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Laser Eye Surgery Gains Popularity Among Nearsighted Pilots Seeking Better Vision

New techniques to reshape the cornea are giving most patients 20/20 eyesight. The U.S. Federal Aviation Administration is issuing medical certificates to pilots who have undergone the procedures, but the agency has questions about long-term side effects.

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A laser technique to correct nearsightedness (myopia) has become increasingly popular in the late 1990s, and thousands of people — including pilots — have been treated by this latest form of vision-correcting surgery, known as laser-assisted in situ keratomileusis (LASIK).[1,2]

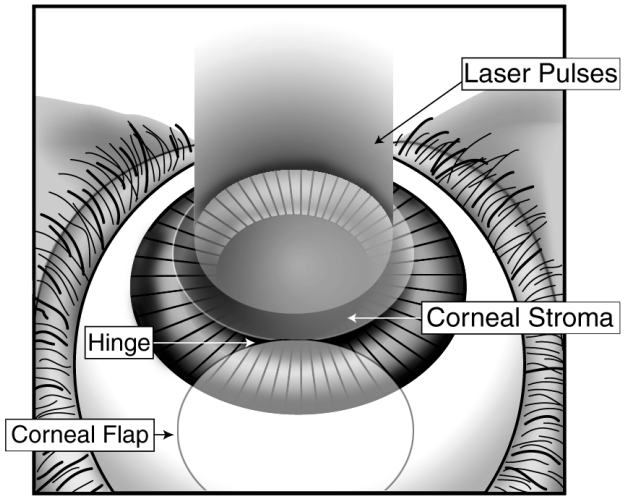
Nevertheless, the U.S. Federal Aviation Administration (FAA) has suggested monitoring pilots who undergo the procedure to evaluate them for side effects.

LASIK (Figure 1, page 2) shares the goal of the series of similar surgical procedures that preceded it: flatten the bulge in the cornea that is characteristic of nearsightedness, and by doing so, dramatically improve the patient's ability to see distant objects without vision correction, such as eyeglasses or contact lenses.

In an eye with normal vision (Figure 2, page 2), the cornea has a rounded curve. Light passes through the cornea and the pupil to the lens, which focuses light on the retina, the eyeball's light-sensitive innermost lining. In the nearsighted eye, the rounded curve of the cornea bulges out, and the distance from the cornea to the retina increases. Light rays come to a focus not on the retina but in front of it, and the misplaced focus makes distant objects appear blurred.

LASIK and other surgical techniques for reshaping the cornea, known as refractive surgeries, reduce the bulge in the cornea so that light focuses properly on the retina.

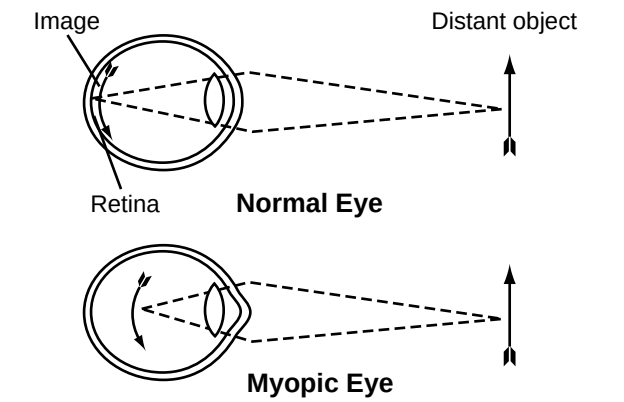
In the United States, most applicants for FAA medical certificates who have had the LASIK procedure or similar refractive surgical procedures, such as photorefractive keratectomy[3] (PRK) and radial keratotomy[4] (RK), are currently being certified medically, depending on the quality of their vision after surgery. If corrective lenses are needed to meet FAA medical standards, a limitation is placed on the medical certificate stating that the pilot shall wear corrective lenses (while exercising the privileges of an



*LASIK = Laser-assisted in situ keratomileusis

Source: U.S. Federal Aviation Administration

Figure 1



Source: Stanley R. Mohler, M.D.

Figure 2

airman certificate). No discretionary issuance, commonly known as a waiver, is required.

After undergoing a vision-correcting procedure, the applicant obtains FAA form 8500-7 — the "report of eye evaluation" form — from an aviation medical examiner (AME). The applicant, after recovery from the procedure is complete, takes the form to an eye specialist who examines the eyes, completes the form and returns the form to the applicant. The applicant then takes the form to the AME, who determines whether the applicant's vision meets the vision standards published in U.S. Federal Aviation Regulations (FARs) Part 67. If the standards are met, the medical certificate is issued, and the pilot may resume flying.

Under standard guidelines on selection criteria for the LASIK procedure, the patient should be at least 18 years old and have normal ocular health, stable vision that can be forecast to be corrected by the procedure to 20/40 or better, and a realistic expectation concerning the procedure's outcome. Doctors who perform the LASIK procedure will check other medical criteria to ensure that patients who undergo the procedure have nearsightedness that is no more severe than a myopia refractive error of minus 15 diopters and astigmatism no more severe than an astigmatic refractive error of less than 8 diopters. (A diopter is a unit of optical measurement.) A pupil size of six millimeters (mm; 0.2 inch) or less in normal room lighting environments is another requirement, because patients with larger pupils are likely to see halos around lights after undergoing the procedure.

LASIK and similar procedures will not eliminate the need for reading glasses when a patient reaches the age (generally in the 40s) when the eyes typically lose their ability to focus clearly on near objects. That condition, known as presbyopia, occurs because, as a person ages, the eye's lens loses some of its elasticity.

In rare cases, some LASIK patients experience complications. If the removal zone is not centered exactly, for example, the treated eye may have a misshapen cornea, a condition known as monocular diplopia in which two images of a single object are seen. Wearing corrective lenses usually will eliminate this. A detached corneal flap can cause problems achieving a proper reattachment; the outer layer of the cornea may grow into the flap in a way that produces roughness. In rare cases, a perforation of the eye may occur. Hemorrhages into the white of the eye may appear.

Side effects also have been reported in some cases, including glare, halos around lights, reduced contrast sensitivity and fluctuating visual acuity.

FAA certifies pilots who have recovered from LASIK and other refractive surgeries if their vision after surgery, with or without corrective lenses, meets the standards established for the class of medical certificate that the pilot is seeking. Those standards, detailed in FARs Part 67, specify that, for a first-class medical certificate or second-class medical certificate, the pilot must have "distant visual acuity of $20/20^{5}$ or better in each eye separately, with or without corrective lenses." For a third-class medical certificate, distant visual acuity of 20/40 or better in each eye, with or without corrective lenses, is required.

Patients who have undergone LASIK surgical procedures report an experience that is generally as follows:

The patient arrives about an hour before the surgical procedure is scheduled, and the eye is scanned by a computer-controlled measuring device to determine the precise location within the eye where light is focused. Special software creates and retains a digital model of the eye. The software then enables the

physician to compute the changes that will be needed to modify the inner layers of the cornea to produce the desired change in vision.

The patient might be offered a tranquilizer to ease anxiety. Then, the patient lies on his or her back, and eye drops containing a local anesthetic are placed on the cornea. As the patient remains still, a suction device is placed on the cornea, and the microkeratome, a knife blade that is capable of making thin, precise cuts, is used to cut a circle in the thin membrane that covers the cornea, leaving a small edge piece attached. The flap is folded back, exposing the inner corneal layers known as the corneal stroma, which are about two mm (0.08 inch) thick. As the flap is folded back, the patient stares at a small blinking light directly above his or her eye.

The excimer laser (a laser designed especially for use in ophthalmic procedures), which has been programmed with data gathered during the computerized eye scan, is used to remove enough of the corneal stroma to move the point at which light focuses in the eye to the desired position on the retina, thereby correcting the vision to 20/20.

Then the flap is placed back over the remaining inner corneal tissue.

The second eye may be treated immediately, or the patient may wait a day or longer to undergo the procedure on the second eye.

The procedure takes about 20 minutes, and in most cases, about 15 minutes after the procedure is complete, the corneal flap becomes adhered in place, and vision begins to return to normal. The eye may feel scratchy for a day or two. And after a few days, vision should be about 20/20.

About two days after the procedure, the patient is released from the doctor's care. Recovery is essentially complete within days, and 20/20 vision, or vision that approaches 20/20, is the most common outcome. If uncorrected vision after the procedure is not 20/20 (if it is, for example, 20/25 or 20/30), the patient can be fitted with eyeglasses that are much thinner than might have been required before the procedure if vision had been, for example, 20/200 or 20/400. Some of those patients can be fitted with contact lenses instead of glasses; other patients might find that the procedure left their eyes too sensitive to wear contact lenses comfortably.

A pilot or aspiring pilot who is young or middle-aged and whose vision requires refractive correction to meet FAA standards should consider several factors in deciding whether to undergo the laser procedure. Among them are:

- Does the use of eyeglasses for nearsightedness or astigmatism or both present a serious annoyance in the conduct of daily activities, including flying? Do contact lenses cause problems in flying?
- Can the individual afford the cost of the procedure, generally about US$2,500 for each eye, and the cost of missing time from work? and,
- Is the individual willing to take the risk that the surgery might not be a success and that vision after the procedure might be worse than it was before?

Industry analysts have predicted that by 2000, 1 million U.S. residents a year will undergo LASIK or some other form of refractive laser surgery, and projections in a study by the FAA indicated that the number will include more than 1,200 civilian pilots.[1]

Another FAA study found that, from 1994 to 1996, some form of refractive surgery was performed on 3,761 pilots of the 605,296 who held U.S. pilot certificates. Most were general aviation pilots, but 133 of those pilots were employed as airline captains, first officers, second officers or flight engineers.[6]

Long-term effects of newer refractive surgical techniques, such as LASIK, are not known, and an FAA study has recommended special monitoring and evaluation of pilots who have undergone the procedures to check for potential long-term side effects that might lead to "operational problems in the aviation environment."[6]

Some known side effects, including glare and reduced contrast sensitivity, "suggest that the quality of vision after refractive surgery may prove unacceptable in a cockpit environment," the FAA study said. "In addition, it is not known if post-refractive surgery problems could be compounded by the normal age-related decline in vision."[6]

There are a number of theories with respect to why healthy individuals might be nearsighted or might have astigmatism. Diet, allergy, light conditions, vitamin deficiencies, genetics and obesity all have been implicated, along with other factors. In some nearsighted and astigmatic people, these conditions, separately or together, have existed since birth. In other cases, the conditions appeared in childhood or later as the shape of the eyeball changed, resulting in nearsightedness or astigmatism or both.

Refractive surgery appears likely to be an increasingly popular method of treatment for nearsightedness and astigmatism. Advances in corrective techniques undoubtedly will continue, and surgery will become a more attractive option for those with marked myopia or astigmatism.♦

Notes and References

1. Nakagawara, Van B. and Wood, Kathryn J. "The Aeromedical Certification of Photorefractive Keratectomy in Civil Aviation: A Reference Guide." Office of Aviation

Medicine. Federal Aviation Administration. September 1998. DOT/FAA/AM-98/25, 1–37.

2. Guell, J.L. and Muller, A. "Laser in situ Keratomileusis (LASIK) for Myopia -7 to -18 Diopters." *Journal of Refractive Surgery* (January/February 1996): 12–1, 222–8.

3. Photorefractive keratectomy (PRK) uses an excimer laser's high-energy laser light to vaporize 0.25-millimicron portions of the cornea by photochemically disrupting its molecular bonds. The laser reshapes the cornea's curve and removes the outer layer of the cornea to correct for the refractive error that results in nearsightedness.

4. Radial keratotomy (RK) uses a diamond surgical blade to make radial incisions on the edges of the cornea. The incisions weaken the edges of the cornea and allow pressure within the eye to flatten the cornea.

5. A person with 20/20 vision has what is considered normal visual acuity and is able to see clearly at 20 feet (6.1 meters) what the normal eye sees at 20 feet.

6. Nakagawara, Van B., Wood, Kathryn J. and Montgomery, Ronald W. "Refractive Surgery in the Civil Airman Population by Class of Medical Certificate and by Aviation Occupation." Office of Aviation Medicine, Federal Aviation Administration. February 1999. DOT/FAA/AM-99/6, 1–7.

About the Author

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Mohler, who holds an airline transport pilot certificate and a certified flight instructor certificate, was director of the U.S. Federal Aviation Agency's Civil Aviation Medicine Research Institute (now the U.S. Federal Aviation Administration's Civil Aeromedical Institute) for five years and chief of the Aeromedical Applications Division in Washington, D.C., U.S. for 13 years.

Mohler received the 1998 Cecil A. Brownlow Publication Award for journalism that enhances aviation-safety awareness.

Further Reading from FSF Publications

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