Transient Unilateral Facial Nerve Baroparesis with Vertigo on Ascent in the F-16CM

Matthew S. Wimmer; Talib Y. Ali

BACKGROUND: Presented is a rare case of transient unilateral facial nerve paralysis occurring in a pilot while on initial ascent in an F-16CM. This pathology is sporadically observed in the diving community, but rarely described in military or civil aviation. This case was particularly unusual in its promptness of onset, rapid recovery, and its association with vertigo.

CASE REPORT: This case report describes a previously healthy 26-yr-old F-16 pilot who experienced ear block and subsequent unilateral facial paralysis while on initial ascent. This was relieved quickly after clearing the affected ear without any neurological sequelae. A second episode was associated with vertigo in addition to the ear block and facial symptoms. Both episodes were separated by 3 d.

DISCUSSION: Barotrauma to the facial nerve via an uncovered or "dehiscent" facial nerve canal was suggested by the clinical course, computed tomography, and confirmed by expert consultation. Making the diagnosis in an aviator, especially the military aviator, is important for safety of flight, to avoid unwarranted diagnostics, and to minimize operational impact. A mechanism for the aviator's associated vertigo is suggested.

KEYWORDS: barotrauma, facial nerve palsy, eustachian tube dysfunction, dehiscent facial nerve canal, aerospace medicine, pathophysiology, neuropraxis, alternobaric, aviation.

Wimmer MS, Ali TY. *Transient unilateral facial nerve baroparesis with vertigo on ascent in the F-16CM.* Aerosp Med Hum Perform. 2016; 87(2):141–143.

Barotrauma-induced facial nerve palsy is a rare complication observed in the diving community and is even more uncommon in the aviation environment. This phenomenon is thought to be related to multiple intersecting mechanisms, including Eustachian tube dysfunction and individual variations in anatomy, i.e., a "dehiscent" facial nerve canal.[11] Studies of the temporal bone have shown that this unique anatomy (either congenital absence of the bony sheath surrounding the horizontal portion of the facial nerve or an intermittent physiological hiatus) is thought to be a normal variant in 10 to 57% of individuals.[5,7,12] This anatomy exposes the facial nerve to the local environment within the middle ear. As the exposed facial nerve tracks through the middle ear it may become vulnerable to dramatic changes in pressure, as seen in the F-16. Facial baroparesis, the condition in which there is a temporary loss of motor function, can manifest as a feeling of perioral "heaviness," overt facial nerve paralysis, ear pain, changes in hearing acuity, or even spatial disorientation.[1,3,9] In the literature, this is thought to be due to vascular compromise of the facial nerve's capillary blood supply secondary to excess pressure on the nerve.[4] The duration of symptoms can vary, but most reported cases resolve within minutes of pressure equalization of the middle ear.[2] Despite repeat exposure to similar flight conditions and for largely unknown reasons facial nerve baroparesis may occur only once or twice throughout a busy career in aviation.[5] Described in this case study is an F-16 pilot with right-sided facial nerve palsy when exposed to atmospheric pressure changes during initial ascent on two separate flights.

CASE REPORT

A previously healthy 26-yr-old female F-16 pilot and qualified flight lead with over 350 h in high performance jet aircraft reported to the aerospace medicine clinic after completion of a flight. She reported that after takeoff and through the initial

From the U.S. Air Force, 35th AMDS, Misawa AB, Japan.

This manuscript was received for review in August 2015. It was accepted for publication in October 2015.

Address correspondence to Matthew S. Wimmer, D.O., 52nd AMDS, PSC 9, Box 4146, APO AE 09123; matthew.wimmer.2@ua.af.mil

DOI: 10.3357/AMHP.4449.2016

ascent she experienced progressive right ear pain and pressure. Then, between 14,000 and 19,000 ft (4267 and 5791 m) ASL she began to experience right perioral "heaviness" and difficulty closing the right eye. At approximately 19,000 ft (5791 m) ASL she began to level off and noted that it was especially difficult to equalize the pressure in the right ear. No hearing loss was appreciated at the time. The pilot reached her cruising altitude of 20,000 ft (6096 m) ASL and attempted to clear the right ear, eventually clearing it with simple jaw movement and neck extension. Her symptoms completely resolved over the course of 30 s. The pilot did not declare an in-flight emergency and the pilot had an uneventful remainder of the sortie. The rate of climb was not reported as excessive (it was not a combat or unrestricted climb). The aircraft cabin pressurization system in the F-16 was operating within its normal operating parameters during the entire flight. The on-board oxygen generating system (OBOGS) and all other environmental control components were functioning properly during all flight checks and the aviator was compliant with her oxygen mask worn throughout the flight (approximately 21% oxygen). The pilot regularly uses a custom-molded communications earpiece system whose gas expansion vent was found to be patent before and after the flight. She denied any recent upper respiratory symptoms prior to flight and had no past medical history (no previous instrumentation or surgery, seasonal allergy, recent upper respiratory infections) that would predispose her to Eustachian tube dysfunction and subsequent barotrauma. The pilot denied any difficulty clearing her ears in the past, specifically, during her altitude chamber training up to 25,000 ft (7620 m). She denied the use of any prescription or over-the-counter medications, supplements, or herbal products. Upon further questioning the flyer indicated that a similar episode had occurred 3 d prior. This was associated with a fleeting bout of nondisabling spatial disorientation in addition to the ear fullness and facial symptoms. This was described as a tumbling sensation that lasted for less than a second. The vertiginous symptoms occurred just prior to clearing the ear. No notifications were made to the flight surgeon at the time.

The physical exam was unremarkable with the exception of trace erythema circumferentially from the four to seven o'clock positions around the right tympanic membrane. The middle ear structures were otherwise noted intact and without a fluid layer. Upon instruction the pilot was able to perform the Valsalva maneuver with only mild discomfort. A complete neurological exam noted no focal abnormalities. A tympanogram was noted to be normal bilaterally. Noncontrast head computed tomography with coronal temporal bone reformats showed no evidence of intracranial or temporal pathology. However, the temporal bone imaging did show a right facial nerve traversing within the cavity of the middle ear without any apparent bony sheath surrounding the nerve (**Fig. 1**, white arrow).

Pure tone audiography showed normal symmetric thresholds between 500 and 6000 Hz in both ears. Laboratory tests were not indicated at the time and there was no general systemic cause identified. Otolaryngology was consulted and confirmed the suspected diagnosis of facial nerve barotrauma secondary to temporary Eustachian tube dysfunction. The specialist hypothesized that this aviator likely had a dehiscent facial nerve canal predisposing her to this event, but indicated that recurrence of the facial symptoms would be rare in most cases. No further work-up was recommended and the pilot was returned to flight status approximately 1 wk after the inflammation around the tympanic membrane had resolved. The aviator was cautioned about flying in the future with any upper respiratory symptoms, including any difficulty performing the Valsalva maneuver. No further episodes have occurred since these two events and at the time of this manuscript's submission the aviator had successfully logged over 700 h of flight time in high performance jet aircraft (approximately 500 total hours in the F-16).

Fig. 1. Temporal bone protocol computed tomography (coronal sectioning); the horizontal segment of the facial nerve (arrow) is seen coursing through the middle ear cavity. There is no bony sheath surrounding this portion of the facial nerve, which exposes the nerve to the local environment within the middle ear.

DISCUSSION

Otitic barotrauma associated with facial nerve baroparesis is a relatively rare complication of Eustachian tube dysfunction and is infrequently described in the aviation medical literature. In the F-16 the cabin pressure approximates the ambient pressure until 8000 ft (2438 m) ASL, after which the cabin pressurizes according to a 4.5 PSI pressure differential schedule. If the flight

referenced above started at sea level, at just 8000 ft (2438 m) there is a potential pressure differential within the middle ear of approximately 266 cm of H_2O (or 26.1 Kilo-Pascals).[10] This pressure differential, if unvented, would easily surpass the average capillary blood pressure in the vasculature supplying the facial nerve.[10] Under typical flight conditions the middle ear pressure would equalize as gas is forced through the Eustachian tube. Any interruption in this process could result in higher middle ear pressures and could traumatize vulnerable structures within the middle ear. In this case an exposed or "dehiscent" facial nerve contributed to the symptoms experienced by the aviator. The pathophysiology of facial nerve baroparesis is not completely understood, but the disorder has been associated with a combination of factors including: Eustachian tube dysfunction, anatomical variants of normal (facial nerve canal "dehiscence"), varying Eustachian tube length/tortuosity, upper respiratory infections, mucosal edema, and inadequate pressure equalization of the middle ear compartment.[4,8,9] Another theory reported in the literature states that even with a nondehiscent facial nerve canal excess pressure may be transmitted across the fenestra of the chorda tympani.[6] Both proposed mechanisms might explain why this condition presents transiently and subsequently resolves rapidly. However, in this case, the imaging shows an exposed facial nerve and as such we believe the former explanation was most plausible. Because most affected aviators experience this only once or twice during their career, it is suspected that these predisposing factors are an incomplete list of potential causes.[5,10] It is also speculated that multiple factors would have to overlap at any point in time to produce the effects described in this case.[10] When symptoms do occur they tend to be transient and often resolve upon clearing of the middle ear.[2] Because the condition is generally described as transient in nature and because so many individuals are thought to have the prerequisite anatomy we would hypothesize that this is an under-reported event. Where symptoms do not resolve spontaneously, the neuropraxia is thought to be related to a more prolonged ischemic insult.[8] In these cases, persistent neuropraxia is believed to be observed when the pressure inside the middle ear exceeds the hydrostatic pressure within the microvasculature of the facial nerve's blood supply for an extended period of time.[4] Fortunately for our aviator no permanent deficit was observed.

Of particular interest in this case was its association with vertigo. This happened during the first flight 3 d preceding the initial presentation to our clinic. From the aviator's account it was described as a tumbling sensation and lasted for less than a second. It occurred just prior to successful clearing of the ear, and can be explained by several possible etiologies. First, in an effort to clear the blocked ear the flyer could have oriented the head into several different positions, which could have caused multiple conflicting inputs to the vestibular system, producing a Coriolis illusion.[3] A second plausible etiology might occur when the middle ears experience unequal venting bilaterally. This leads to an excessive pressure difference between ears, producing contradictory positional cues from the vestibular apparatus. This phenomenon is theorized to cause increased labyrinthine excitation resulting in irritative nystagmus and vertigo.[7,9] The later effect has been labeled alternobaric vertigo and can be disabling in flight if prolonged.[3]

With the relatively rapid resolution of our aviator's symptoms, expert consultation, and the imaging results noting a dehiscent facial nerve, we felt comfortable returning the flyer to flight duties after the right tympanic membrane had returned to normal. The medical literature supports this approach as most aviators will only experience this type of event once despite a lengthy career in aviation.[5,10] Decompression illness was thought to be exceptionally unlikely in the absence of other associated symptoms and with normal cockpit pressurization. In this case, we postulated that an occult viral respiratory infection or environmental trigger could have predisposed the aviator to these events. This was in addition to the imaging that suggested a dehiscent facial nerve canal was present. No further studies were recommended by the otolaryngologist who also confirmed our diagnosis. The hazards of flying if unable to Valsalva or with any upper respiratory symptoms were re-emphasized to the aviator prior to return to flight duties. The pilot was also encouraged to always have oxymetolazone nasal spray available for occult ear block in flight and was released with strict return precautions.

In conclusion, facial nerve baroparesis can present in several different ways, many of which can be quite disconcerting to the evaluating physician and aircrew member. However, transient facial nerve baroparesis related to isolated Eustachian tube dysfunction is largely recognized as a benign process. As such, making the diagnosis in an aviator, especially the military aviator, is important for safety of flight, to avoid unnecessary diagnostics, and to minimize operational impact.

REFERENCES

1. Ah-See K, Shakeel M, Maini S, Hussain S. Facial Paralysis during air travel: case series and literature review. J Laryngol Otol. 2012; 126(10):1063–1065.
2. Ardehali M, Yazdani N, Heidarali M. Transient Facial Nerve Baroparesis: Case Report. Pak J Biol Sci. 2009; 12(5):476–479.
3. Davis J, Johnson R, Stepanek J, Fogarty J, editors. Fundamentals of aerospace medicine, 4th rev. ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2008:387.
4. Eidsvik S, Molvaer O. Facial baroparesis: a report of five cases. Undersea Biomed Res. 1985; 12(4):459–463.
5. Grossman A, Ulanovski D, Barenboim E, Azaria B, Goldstein L. Facial Nerve Palsy Aboard Commercial Aircraft. Aviat Space Environ Med. 2004; 75(12):1075–1076.
6. Hyams A, Toynton S, Jaramillo M, Stone L, Bryson P. Facial baroparesis secondary to middle-ear over-pressure: a rare complication of scuba diving. J Laryngol Otol. 2004; 118(9):721–723.
7. Ingelstedt S, Ivarsson A, Tjernstrom O. Vertigo due to relative overpressure in the middle ear. Acta Otolaryngol. 1974; 78(1):1–14.
8. Kamide D, Matsunobu T, Shiotani A. Facial Baroparesis Caused by Scuba Diving. Case Rep Otolaryngol. 2012; 2012:329536 epub.
9. Kumar A. Alternobaric Vertigo: A case report. Ind J Aerospace Med. 2001; 43(1):64–67.
10. Motamed M, Pau H, Daudia A, Narula A. Recurrent facial nerve palsy on flying. J Laryngol Otol. 2000; 114(9):704–705.
11. Whelan TR. Facial nerve palsy associated with underwater barotrauma. Postgrad Med J. 1990; 66(776):465–466.
12. Yetiser S. The Dehiscent Facial Nerve Canal. Int J Otolaryngol. 2012; 2012:679708 epub.