within the eye. Because the ophthalmologist doesn't have to cut open the eye during laser surgery, there are fewer risks of infection and less pain than with standard surgery. Laser surgery can be done in an ophthalmologist's office or hospital outpatient department, so it also is less expensive.

### Membranes of the Eye

Approximately half of all patients who have cataract surgery need the type of laser surgery Chudnow had. A cataract is a clouding of the normally clear and transparent lens of the eye. (See "Lifting the Clouds of Cataracts" in the December 1989-January 1990 issue of *FDA Consumer*.)

During cataract surgery, an ophthalmologist often replaces the natural lens of the eye with an artificial one. Several months later, however, the membrane in the back of the eye, which surrounds and supports the lens, may become cloudy, impairing vision.

Ophthalmologists counter this problem by using the intense infrared light of a neodymium: yttrium aluminum garnet (Nd:YAG) laser to create an opening in the membrane. During this procedure,



*Laser surgery is done in a darkened room. In this picture posed in the light, Patricia A. Smith (left), head nurse of Same Day Surgery at Shady Grove Hospital in Maryland, looks through the slit lamp of the argon laser as if in preparation for surgery to relieve pressure on the retina of Eleanor Miller, a hospital volunteer.*

called a posterior capsulotomy, each flash of the laser causes a microscopic explosion in the membrane. The mini-explosion is thought to vaporize cells.

Although the laser beam travels through other eye tissues before it reaches the membrane, it doesn't harm these tissues because only the highly focused tip of the beam has enough energy to cause a microexplosion. This tip touches only the membrane in the back of the eye, which has no nerve endings. Posterior capsulotomies, consequently, are painless. This quick procedure rarely has any serious complications.

### **Glaucoma**

An Nd:YAG laser is also used to treat some cases of glaucoma. This disease, which affects at least two out of every 100 Americans over 35, according to the American Academy of Ophthalmology, is one of the leading causes of blindness in this country. (Earlier this year, President Bush was diagnosed as having a type of glaucoma.)

The hallmark of glaucoma is an excessive build-up of fluid pressure in the eye. The unhealthy pressure is caused by a blockage of the canals through which the clear inner eye fluid continuously flows. If left untreated, glaucoma eventually damages the sight (optic) nerve.

An Nd:YAG laser can relieve the fluid pressure by creating an opening, allowing the eye fluid to drain properly. Although a slight risk of bleeding accompanies this type of laser surgery, it rarely

causes serious problems.

### **Macular Degeneration**

A different type of laser—the argon laser—is used to treat some patients with the more severe form of an eye disorder called macular degeneration. Although this disease doesn't cause total blindness, it is a leading cause of loss of both central and reading, vision. Macular degeneration is particularly common in people over 65.

The macula is the portion of the light-sensing retina (see diagram) that light rays strike to provide the sharp, straight-ahead vision needed for driving and reading small print. In the less common but more severe form of macular degeneration, for no known reason, new blood vessels grow beneath the macula. These abnormal vessels leak fluid and blood, destroying nearby macula cells. If the leakage and bleeding continue, much of the macula may be damaged irreparably within a few weeks or months. The resulting dense scar tissue blocks out central vision, much like an opaque smudge does in the center of one's glasses.

With early detection, severe vision loss from this type of macular degeneration can usually be prevented with argon laser treatment. This relatively low-energy laser heats, rather than vaporizes, tissues, acting essentially like a welder. A study conducted by the National Eye Institute showed that argon laser treatment can slash by more than half the chances of experiencing severe vision

loss from macular degeneration.

The green beams of the argon laser are only absorbed by red objects, so it selectively heats up and seals blood vessels (because they contain red blood cells) and leaves most other parts of the eye undisturbed. The narrowness of the beam enhances laser precision, allowing the ophthalmologist to target only diseased blood vessels.

This type of surgery generally takes only a few minutes and may be done with the aid of a local anesthetic to prevent discomfort. Soon afterwards, the patient is able to return home and resume normal daily activities.

A fungal disease called ocular histoplasmosis can cause faulty blood vessels to grow and damage the macula. This is a significant cause of vision loss in the southeast and midwest United States, where this particular fungus is prevalent. Experts estimate that laser treatment of the abnormal vessels can prevent up to 2,000 cases of serious vision loss due to the disease each year if treatment is given early, before extensive damage has occurred.

### **Diabetic Retinopathy**

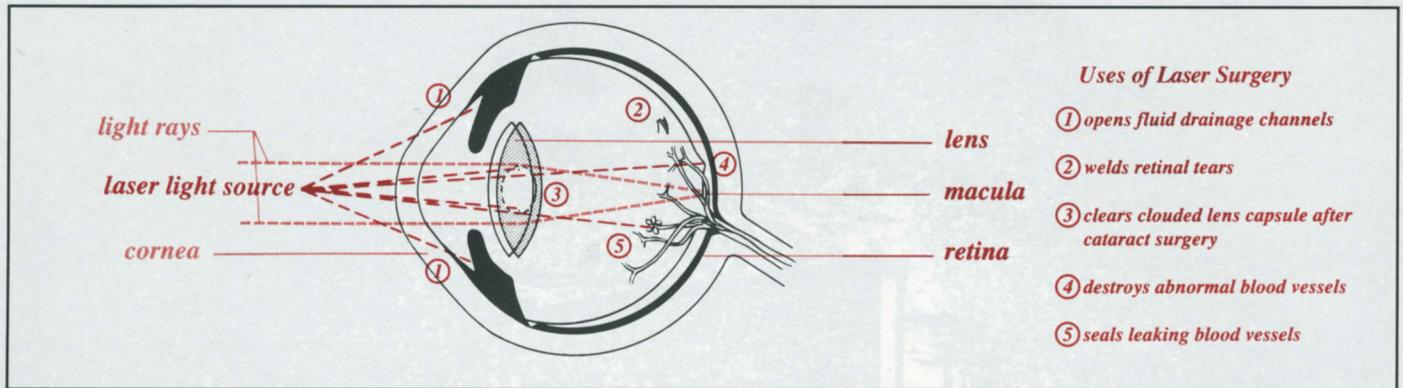
Ophthalmologists use a similar procedure to seal off leaky blood vessels or destroy diseased tissue in the retinas of patients with diabetic retinopathy, another leading cause of blindness. The hallmark of this disease is faulty blood vessels on or within the retina. These vessels bleed, scarring the retina. According to the National Eye Institute, nearly half of all diabetics have at least mild diabetic retinopathy. If used in early stages of the disease, laser treatment often halts the patient's loss of vision and sometimes even reverses it. The procedure is usually painless and without complications.

### **Retinal Tears**

An argon or another type of tissue-heating laser called a krypton laser is also used to spot-weld retinal tears. These horseshoe-shaped holes in the retina may open small blood vessels and cause bleeding into the central cavity of the eye. Often caused by a blow to the head, retinal tears can cause flashes of color or black spots to appear in one's line of sight.

### **Laser Sculpting**

Still experimental is the use of the laser on the eye's surface to treat people



for nearsightedness, farsightedness or astigmatism.

When light rays enter the normal eye, they are bent by the transparent front covering of the eye (cornea) and the lens so that they are brought to a single, sharp focus on the retina. But in the nearly one-third of Americans who are nearsighted (have trouble seeing distant objects), the light rays bouncing off far-away objects come to focus in front of—instead of directly on—the retina. This happens because either the curve of the lens or cornea is too steep or the eye is too long. In farsightedness (trouble seeing objects close up), the eye is too short or the curve of the cornea or lens is not steep enough. The rays, consequently, merge in back of the retina. The end result in both conditions is blurred vision.

To counter these vision flaws, most nearsighted or farsighted individuals wear glasses or contact lenses shaped to bend the light rays so that they properly reach the retina. By precisely reshaping the cornea with the laser, ophthalmologists hope to achieve the same effect. Theoretically, once the laser surgery is done, the person could throw away the no-longer-needed glasses.

### Nearsightedness

Corneal surgery to cure nearsightedness has been attempted with traditional surgical tools, but without reliable results. In this procedure, called a radial keratotomy, an ophthalmologist uses a scalpel to cut several small slits in the cornea. These slits slightly flatten the cornea by changing the pressure in the eye and weakening the cornea's structure.

But nearly half of all the eyes treated with this procedure are either undercorrected or overcorrected, according to a

study published in the Feb. 22, 1990, *Journal of the American Medical Association*. Apparently, the surgery often fails because the depth and shape of cuts made by the hand-held scalpel are inconsistent, or because scar tissue alters the desired contour of the cornea.

When an ultraviolet excimer laser is used, however, preliminary studies show that exact uniform tissue removal cuts can be accomplished with minimum scarring. The high energy of this laser beam ejects cell-sized fragments from the surface of the cornea. Such precision has enabled several research groups to directly remove minute quantities of tissue from the center of the cornea to flatten it, thus restoring sharp vision. Investigators hope to use the excimer laser on farsighted individuals, in whom the curve of the cornea is steepened rather than flattened.

Researchers speculate that because the excimer laser damages such small amounts of tissue, it "fools the eye into not knowing it's been traumatized," says Weiblinger. "Once the body knows it's been invaded, it tries to heal itself. That healing process can alter the desired recontouring of the eye."

The total sculpting procedure with the excimer laser takes less than a minute to complete, although about 20 minutes are needed beforehand to train patients to keep their eyes steady. The cornea may ache for about a day following surgery, and patients need to wear an eye patch for one or two days.

Initial results of laser sculpting by researchers at Louisiana State University Eye Center in New Orleans and Johns Hopkins University in Baltimore are encouraging. These investigators were able to improve one patient's 20/300 eyesight to 20/40 eight weeks after treatment.

Another woman, whose nearsighted eye was corrected nearly two years ago, still sees perfectly without glasses or contact lenses. More extensive and longer-term testing will have to be done, however, to ensure the safety and effectiveness of laser sculpting for nearsightedness.

### Astigmatism

The excimer laser is also being used experimentally to correct astigmatism. This blurred vision is caused by bumps and pits on the corneal surface, which prevent light rays entering the eye from merging into a single, sharp focus. Preliminary tests on more than 50 patients in Berlin, Germany, indicate that a series of T-shaped incisions made by the laser may be effective in smoothing out corneal irregularities. Various researchers in the United States are trying the same procedure on persons with astigmatism, but have not yet reported results.

If more extensive tests show laser sculpting is a safe and effective method for correcting near- or farsightedness or astigmatism and it becomes an accepted practice, various laser companies estimate the procedure will probably cost between \$1,000 to \$2,000 per eye.

Even if laser sculpting continues to show promise in clinical trials, however, it will be several years before a patient will be able to enter the ophthalmologist's office wearing glasses, get a few zaps of laser light, and achieve perfect vision after a few weeks. Though today it's hard to imagine such a scenario, several years ago it would have been just as hard to believe the quick and easy laser surgery Chudnow had would one day be possible. ■

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