Biomedicine

Rick Weiss reports from Universal City, Calif., at an ophthalmology seminar sponsored by Research to Prevent Blindness, Inc.

Close laser shave for corneal scars

Laser treatments may someday make many corneal transplants unnecessary, new research suggests.

Preliminary results from clinical trials with excimer lasers indicate that the ultraviolet beams can shave layers of cells off the eye's clear outer coating, or cornea, leaving an unscarred, "exquisitely smooth surface," says Walter J. Stark, an ophthalmologist at the Johns Hopkins University School of Medicine in Baltimore. He suggests the technique may someday find broad application in removing sight-impairing corneal scars that result from injury or infection.

Widespread use of lasers to correct nearsightedness or farsightedness by reshaping the cornea remains farther down the road, he says. In most cases, those conditions are easily corrected with eyeglasses or contact lenses, and preliminary data suggest that many corneas reshaped by laser revert to their former curvature, Stark says.

For corneal scarring, however, "we're very excited about the [technique's] potential," he says. Stark reports that 15 of the 19 people with corneal scars treated with an excimer laser in his study have regained enough visual acuity to avoid corneal transplants, at least for now. He suspects the treatment could postpone or replace corneal transplantation in 10 to 15 percent of patients now in need of the expensive transplant surgery, which is plagued by a shortage of donors.

It remains unclear how expensive the laser procedure might be. The machines aren't cheap, costing $250,000 to $350,000 each and requiring maintenance to the tune of $100,000 to $150,000 per year, Stark says. But he suggests the experimental technique could become cost-effective on a per-patient basis after FDA approves it for general use and patient volume increases. He expects such approval within four years.

Other researchers caution that ophthalmologists shouldn't jump on the laser bandwagon before the procedure is perfected and long-term data come in. They note that most sight-impairing corneal scars in U.S. patients today arose from damage incurred during cataract surgery years ago, before ophthalmologists had perfected that technique.

Long-term contacts look good in monkeys

Research with biocompatible polymers and collagen adhesives hints at a new generation of super-extended-wear contact lenses. Researchers are already fitting monkeys with these "almost forever" lenses, which humans may someday wear day and night for years without the risk of corneal damage or infection inherent in today's extended-wear lenses.

Keith P. Thompson of the Yerkes Regional Primate Research Center in Atlanta is experimenting with a technique called laser-adjustable synthetic epikeratoplasty. It involves scraping away the thin outer layer of epithelial cells covering the cornea, then permanently attaching a refractive, biocompatible corneal covering, or lenticule. The lenticule is made of chemically altered collagen, a naturally occurring protein. Once the lenticule is in place, Thompson uses a laser to fine-tune its curvature for maximum vision correction. Epithelial cells eventually grow over the newly augmented cornea.

Thompson says he's "encouraged" by the results so far, adding that some monkeys have worn the permanent lenses for more than a year. But he says evidence of some erosion of the collagen-based lenses – probably from enzymes released by surrounding cells – indicates a need to find better materials. Such materials must be optically clear, laser adjustable, gas permeable, structurally stable and capable of transporting nutrients from inside the eye to the epithelial cells growing outside the lenticule, he notes.

Thompson says he has recently developed enzyme-resistant lenticule materials and collagen-based adhesives that may prove superior to those used in the monkey experiments. He hopes to make sufficient progress within the next few years to obtain FDA approval for safety and stability tests on sightless human eyes.

Uprooting a major cause of blindness

A new laser technique developed by a husband-and-wife research team shows promise as a treatment for age-related macular degeneration, the most common cause of irreversible blindness in U.S adults over 65 years old. The condition begins with a proliferation of leaky blood vessels under the macula, or central portion of the retina, causing damage and scarring followed by progressive blindness.

The macula – 100 times more sensitive to visual detail than other parts of the retina – is essential to such activities as reading fine print, driving a car and recognizing faces. Nobody knows why the underlying blood vessels so often begin to proliferate late in life. But early detection and ablation of these leaky vessels is critical, since the light-detecting macular cells won't recover once they're damaged by the seeping blood plasma and other fluids.

Ophthalmologists already use lasers to destroy proliferating vessels in some patients with early macular degeneration. This prevents the vessels from disrupting the delicate retinal architecture and stanches the leakage of damaging fluids. But the treatment's value remains limited to the 25 percent of cases in which only a few, easily targeted abnormal vessels have developed. Most cases involve many abnormal vessels scattered beneath the macula, leaving ophthalmologists uncertain where to aim the beam. And because each laser hit destroys a tiny portion of the retina, wholesale lasing of every leaky vessel might take too heavy a toll on visual acuity.

Neil M. Bressler and Susan B. Bressler of the Johns Hopkins University School of Medicine started a pilot trial one year ago for patients with diffuse macular vessel proliferation. Using krypton and tunable dye lasers, they applied tiny laser hits in a grid pattern over the back of the retina. The treatment gives the retina the appearance of a miniature pegboard, with hits 150 microns apart, but it leaves the vast majority of the retina intact while zapping a significant number of abnormal blood vessels, the researchers say. Moreover, they report indirect evidence that the treatment may prompt certain specialized retinal cells to release so-called anti-angiogenic factors, which suppress vessel proliferation.

As of July, the Bresslers had treated 53 patients. They say the results are encouraging; in some cases the treatment has led to complete elimination of retinal fluid leakage within six weeks.

Many more patients must receive the experimental treatment before its usefulness can be confirmed, the researchers add. And since scientists don't really know what ultimately causes blindness in victims of macular degeneration, it remains unclear whether the anatomic improvement achieved with laser treatment will ultimately preserve patients' vision. The Bresslers hope to answer that question within another year.

Meanwhile, in the October ARCHIVES OF OPHTHALMOLOGY, they will report results from the first large-scale, prospective study seeking to identify those people at highest risk of developing age-related macular degeneration. The Hopkins team examined a five-year series of retinal photographs from 127 people who developed macular degeneration, tracking the changes in various cellular features. From those data, they created a predictive diagnostic formula that identifies those patients at highest risk of developing the vision-threatening vessel profusion.