Laser in situ keratomileusis flap stability in an aviator following aircraft ejection

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We present the case of a 28-year-old male F/A-18F Super Hornet naval flight officer who ejected from an aircraft at 13,000 feet at a speed in excess of 350 knots 7 years after uneventful laser in situ keratomileusis (LASIK). The patient was evaluated the day after the ejection. No LASIK flap complications or epithelial defects were found, and the corrected distance visual acuity was 20/15 in both eyes.

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Traumatic flap dislocation is a serious potential complication of laser in situ keratomileusis (LASIK), of particular concern for the military aviation community due to the windblast and G-forces typically experienced during ejection. Although LASIK has been shown to be safe and effective, traumatic flap dislocations can be visually devastating. Two animal studies have demonstrated the safety and stability of the LASIK flap during simulated ejection environments.

To our knowledge, this is first case of an aviator ejecting from a high-performance aircraft after having LASIK.

CASE REPORT

A 28-year-old white man presented the day after he ejected from an F/A-18F Super Hornet with the chief complaints of eye redness and photophobia. Laser in situ keratomileusis had been performed 7 years previously in September 2009. The preoperative sphere was −3.50 diopters (D) in the right eye and −3.25 D in the left eye, and the corrected distance visual acuity (CDVA) was 20/20 in both eyes. The preoperative scanning-slit topography (Orbscan, Bausch & Lomb) showed corneal thicknesses of 625 μm and 620 μm, respectively.

A superior hinged flap with a thickness of 120 μm and a diameter of 8.6 mm was created in both eyes with the IntraLase femtosecond laser (Abbott Medical Optics, Inc.). The wavefront-guided ablation was performed with the Star S4 IR excimer laser (Abbott Medical Optics, Inc.).

Six months postoperatively, the uncorrected distance visual acuity (UDVA) was 20/20 in both eyes. No complications were noted after the surgery. When the patient was evaluated as a student naval aviator candidate in December 2010, the UDVA was 20/20 in the right eye and 20/20 in the left eye with a manifest refraction of +0.75 −0.25 × 82 and +0.50 −0.50 × 146, respectively, yielding a CDVA of 20/20 in both eyes.

Following an inflight mishap, the patient ejected from the aircraft at 13,000 feet with airspeed in excess of 350 knots in May 2016. The patient was wearing an oxygen mask and his visor was down at the time of ejection, but he removed them during the parachute descent before landing in the Atlantic Ocean. He does not recall specific trauma to his face but presented to the Department of...
Ophthalmology, Naval Medical Center Portsmouth, Virginia, the day after the mishap with complaints of red eyes and light sensitivity. Examination found a UDVA of 20/15 in both eyes, mild edema of the lids bilaterally, a small area of ecchymosis in the right lower lid, and several small subconjunctival hemorrhages bilaterally. Intraocular pressure, pupil examination, motility, and posterior segment examinations were normal in both eyes. Neither LASIK flap was displaced, and there were no striae or epithelial defects.

DISCUSSION

Laser in situ keratomileusis has become a successful method of correcting various refractive errors. The procedure has been shown to be effective and safe for correcting refractive errors in naval aviators and has become increasingly popular among this population since 2011, when the Naval Aerospace Medical Institute authorized waivers for flight duty following successful LASIK. Any medical procedure in an aviator requires a period of medical grounding. The major advantage of LASIK is that the time spent out of the aircraft by United States Navy aviators is 2 weeks for myopia correction and 4 weeks for hyperopia correction. This is in contrast to photorefractive keratectomy (PRK); naval aviators are grounded for 3 months after PRK for myopia and 6 months after PRK for hyperopia.

The possibility of traumatic flap dislocation is a concern because of the minimal central wound healing at the stromal–stromal interface. Histologic studies in rabbits show that the flap heals by epithelial adhesion at the circumferential edge of the wound and the central cornea remains clear. Two animal studies have looked at the stability of the LASIK flap in environments that mimic those of an aircraft ejection. A U.S. Navy study exposed rabbit eyes to bursts of compressed carbon dioxide at various pressures following LASIK with a microkeratome-created flap and excimer laser ablation, showing that the force of air required to dislodge the flap was significantly greater than that of blunt trauma by a tree branch or finger strike. In addition, 3 eyes were exposed to wind speeds of 180 mph and subsequently of 400 mph for 30 seconds and the only effect on the eye was corneal dryness; there was no effect on the flap. The study concluded that ejection from a high-performance aircraft posed no significant risk to the LASIK flap. In a U.S. Air Force study, rabbits with microkeratome-created corneal flaps were subjected to a simulated ejection with forces 9 times that of gravity (+9 Gz) and none of the flaps dislocated. Although these animal studies rigorously tested the stability of the LASIK flap under well-controlled extreme conditions in the laboratory, it is difficult to fully recreate the host of physiologic stressors encountered during a real-world ejection sequence. Two cases of an ejection after PRK or intraocular lens (IOL) placement have been reported, and no change in UDVA was seen after the ejection. To our knowledge, this is the first reported case of an aviator ejecting from a high-performance aircraft after LASIK. The ejection occurred at 13 000 feet at a speed in excess of 350 knots with gravitational forces up to +23 Gz. While undergoing these forces, the patient clearly sustained periocular stress and injury, as evidenced by the subconjunctival hemorrhages, eyelid edema, and ecchymosis; however, the LASIK flaps were unaffected. It should be noted that the LASIK flaps had been created using a femtosecond laser, whereas the previously mentioned animal studies showed the stability of microkeratome-created flaps. The results should easily translate to femtosecond-created flap stability as femtosecond-created flaps have been shown to have greater adhesion and to be more resistant to dislocation than microkeratome-created flaps.

The U.S. Navy performed extensive research on corneal refractive surgery, both PRK and LASIK, before the procedures were authorized for naval aviators. Many concerns had to be addressed prior to approval, such as the rate of postoperative visual recovery, the effect on night vision, refractive stability under hypobaric and hypoxic conditions, as well as the stability of the LASIK flap during ejection. This real-world case involving a high-speed ejection validates the research and provides further evidence that LASIK is a safe refractive surgical option for military aviators.

REFERENCES


OTHER CITED MATERIAL