

## You're the Flight Surgeon

This article was prepared by Elizabeth Anderson-Doze, M.D., M.P.H.

You're the flight surgeon at an overseas base. A 45-yr-old male aviator, a visiting U.S. Air Force (USAF) flight surgeon on an extended temporary duty assignment at your base, presents for a routine periodic health assessment. He denies any specific complaints and has a benign past medical history with the exception of spectacle lens correction for myopia and an appendectomy as a teenager, as well as a permanent waiver for excessive refractive error. He also takes no routine medications. Family history is significant for hypertension in both parents and an older sibling, glaucoma in his father, and age-appropriate cataracts in both parents. He has been a flight surgeon for 12 yr and has had no physical training profiles or any issues on previous health assessments. He does mention, however, that he usually has to be referred to optometry because of changes in his spectacle prescription from year to year. He also expresses an interest in undergoing the screening process for eligibility for possible refractive surgery. He is not now, nor has he ever been, in the soft contact lens program, as he has never been able to find a toric contact lens that provided adequate vision correction. On evaluation his blood pressure is 130/78 with a heart rate of 86. The rest of his physical exam is remarkable for distant uncorrected visual acuities of 20/400 OD (right eye) and OS (left eye), with near uncorrected visual acuities of 20/30 OD and 20/40 OS. Best corrected acuities are 20/25 OD, 20/20 OS at distance, and 20/20 OD and OS at near through a bifocal add. Intraocular pressures are 19 OD and 18 OS, and he is able to demonstrate stereopsis down to 25 arcseconds or line D on the Armed Forces Vision Test, meeting USAF aircrew standards.

### 1. What is your initial assessment?

- A. Myopia and astigmatism.
- B. Hyperopia.
- C. Anisometropia
- D. Age-related presbyopia.
- E. A and D.

### ANSWER/DISCUSSION

**1. E.** Myopia or "near-sightedness" is a condition caused when the anatomic shape of the eyeball, anteriorly to posteriorly, is too long, causing the focal point of an image to fall in front of, or short of, the retina. This results in a blurred image when viewing distant objects. This diagnosis is confirmed based on relatively normal uncorrected near visual acuity with significantly reduced distant visual acuity. Astigmatism is a

refractive error typically associated with asphericity of the cornea, resulting in multiple points of focus and can be inferred in this patient because of his need for toric lenses.

Presbyopia is observed nearly universally in patients over the age of 45. With advancing age the lens in the eye hardens and is more resistant to attempts of the ciliary muscles to change its shape during accommodation, to shift the focus viewing of objects from far to near objects.<sup>4</sup> The fact that a bifocal is required to achieve optimal near vision confirms this diagnosis.

Anisometropia refers to the difference in refractive error between the two eyes and, if left uncorrected, results in the inability of the two eyes to focus together on the same object to produce binocular vision. This diagnosis can be excluded in this patient since the distant and near uncorrected acuities are nearly identical and he has no difficulty passing the exam for stereopsis. This suggests normal binocular vision function. Similarly the diagnosis of hyperopia, or far-sightedness, would not be appropriate as this is associated with poorer uncorrected acuities at near versus distance. Hyperopia is essentially the opposite of myopia, as the focal point falls behind the retina in a hyperopic eye.<sup>3</sup> This patient has a documented history of myopia and astigmatism that has progressed each year, but now he can no longer be corrected to 20/20.

### 2. What should be the next step in his workup?

- A. Refer to optometry.
- B. Refer to ophthalmology.
- C. Refer to Aeromedical Consultation Service (ACS).
- D. No further workup needed; he is 20/20 in at least one eye, which is satisfactory enough for a nonpilot Flying Class (FC) II exam.

### ANSWER/DISCUSSION

**2. A.** Refer to optometry. He does not correct to 20/20 in both eyes in the Flight Medicine clinic. He therefore does not meet requirements for an FC II exam. Per USAF medical standards, all FC II aviators must be correctable to 20/20.<sup>\*</sup> Optometric evaluation, including refraction to best corrected vision, would be the most appropriate action.

<sup>\*</sup> U.S. Air Force. Section C: eyes and vision USAF medical standards. In: Medical standards directory; 2013:7. [Accessed 15 Oct. 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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Referral to ophthalmology or the ACS would only be appropriate after optometric examination. Furthermore, most USAF bases do not have an ophthalmology clinic.

The patient is seen by optometry and the findings are shown below:

OD:  $-6.50 +2.75 \times 130$ ; Add +1.50; VA Dist 20/25; VA Near 20/20-4

OS:  $-6.00 +1.75 \times 010$ ; Add +1.50; VA Dist 20/20; VA Near 20/20

**3. At this point he is still not able to be corrected to 20/20 OD, so which of the following should be done?**

- A. Refer to ophthalmology.
- B. Perform a dilated funduscopic exam.
- C. Perform corneal topography (CT).
- D. Perform a slit lamp examination.
- E. Perform retinoscopy.
- F. B, C, D, and E.

**ANSWER/DISCUSSION**

**3. F.** Patients with progressive myopia and astigmatism who are not correctable to 20/20 should be further evaluated for potential corneal pathologies such as keratoconus or topographic pattern suggestive of keratoconus (TPSK). Slit lamp examination and retinoscopy may further confirm such a diagnosis, but the gold standard is CT.<sup>3</sup> A dilated funduscopic exam should also be performed to assess for peripheral retinal pathology, which is more prevalent in eyes with myopia greater than  $-5.50$  D.

Topography shows inferior steepening of the cornea OD > OS with an inferior to superior (I-S) difference of 3.12 D OD and 1.14 D OS and central powers of 48.8 D OD and 46.7 D OS. Slit lamp examination by the optometrist is negative for a Fleischer ring, Vogt's striae, or Munson's sign. There is, however, unequivocal scissoring on retinoscopy OD. Dilated retinal exam is unremarkable.<sup>5</sup>

**4. At this point your diagnosis is:**

- A. Pathological myopic astigmatism.
- B. Keratoconus.
- C. TPSK.
- D. Glaucoma.

**ANSWER/DISCUSSION**

**4. B.** Keratoconus, or a variant of it known as pellucid marginal degeneration, is an eye disorder involving protrusion and thinning of the cornea over time, leading to irregular astigmatism and poor visual acuity. Often these patients are diagnosed as teenagers or young adults because of the need for frequent spectacle prescription changes and increasing astigmatism.<sup>7</sup> TPSK is a term unique to the ACS and coined by them, referring to corneas with suspect topographies but without the diagnosis of keratoconus. Early changes associated with keratoconus are best identified using CT. In some cases the progression is naturally halted, a condition referred to as forme fruste keratoconus. Most clinicians do not make the diagnosis unless confirmed by clinical evaluation. In this case, scissoring on retinoscopy is the confirmatory finding.

In their landmark 1989 study, Rabinowitz and McDonnell described three characteristics found on CT of keratoconic eyes distinguishing them from normals.<sup>5</sup> These were steeper central corneal power, a

marked difference in the dioptric power between the two eyes of the same patient, and increased steepness of the inferior aspects of the cornea relative to the superior aspect, referred to as the I-S difference. Rabinowitz reported that normal eyes should have an I-S of no more than 1.26 D, central power of less than 46.55 D, and no more than 0.92 D difference between the eyes.<sup>5</sup> In the patient discussed, the right eye exceeded the limit for I-S and central power and the difference between the eyes was 2.1 D.

This patient was referred to the ACS and underwent repeat CT as well as additional corneal imaging, including Pentacam and OrbScan to confirm the diagnosis. Baseline visual function consisting of contrast sensitivity and high and low contrast acuity was also performed and will be used to monitor the stability of the condition over time. The remaining portions of the exam, including intraocular pressures, automated visual field testing, and funduscopic exam, were all within normal limits. Bifocal spectacles were dispensed (with the refraction shown below) as well as toric soft contact lenses with reading glasses for near work.

OD:  $-6.00 +2.50 \times 125$ ; Add +1.50; VA Dist 20/25; VA Near 20/17

OS:  $-6.25 -2.00 \times 005$ ; Add +1.50; VA Dist 20/20; VA Near 20/15

The ACS recommended that this flyer be recommended for an FC II waiver from his major command with reevaluation required by them in 2 yr. The major command granted a 2-yr waiver 3 wk after this recommendation and the patient was returned to flying status.

In the USAF Waiver Guide, aeromedical concerns for flyers with keratoconus include the risk of sudden incapacitation secondary to breaks in Descemet's membrane and endothelium with resulting corneal edema and blurred vision. This condition, termed corneal hydrops, occurs in 2–3% of these patients. The result is a sudden clouding of vision. Other more common features of keratoconus are reduced quality of vision and subjective awareness of glare and halos at night with streaking of lights. Some keratoconics require use of rigid contact lenses or toric hybrid lenses (rigid lenses embedded in a soft lens) in addition to use of spectacles to correct visual defects. They are required to carry backup spectacles with them during flying operations at all times.<sup>3</sup>

Keratoconus and its closely related variant pellucid marginal degeneration are disqualifying for all flying classes in the USAF. It is not waivable for FC I/IA or initial FC II/III. A waiver is possible for pilots already trained if aeromedical standards for visual acuity and stereopsis can be met. In pilots with more advanced keratoconus an FC IIC waiver restricting them to multicrew aircraft may be given. If an aircrew member requires specialty contact lenses such as rigid, gas-permeable, or hybrid (a combination of rigid/soft lenses), they must be provided by the ACS, and reevaluations must be performed every 1 to 3 yr by the ACS for continuation of waiver status.<sup>3</sup>

U.S. Army Regulation 40-501 states that keratoconus and any form of irregular astigmatism are disqualifying for admission into the Army. For trained soldiers a waiver may be requested, and waivers may be granted on a case-by-case basis depending on the needs of the Army.<sup>1</sup> In the U.S. Navy Aeromedical Reference and Waiver Guide, keratoconus is disqualifying among initial flying applicants. In trained pilots a waiver "may" be considered in those who are correctable to 20/20 with spectacles or contacts.<sup>6</sup> The Federal Aviation Administration does not

require Special Issuance as long as the pilot candidate/pilot is correctable to the minimum required visual acuities.<sup>2</sup>

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This article was prepared by Tory W. Woodard, M.D., M.P.H.

You're the flight surgeon at a busy fighter training base and have been called to respond to an in-flight physiological emergency. Your patient is a 28-yr-old student pilot who has just landed from a training flight. He had been flying solo in the aircraft and performing basic fighter maneuver "dog-fighting" engagements with his instructor pilot. He reports that he had some significant "light-loss" on one of his air-to-air engagements. As per emergency procedures, he selected 100% oxygen on his regulator, declared an emergency, and immediately returned to base. He denies complete vision loss or gravity-induced loss of consciousness during the event. He currently feels fine and denies any symptoms such as lightheadedness, dizziness, fatigue, headaches, or breathing difficulties. He denies any problems with the cabin pressurization system or life support equipment (mask, helmet, and G-suit). His vital signs and pulse oximetry are normal when checked in the ambulance.

### 1. What's the next step?

- A. No further work-up is required as he is asymptomatic and vital signs are normal.
- B. Further evaluation in the clinic, including detailed history and physical exam.
- C. Evaluation of pilot's life support equipment to check for malfunctions.
- D. Laboratory evaluation to include complete blood count and metabolic panel.
- E. B, C, and D above.

## ANSWER/DISCUSSION

**1. E.** After a suspected physiological incident, it is appropriate to bring the aviator back to the clinic and perform a thorough, but

focused, history and physical exam. This would include a 72-h history evaluating sleep, crew-rest hours, hydration, nutrition, and any current interpersonal or family stressors. The physical exam should include a full set of vital signs with focus on the cardiovascular, pulmonary, and ear, nose, and throat systems. Additional organ systems may receive a targeted exam based on any significant symptoms or findings elicited from the history.

Laboratory evaluation is indicated and should be routinely used after in-flight physiological events to assess the aviator's current metabolic state and evaluate for occult disease. Suggested initial laboratory evaluation for a physiological event includes a complete blood count (CBC), basic metabolic panel (Chem-7, etc.), and a urinalysis. The urinalysis may be helpful in evaluating the hydration status of the aviator and should also be used to screen for elevated glucose levels. Because the physiological event could result in a future safety investigation, getting additional labs as part of this initial screen should be considered. These tests could include a blood alcohol level and urine drug screen.<sup>5</sup> Other additional laboratory testing may be performed as indicated, such as when evaluating specific symptoms or following a patient's previously known medical condition. For example, a thyroid-stimulating hormone test would be indicated in a patient with a known thyroid disorder.

The patient in this case was brought to the clinic and evaluated. His vital signs, including pulse oximetry, were normal. His 72-h history was unremarkable and there were no indications of abnormal sleep or nutrition habits. The patient did report a 1- to 2-mo history of vague midabdominal pain, though. This pain was described as burning, intermittent, and not associated with food intake. He denied any prior history of gastrointestinal problems or prior abdominal surgery.

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