Non-Arteritic Anterior Ischemic Optic Neuropathy in Pilots

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BACKGROUND: Non-arteritic anterior ischemic optic neuropathy (NAION) is a common cause of optic neuropathy with the exact pathophysiology unknown. Risk factors include advanced age, small optic nerve head, hypertension, diabetes mellitus, and sleep apnea.[6] High altitude is considered another risk factor, although only few cases have been reported. No cases of NAION have been reported to occur during flight.

CASE REPORT: A 41-yr-old male pilot presented with vision change while performing high G-force maneuvers in an A10 fighter jet. He developed a paracentral visual field defect superiorly in the left eye. Contrasted MRI was within normal limits. The left optic nerve showed blurred margins while the right was sharp, but cupless. The left eye had similar episodes 16 mo before and 8 mo after, but not during flight.

DISCUSSION: Our case may be the first reported NAION during flight in an airplane pilot. Our patient was an active U.S. Air Force pilot whose second episode of NAION occurred while performing maneuvers in a fighter jet. The patient is younger than expected for NAION and he did not have any of the commonly associated risk factors. His nonflight episodes suggest he was predisposed to NAION. G-force maneuvers, which restrict blood flow and force blood to the extremities away from the optic nerve head, were the precipitant of his second NAION. With a single case, whether high G maneuvers in general are a risk factor for NAION is unknown.

KEYWORDS: NAION, optic neuropathy, high altitude, vision loss, G force.

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Nonarteritic anterior ischemic optic neuropathy (NAION) is the most common acute optic neuropathy in patients older than 50 yr of age.[8] Patients classically present with acute, painless vision loss in one eye upon awakening. Affected patients may have a decrease in visual acuity, color vision, depth perception, or any type of visual field loss.[14] The pathophysiology behind NAION is not well understood, but ischemia plays a key role. It is differentiated from arteritic anterior ischemic optic neuropathy, which is caused by inflammation of medium to larger arteries. NAION is not an inflammatory disorder and is much more common than its arteritic counterpart.[2] Known risk factors include small optic nerve head, hypertension, diabetes mellitus, and sleep apnea.[8] Although an increased risk of ischemic retinopathy associated with exposure to high altitude has been described,[3,10] few cases of NAION associated with high altitude are reported in the literature. No cases of NAION have been reported to occur during flight in airplane pilots. Pilots are subject to frequent episodes of hypoxia as the cabin pressure decreases with increased altitude, which is mitigated with the proper use of safety equipment and supplemental oxygen. High gravitational force (G-force) maneuvers may lead to additional optic nerve ischemia. NAION is of particular importance to pilots due to its rapid onset and possibly severe effect on visual parameters. There are currently no known treatments with proven efficacy in NAION. In addition, the risk of recurrence in the same or fellow eye is significant when considering future flight safety. Here we report a case of a fighter pilot who developed NAION in-flight.

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CASE REPORT

A 41-yr-old male pilot with a past medical history of only seasonal allergies presented with inferior visual field blurring in the left eye noted upon awakening. Uncorrected vision was 20/20 in each eye with a trace afferent pupillary defect (APD) in the left eye. The right optic nerve was cupless and the left optic nerve had a blurred superior margin. Humphrey visual field was normal in the right eye and showed inferonasal changes in the left eye. He experienced gray out of his vision for 3 s 16 mo later, while performing high G-force maneuvers in an A10 fighter jet. He immediately performed an anti-G straining maneuver. His vision recovered except for a paracentral visual field area superiorly in the left eye, described as looking through a fogged lens. The patient was referred to us for further neuro-ophthalmic evaluation by the U.S. Air Force. Visual acuity remained at 20/20 in both eyes with a relative APD in the left eye. Humphrey visual field was again normal in the right eye, but showed a new superior paracentral defect in addition to the prior inferonasal defects in the left eye. Contrasted MRI showed no compressive optic nerve lesions or optic nerve enhancement. The patient noted a new inferior visual field blurring in the right eye 8 mo later. Vision remained 20/20 in both eyes with blurring of the superior optic nerve margin in the right eye and pallor of the left optic nerve. Humphrey visual field showed inferonasal defects in the right eye and was unchanged in the left eye. Blood testing for vasculitic and hypercoagulable causes was negative. At this time the patient was working as a commercial airline pilot, but was not flying.

DISCUSSION

Most cases of NAION do not have a definitive known cause. Associations between the presence of a small crowded optic disc and systemic comorbidities are usually implicated. The optic nerve configuration is generally gleaned from the fellow eye as acute nerve edema and subsequent pallor make detection of the optic nerve and cup size difficult in the affected eye. Presumed vascular insufficiency causes ischemia to the retrolaminar optic nerve head. Small, crowded optic nerves are thought to be at higher risk from ischemia, with development of edema related to anatomical mechanical obstruction of axoplasmic flow, creating a compartment syndrome.[6] About 97% of patients with NAION are found to have an optic disc diameter less than 1.2 mm with a cup to disc ratio of less than 0.2.[4,5] Common risk factors are conditions that decrease blood flow to the optic nerve head, including hypertension, diabetes mellitus, nocturnal hypotension, optic disc drusen, and certain medications.[8,9] Antihypertensive medications are implicated in the worsening of physiological nocturnal hypotension when taken before bedtime. Sildenafil, a phosphodiesterase type 5 inhibitor causing vascular smooth muscle relaxation and vasodilation, may reduce blood flow to the optic nerve head through systemic hypotension.

Ischemia to the optic nerve head can also originate from decreased oxygenation. Obstructive sleep apnea has been associated with NAION. High altitude has also been implicated as a cause of hypoxia leading to NAION, but has not been well studied, with few reports available. De Bats et al. described a case of bilateral NAION in a hiker at high altitude, although the case was complicated by underlying hypertension and hyperlipidemia.[8] Another report presented a 12-yr-old male who awoke with vision loss in the left eye from NAION while on a hiking trip at high altitude. The patient additionally had experienced episodes of emesis and fever prior to the loss of vision and had optic disc drusen.[9] Optic disc drusen and a possible dehydrated state likely contributed to the NAION, with high altitude possibly playing an additive effect. Bandyopadhyay et al. described a case of NAION in a 33-yr-old man with no systemic risk factors or optic nerve anomalies after 3 mo at high altitude.[3] Nonetheless, review of the literature does not reveal any reported cases of NAION occurring during flight.

Our case may be the first to document NAION occurring during flight in an airplane pilot. NAION during flight is a rare, yet important issue in aerospace medicine given the sudden loss of vision, visual field, stereopsis, and/or color vision that can compromise a flight mission in addition to the pilot's own safety.[12] Over the months following an NAION event, about one-third of patients will show improvement, one-third will stabilize, and one-third may worsen somewhat followed by stabilization. Even in mild or improved cases, the risk of future NAION in the fellow eye or recurrence in the same eye is of particular concern for U.S. Air Force pilots. Of patients with unilateral NAION, 15–21% go on to develop contralateral NAION and less than 10% may have recurrence in the ipsilateral eye.[11,14] Pilots are frequently exposed to environments of hypoxia at high altitude. Without safety precautions, pilots could experience symptoms such as lightheadedness, dizziness, reduced vision, and euphoria.[1] Air Force pilots are required to use supplemental oxygen when reaching an altitude of 10,000 ft (3048 m) to combat these effects, while civilian pilots in unpressurized cabins must use supplemental oxygen above 12,500 ft (3810 m).[1] Air Force pilots are theoretically at increased risk of NAION with continued exposure to high gravitational forces and unpressurized cabins. U.S. Air Force protocol recommends restricting pilots who experience an episode of NAION to flying nonhigh performance, multipiloted aircraft and maintaining cabin altitudes of less than 8000–10,000 ft (2438.4–3048 m). In addition, pilots are sent to an ophthalmologist, who must evaluate for systemic issues that can predispose to NAION. If needed, the patient is sent to Internal Medicine for further work-up and management. Pilots requesting a waiver to return to flight duty would need to be evaluated by the Aeromedical Consultation Service, but may not be able to return to their previous flying duties even if vision returns to normal due to concern of repeat NAION. The U.S. Air Force lists optic neuropathies as disqualifying for Flying Class I, IA, II, III, and RPA pilot duties. Aside from I/IA, the other flying classes do have potential for waiver.[12]

Treatment for NAION is unfortunately limited and controversial. Aside from control of underlying systemic issues to

prevent new episodes, some patients receive systemic corticosteroids in an attempt to treat the acute event. Whether corticosteroids help is controversial. Clinicians must weigh the risks and benefits of this treatment given the side effect profile of corticosteroid administration, especially if there is underlying hypertension or diabetes mellitus.[7] Surgical decompression of the optic canal was attempted in the past to help relieve ischemia, but has been found to be an ineffective treatment.[13] Aspirin can be given to patients without contraindications as it is commonly given to patients with other systemic manifestations of ischemia, although the benefit in NAION treatment or prevention is still unknown. Further research continues in efforts to treat this often debilitating optic neuropathy.

Our patient was an active U.S. Air Force pilot whose first and third NAION episodes occurred on the ground, and his second episode occurred while performing maneuvers in a fighter jet. The patient's age is on the younger range of the demographics of NAION and he did not have any of the commonly associated systemic risk factors. However, his NAION episodes prior to and after the NAION that occurred during fighter jet maneuvering suggest he was predisposed to NAION. G-force maneuvers, which restrict blood flow and force blood to the extremities away from the optic nerve head, were the precipitant of his second NAION. Given this is a single case, whether high G maneuvers in general are a risk factor for NAION is unknown.

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