

You're the Flight Surgeon

This article was prepared by Kevin VanValkenburg, D.O., M.S.

You're a training base flight surgeon. A 50-yr-old flight surgeon, frustrated with his visual acuity, complains of problems with his gas mask inserts and visual difficulties when he misplaces his spectacles. He feels he would be a liability in deployed environments if he lost his glasses, so he wants corneal refractive surgery (CRS). Health history includes seborrhea treated with topical corticosteroids. His manifest refraction was $-4.25-0.75 \times 012$ oculus dexter (OD, right eye) and $-3.75-1.00 \times 010$ oculus sinister (OS, left eye). Uncorrected visual acuity (VA) is 20/400 OD and 20/300 OS. Intraocular pressure (IOP) was 16 mmHg OD and 15 mmHg OS. His corneal topography and corneal keratometry were normal.

1. What are the limitations for CRS for military aircrew?

- Up to -1.5 diopters (D) myopia is allowed, but can be waived up to -3.0 D myopia.
- Limited to -8.00 D myopia.
- Limited to -4.00 D myopia.
- There are no limitations now due to more advanced photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK) techniques.

ANSWER/DISCUSSION

1. B. CRS patients cannot have more than -8.00 D myopia, $+3.00$ D hyperopia, or 3.00 D astigmatism. They must have normal corneal topography and corneal keratometry, be 21 yr old with at least 6 mo of retainability, and be 6 mo postpartum and postbreastfeeding. Soft contact lenses may not be worn for 30 d or hard contact lenses for 90 d prior to preop CRS evaluation. Army Regulation 40-501 and the Navy's NAVMED P-117 also specify a sphere of -8.00 to $+8.00$. The Army specifies an astigmatism limit of 3.00 D, but NAVMED has no specification.^{5,11} The Federal Aviation Administration simply specifies vision be corrected to 20/40 or better in each eye separately for a Third Class medical certificate. For First and Second Class medical certificates, pilots must have 20/20 or better for distant vision and 20/40 or better for near vision.⁶ Answer A applies to initial Flying Class (FC) I standards. Vision must be correctable to the Medical Standards Directory standards for the best and worst

eye.* PRK and LASIK are approved CRS procedures. Military members need their commander's permission to proceed and authorization from the aircrew refractive surgery program to qualify for a waiver for flying duties after CRS. Manifest refraction format is sphere \pm cylinder x axis. Negative sphere indicates myopia, corrected with concave (negative) lenses. Cylinder indicates astigmatism, two different focal points in the eye with vertical and horizontal meridians. Cylinder correction is present if image distortion occurs when rotating the lens. The axis value always lies between 1 and 180°. This patient meets the criteria for CRS and he has myopia and astigmatism.

2. Does this patient meet criteria for FC II standards as a flight surgeon?

- Yes, he meets criteria for FC II standards for both pilot and nonpilot classifications.
- No, he does not meet criteria for FC II standards for either pilot or nonpilot classifications.
- Yes, he meets criteria for FC II standards for pilot but not nonpilot levels.
- Yes, he meets FC II standards for nonpilot, but would not qualify for FC II pilot standards.

ANSWER/DISCUSSION

2. D. FC II sphere standards are -4.00 to $+3.50$ for pilots and -5.50 to $+5.50$ for nonpilots. FC II cylinder limits are less than 2.00 for pilots and less than 3.00 for nonpilots.[†] His manifest refraction of -4.25 OS meets FC II nonpilot standards, but not pilot standards. His cylinder values are less than 2.00 and meet both pilot and nonpilot standards.

A week after PRK surgery, uncorrected VA was 20/30 OD and 20/40 OS. Postop medications include a 4-mo corticosteroid ophthalmic

* U.S. Air Force. Section C: eyes and vision USAF medical standards, C2. In: Medical standards directory. 2013:11. [Accessed 15 Dec. 2014]. Available to those with access from [https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20\(MSD\)/MSD%202013-Dec-2.pdf](https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20(MSD)/MSD%202013-Dec-2.pdf).

† U.S. Air Force. Table One: vision & refractive error standards for FC/SOD. In: Medical standards directory. 2013:13. [Accessed 15 Dec. 2014]. Available to those with access from [https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20\(MSD\)/MSD%202013-Dec-2.pdf](https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20(MSD)/MSD%202013-Dec-2.pdf).

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drop taper. VA improved to 20/30 OD and 20/25 OS at 1 mo, but IOPs increased to 19 mmHg OD and 21 mmHg OS. Vision was corrected to 20/20 with a prescription of $-0.75+0.75 \times 004$ OD and Plano $+0.50 \times 010$ OS at 3 mo. IOPs decreased to 16 mmHg OD and 17 mmHg OS at 6 mo postop.

Reading glasses are needed 2 yr post-PRK. Cup-to-disc (CD) ratio was 0.35 OD and 0.4 OS with IOPs of 22 mmHg OD and 24 mmHg OS when adjusted for central corneal thickness. Preglaucoma was diagnosed based on mild optic nerve head asymmetry with mild elevated IOP. IOP responsiveness to topical steroids was also noted. Serial tonometry, to determine diurnal IOP variations, showed IOP ranges of 11–15 mmHg OD and 14–15 mmHg OS. Visual fields (VF) were normal and nonspecific for any glaucomatous etiology.

3. What is the earliest optic nerve change indicating possible glaucoma?

- A. Increase of IOP in both eyes.
- B. Asymmetric increase in IOP.
- C. Generalized enlargement of the optic cup.
- D. Vertical CD ratio less than 0.4.

ANSWER/DISCUSSION

3. C. Early optic nerve changes from glaucoma are generalized enlargement of the optic cup, focal enlargement of the optic cup with localized notching or narrowing of the rim, and retinal nerve fiber layer superficial flame hemorrhages (Drance) on or near the optic disc. One notable sign is asymmetry of cupping between the patient's eyes. Disc asymmetry is unusual in normal individuals, and a CD ratio difference of more than 0.2 between the eyes occurs in less than 1% of normal individuals.¹ The etiology of glaucoma is generally regarded as an abnormality in the trabecular meshwork extracellular matrix and in the trabecular cells in the juxtacanalicular region. Normal vertical CD ratio is 0.1–0.4, but 5% of normal individuals have a CD ratio greater than 0.6.¹

4. All of the following statements about IOP are true except for which of the following?

- A. IOP can vary 2–6 mmHg over a 24-h period.
- B. IOP increases with aerobic exercise, pregnancy, and alcohol.
- C. Higher IOP is associated with greater diurnal fluctuations.
- D. A diurnal fluctuation of more than 10 mmHg is suggestive of glaucoma.

ANSWER/DISCUSSION

4. B. Aerobic exercise, pregnancy, and alcohol/marijuana use decrease IOP. Valsalva, forward bent and supine postures, increased body temperature, hypothyroidism, systemic and topical corticosteroids, and anticholinergics increase IOP.¹

Four years postop, the patient noted blurry vision in his left eye. Optometry noted IOPs of 20 mmHg OD and 18 mmHg OS, CD ratios of 0.43 OD and 0.55 OS, with optic nerve head asymmetry OS > OD. Ophthalmology evaluation noted the manifest refraction OS changed from $-0.50-0.50 \times 015$ a year prior to $-2.25+0.25 \times 080$. He was noted to have thin corneas and normal VF. Borderline glaucoma and

possible early cataracts were discussed, but his VA loss was attributed to presbyopia.

On his next FC II physical, he did not meet FC II VA standards OS. Corrected distance vision was 20/17 OD and 20/40 OS. Corrected near vision was 20/20 OD and 20/30 OS. Optometry noted a cataract OS. His CD ratio was 0.35 OD and 0.45 OS. Ophthalmology noted a 1–2+ nuclear sclerotic cataract OS. Cataract extraction with intraocular lens (IOL) replacement was scheduled.

5. What limitations exist for IOL replacement surgery for patients on flying status?

- A. No limitations concerning cataract surgery or the IOL used for flyers compared to nonflyers.
- B. No limitations concerning cataract surgery, but the IOL cannot have a yellow tint with blue light filtering. Lenses must be acrylic and monofocal and have arm haptics.
- C. The only cataract surgery allowed for flyers is phacoemulsification (PE). The IOL cannot have a blue tint that filters green light.
- D. Cataract surgery techniques with incisions greater than 4 mm for ease of IOL placement show better healing and more stability postoperatively, so the IOL options are not limited.

ANSWER/DISCUSSION

5. B. Patients on flying status cannot have IOLs with yellow tint or blue light filters that could potentially alter hue and color perception and cause aircrew to misinterpret instruments and direction lights outside the cockpit.

The patient underwent PE surgery with IOL replacement with 20/20 vision OD and OS the next day. He was prescribed ophthalmic drops, including a topical corticosteroid taper over a month. Follow-up at 1 wk showed improved vision, but IOP was 36–37 mmHg OS. A beta antagonist ophthalmic drop improved IOP to 13 mmHg OS.

6. What is the usual period for duties not including flying (DNIF) postcataract surgery with IOL placement?

- A. 30 d.
- B. 60 d.
- C. 90 d.
- D. 120 d.

ANSWER/DISCUSSION

6. C. Cataract surgery with IOL placement requires DNIF for 90 d and a waiver to return to flying duties after meeting FC vision standards. The 90 d permits ample time for the IOL to scar in place inside the capsular bag and time for any complications to present. PRK or LASIK requires 30 d DNIF. It is also likely the patient expresses the TIGR gene, responsible for trabecular meshwork swelling when exposed to 3–4 wk of systemic or topical corticosteroids. Topical beta antagonists decrease aqueous fluid production to decrease IOP.²

7. With this patient's advanced age, what type of age-related cataract can be found?

- A. Nuclear cataract.
- B. Cortical cataract.

- C. Posterior subcapsular cataract.
- D. All of the above are possible.

ANSWER/DISCUSSION

7. D. Cataracts are a common cause of visual impairment in the aging lens. New cortical fiber layers form, compressing the lens nucleus (nuclear sclerosis). Lens protein changes scatter light rays, decrease lens transparency, and change the refractive index of the lens. Nuclear cataracts are caused by excessive sclerosis that causes slowly progressing, usually bilateral central opacity, causing greater impairment of distance vision more than near vision. Lenticular myopia occurs early from hardening and thickening of the lens, which cause a short-lived second sight phenomenon as the lens progressively yellows, causing poor hue discrimination, especially in the blue spectrum. Cortical cataracts develop from changes in the ionic composition of the lens, resulting in hydration of the cortex fibers and cortical opacification. These are usually bilateral but can be asymmetric. A common symptom is glare from intense light sources. As this cataract matures, the entire cortex becomes white and opaque. Posterior subcapsular cataracts are often seen in patients younger than those with nuclear or cortical types. These are located in the posterior cortical layer and are usually axial. These can be associated with corticosteroids, trauma, radiation, and genetics. Patients complain of glare and poor bright light vision due to the axially located cataract that obscures the pupillary aperture with the miosis that occurs in these bright light conditions. Near VA is worse than distant VA.²

8. Which medication or history is not associated with an increased risk of cataract formation?

- A. Topical corticosteroid.
- B. Proton pump inhibitors.
- C. Statin.
- D. Infrequent use of sunglasses at home and during desert deployments.

ANSWER/DISCUSSION

8. B. Long-term use of systemic or topical corticosteroids may cause posterior subcapsular cataracts. In one study, half of the patients using topical corticosteroids for 10.4 mo after keratoplasty developed cataracts. Statins, especially simvastatin with erythromycin, can cause a two- to threefold increased risk of cataract formation. The lens is especially susceptible to ultraviolet (UV) B (290–320 nm) exposure, increasing risk of cortical and posterior subcapsular cataracts. UV absorbing sunglasses can block 80% of UV. Proton pump inhibitors do not increase risk of cataract formation.²

9. What is the association between cataracts and glaucoma?

- A. They are coincidental as both are age-related pathologies.
- B. Lens-induced glaucoma (phacolytic glaucoma) is a complication of mature cataracts and is permanent if not surgically corrected prior to its development.

- C. IOP elevation is common after cataract surgery, is generally mild and self-limiting, and responds to temporary medical treatment.
- D. Long-term use of miotics for the treatment of glaucoma has a concomitant benefit of decreasing the rate of cataract formation.

ANSWER/DISCUSSION

9. C. Cataracts and glaucoma are age-related medical conditions. It is almost inevitable that a glaucoma patient will eventually need cataract surgery independent of the glaucoma. PE surgery may cause problems with long-term IOP control in certain patients. Eyes with higher IOPs prior to PE may exhibit worsened IOP control.⁸ Phacolytic glaucoma, a complication of mature cataracts, occurs when denatured lens proteins are ingested by macrophages and clog the trabecular meshwork, causing acute pain, redness, and increased IOP. Treatment involves reducing IOP and inflammation. Surgery is curative. After cataract surgery, IOP can be increased from inflammation or retained viscoelastics, but responds well to a short course of topical beta-blockers. After 5 yr of miotics for glaucoma, 20–60% of patients can develop cataracts.²

AEROMEDICAL DISPOSITION

CRS is a significant military investment and is usually successful, but not risk free. CRS is disqualifying for all flying classes, so waiver approval is required before return to flying. Topical steroids modulate healing and reduce infection, corneal haze, and scarring risks, with minimal risk of elevated IOP and cataracts. For trained aircrew, steroids restrict world-wide qualification and deployment. The aeromedical summary must show all vision standards are met, no post-operative complications exist, and two refractions 2 wk apart differ by no more than 0.5 D. The patient may need corrective lenses. UV lenses may be needed to reduce phototoxic damage and prevent corneal haze. LASIK surgical flap complications include a thin, incomplete, buttonhole, or free flap. Flap striae can develop that require surgical correction. Corneal flap displacement in high G_z forces is believed to be low risk, but has not been formally studied. Infectious keratitis during the immediate postoperative period can threaten vision. Flap complications must be evaluated in person at the Aeromedical Consultation Service even if treated and deemed healed by the treating ophthalmologist.⁷

Cataracts, one of the most common causes of treatable blindness, are disqualifying for flying duties. Decreased visual acuity, contrast sensitivity, or glare associated with cataracts affect mission effectiveness and flight safety. U.S. Air Force aircrew may require corrective surgery earlier than civilian counterparts to meet military vision standards.³ PE surgery is best performed on early-stage cataracts due to capsular fibrosis, adhesions, calcification, and weakness of the zonules of advanced cataracts and higher capsule-related complications.⁴ IOL dislocation with extreme G forces has not been observed in the Air Force or in animal studies up to +12 G_z . An August 2000 case report presented a T-6A Texan pilot who ejected. His IOL was unaffected by ejection seat-induced G force.¹⁰ Aircrew-approved IOLs are specified in the Air Force Waiver Guide. IOLs must be monofocal, not refractive

or accommodative multifocal. Cataracts in FC I/IA are not waiverable, but are potentially waiverable for FC II and FC III.³

Enlarged optic nerve cupping and ocular hypertension (OHT) may indicate early glaucoma. Elevated IOP can affect night vision secondary to halos and flare around lights, decreased contrast sensitivity, changes in color vision, loss of central or peripheral visual fields, and loss of VA, all of which can affect performance, mission effectiveness, and safety. OHT is defined as IOPs between 22–29 mmHg in two or more applanation tonometry measurements or 4 mmHg or more difference between the eyes.³ OHT is disqualifying for FC I/IA, FC II/IIU, FC III, and air traffic controller/ground-based controller. It is not waiverable for FC I/IA, initial FC II/IIU, and initial FC III. Trained aircrew must show acceptable VA, stabilized IOP, and no evidence of optic nerve damage. Glaucoma is waiverable for FC II and FC III if controlled on aeromedically approved IOP lowering agents such as beta-blockers (timolol), prostaglandin analogues (latanoprost), or laser treatment modalities such as selective laser trabeculoplasty. There should be a full binocular VF, no aeromedically significant central VF defects, and no visual or systemic medication side effects. Lantano-prost has fewer cardiovascular side effects compared to timolol, so it is preferred for high-performance aviators.⁹

The patient was evaluated by local base Optometry and the Ophthalmology Branch of the Aeromedical Consultation Service for waiver for IOL placement. Waiver was approved and he was returned to flying status.

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³ U.S. Air Force. Section C: eyes and vision USAF medical standards, C8: ocular hypertension (preglaucoma). In: Medical standards directory. 2013:11. [Accessed 15 Dec. 2014]. Available to those with access from [https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20\(MSD\)/MSD%202013-Dec-2.pdf](https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20(MSD)/MSD%202013-Dec-2.pdf).

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You're the flight surgeon for an F-16 squadron deployed to the Middle East. Your squadron was just tasked with sending a number of personnel forward to a malaria-endemic region. Their projected length of stay is 4 wk. Your pilots are visibly excited when you tell them that they will have to take medication to prevent malaria.

1. Which of the following antimalarials is not approved for U.S. Air Force pilots?

- A. Atovaquone-proguanil.
- B. Mefloquine.

Deputy Director, Residency in Aerospace Medicine Program, for their professional review of this article. The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government.

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- C. Doxycycline.
- D. Chloroquine phosphate.
- E. Primaquine phosphate.

ANSWER/DISCUSSION

1. **B.** In accordance with the Official Air Force Aerospace Medicine Approved Medications list, atovaquone-proguanil (Malarone), chloroquine phosphate (Aralen), doxycycline (Vibramycin), and primaquine

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