Transient Facial Nerve Palsy in Aviation

Sune Land Bloch; Jonas Hertz; Mads Klokker

INTRODUCTION: Facial nerve palsy has been observed sporadically by aviation medicine doctors in recent years. We present two case reports of patients with the rare condition of facial nerve palsy occurring during aviation, along with a review of the literature, an overview of the phenomenon and the described symptoms of the cases. PubMed® including Medline® was searched using the terms nerve palsy and aviation with no restriction. In addition, two new cases of recurrent nerve palsy are described.

CASE REPORTS: We describe two case reports: A 20-yr-old woman reported recurrent transient left-sided facial nerve palsy with increased duration and intensity on four subsequent flights, and a 35-yr-old woman who reported a left-sided transient facial nerve palsy 20 min after ascent.

DISCUSSION: Included in the systematic review were 17 studies. Only case report studies were found. Including the two cases of facial nerve palsy described in this article, the reviewed studies represent 23 cases of peer-reviewed facial baro-palsy in aviation (ages 10 to 62 yr old). Having baro-palsy symptoms during flight is a rare condition, and the mechanism is not well understood. Some typical characteristics and possible mechanisms are discussed. PE tube insertion of the tympanic membrane has been found to be an effective treatment; however, further studies are needed.

KEYWORDS: alternobaric facial paresis, facial baroparesis, ischemic neuropraxia, facial nerve canal dehiscence, Eustachian tube dysfunction.

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Facial nerve palsy during aviation is considered a rare condition. The most widely accepted hypothesis for this condition is ischemic neuropraxia due to excessive middle ear pressure during ascent, transmitted through a facial nerve canal dehiscence of the second part of the facial canal.[2] The increased gas pressure is expected to be followed by a decrease in temporary blood flow in the vase nervorum of the facial nerve.

The first two cases of transient facial nerve palsy in aviation were published in 1967.[5] Since then, 21 cases have been published, and, with the addition of our 2 case studies, the total number of published cases is 23.

In order to characterize the general observations of this rare condition, the main findings of previously published cases were summarized in **Table I**. In most cases, the facial nerve palsy develops gradually during the latter part of the ascent. The paresis is always unilateral, and a numbness or a tingling sensation on the tongue is normally mentioned by the patients. This is probably due to the innervation of the chorda tympani. In addition, early associated symptoms (or "warning symptoms") such as fullness, otalgia, tinnitus, headache, facial pain, and dysarthria may be present.[21] The severity of the facial nerve palsy is typically mild, with symptoms such as a slight facial weakness or the feeling of numbness. In some cases, the symptoms are more severe, including drooling or the inability to close the eye on the affected side of the face. Facial nerve palsy is always transient and may resolve within minutes or last until descent of the flight. However, recurrent and progressive affection of the facial nerve palsy appears to be a common observation during subsequent flights. In all cases where a pressure equalization (PE) tube was inserted into the tympanic membrane prior to aviation, the patients remained symptom-free.[2]

In general, the patients appear to be otherwise heathy individuals, and complaints such as otalgia or the inability to

From the Department of Otorhinolaryngology Head & Neck Surgery and Audiology, Rigshospitalet, University Hospital of Copenhagen, Copenhagen, Denmark.

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Address correspondence to: Jonas Hertz, M.D., Department of Otorhinolaryngology Head & Neck Surgery and Audiology, Rigshospitalet, University Hospital of Copenhagen, Blegdamsvej 9, DK-2200, Copenhagen, Denmark; hertz.jonas@gmail.com.

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Table I. Published Cases of Facial Nerve Palsy in Aviation.

REFERENCE	YEAR	AGE	SEX	SIDE	NO.	ONSET	RESOLVE	DURATION	ASSOCIATED SYMPTOMS	TREATMENT
Bennett et al.[5]	1967	30	M	R	3	After ascent	Descent		None	Nasal spray?
		40	M	L/R	2					
Silverstein[22]	1986	?	F	L	5	After ascent	Descent	?	None	Tube insertion
Motamed et al.[18]	2000	38	M	?	6	Ascent	After ascent	20–30 min	Fullness	Tube insertion*
Berghaus[6]	2001	20	F	L	1	Ascent	During ascent	15 min	None	
Grossman et al.[13]	2004	24	F	R	1	Ascent	Soon after ascent	5 min	Fullness	
Rutten et al.[21]	2010	56	M	R	>4	Ascent	Descent	?	Otalgia, Fullness	
Krywko et al.[16]	2012	55	M	L	1	Ascent	Descent	45 min	Dysarthria, headache	Toynbee, nasal spray*
Ah-See et al.[1]	2012	23	F	L	2	Ascent	Soon after onset	?	Facial pain, tinnitus	
		62	M	L	2	?	?	120 min	Fullness, Pain, tinnitus	Tube insertion*
		27	M	R	3	?	?	45 min	Fullness, earache	Tube insertion*
Wimmer et al.[25]	2016		M	?	2	Ascent	Ascent	Min?	Vertigo in one case	
Vivekananda et al.[23]	2017	51	M	R	2	Ascent	Ascent	15 min	Tingling on face and tongue	
White et al.[24]	2018		M	R	1	Ascent	Cruising	45 min	Ear pressure	
Cheng et al.[9]	2019	37	F	L	>4	Descent	Between flights	5–30 min	Fullness, otalgia	Eustachian tube dilation*
Hom et al.[14]	2019	10	F	L	1	Cruising	Cruising	40 min	Otalgia, fullness	
Mikus et al.[17]	2020	49	F	R	1	?	Descent	30 min	Vertigo	
Our cases	2020	20	F	L	4	After ascent	Soon after ascent	5–25 min	None (headache)	Tube insertion*
		35	F	L	1	After ascent	Soon after ascent	10 min	None	
Alwan et al.[2]	2021	43	M	R	3	After ascent	Soon after ascent	10 min	None	Tube insertion
Caffrey et al.[8]	2020	57	M	R	>9	After ascent and descent	After Nasal decongestant spray	?	Otalgia, numbness	Nasal spray, tube insertion
Cumming et al.[10]	2019	47	M	L	6	After ascent	Descent	Min?	fullness	Nasal spray
	2019	58	M	L	1	During	Descent	Min?	Tinnitus	Nasal spray

*No complaints of facial nerve palsy on subsequent flights.

perform the Valsalva maneuver are not a constant finding. Moreover, oto-neurological examination, naso-endoscopy, and MRC or CT scanning of the temporal bone in order to detect a facial nerve canal dehiscence are, in most cases, normal. Therefore, this topic deserves repeated attention in order to better understand the underlying mechanism of facial nerve palsy in aviation, as well as in diving.

METHODS

On March 21, 2022, PubMed® (including Medline®) was searched using the terms "nerve palsy" and "aviation". No restrictions on age or any other specifics were set. Surprisingly few hits were found. In addition to these findings, two new cases of apparent aviation-induced facial nerve palsy from our clinic are described herein.

RESULTS

The PubMed® search revealed 18 relevant studies on facial nerve palsy during flight, with 23 cases all together. All the publications were case studies.

In the Aviation Medical Section of our department, we received two cases of apparent aviation facial nerve palsy.

Case 1

A 20-yr-old woman reported recurrent transient left-sided facial nerve palsy with increased duration and intensity on four subsequent flights. The onset of the palsy was recognized approximately 20 min after each ascent. On the first flight, the left corner of the mouth was hanging and the patient had an abnormal sensation on the left side of the face and tongue. The symptoms resolved after 5 min. On the subsequent two flights the patient had similar symptoms, with the addition of drooling and a swelling around the left eye region. The symptoms resolved after 25 min. On the fourth flight the patient recalled having a transient left-sided facial nerve palsy and headache for 2 wk. The following neurological examination was normal, including audiometry, tympanometry, and a magnetic resonance (MR) scan of the brain. However, naso-endoscopy revealed extensive nasal polyposis, and the patient had a medical history of chronic rhinosinusitis, which involved pain in the frontal sinuses when diving during her career as a professional swimmer. A computerized tomography (CT) scan confirmed nasal polyposis (**Fig. 1**), and a Computer Assisted Sinus Surgery (CAS) was performed. The patient could not recall any complaints of ear pain, dizziness, fullness, hearing loss, tinnitus, or failure to perform the Valsalva maneuver during the flights and was otherwise healthy, with no prior history of middle ear disease or Eustachian tube dysfunction. The follow-up oto-neurological examinations and naso-endoscopy were normal; an additional CT scan of the temporal bone showed no signs of facial nerve canal dehiscence. After presenting to our medical facility, a pressure equalizer (PE) tube was inserted into the tympanic membrane prior to aviation. After two subsequent flights, the patient had no complaints of facial nerve palsy.

Case 2

A 35-yr-old woman reported a left-sided transient facial nerve palsy 20 min after ascent. The patient was unable to close the left eye and the left corner of the mouth was hanging. The symptoms resolved after 10 min. There were no complaints of ear pain, dizziness, fullness, hearing loss, tinnitus, or failure to perform the Valsalva maneuver. After descent, the patient was immediately evaluated for a suspected transient cerebral ischemia (TCI), including testing of blood gasses, CT angio, ultrasonography of the neck vessels, and x-ray of thorax. All findings were normal. As a child, the patient had a medical history of acute otitis media but was otherwise healthy and ran several marathons every year. The oto-neurological examinations and naso-endoscopy were normal. The patient has not been flying since the incident.

DISCUSSION

When an aircraft ascends, the cabin pressure decreases and the gas in the middle ear expands correspondingly according to

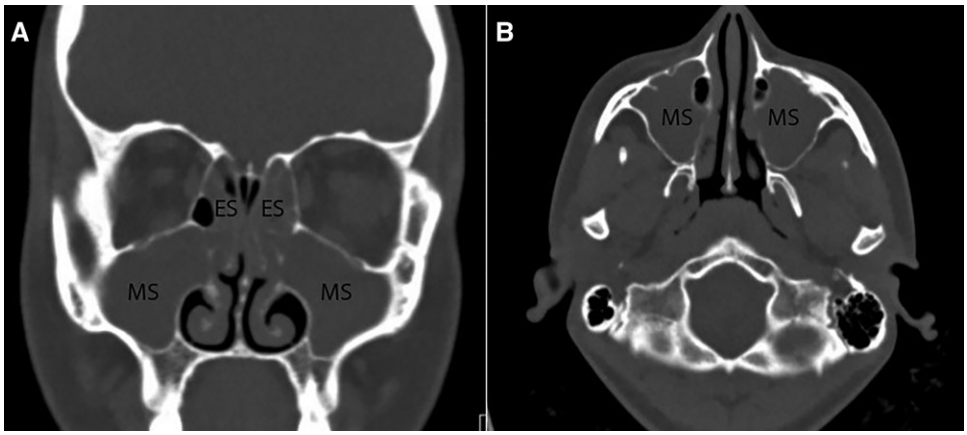

Fig. 1. A 20-yr-old professional swimmer reported recurrent transient and increasing left-sided facial nerve palsy during flight. CT revealed chronic rhinosinusitis of the maxillary sinus (MS) and ethmoidal sinus (ES) on the A) axial and B) coronal planes.

Boyle's Law. In most aircraft, the cabin is pressurized to three-quarters of the pressure at sea level, corresponding to an altitude of 6000–8000 ft (1829–2438 m). A pronounced pressure decrease can cause free nitrogen molecule bubbles to form, leading to embolism (also known as decompression sickness) which, in seldom cases, can give rise to monosymptomatic facial nerve palsy.

Under normal conditions, the pressure difference between the middle ear and the cabin is gradually equalized with every 400 ft (122 m) of increasing altitude. This occurs by gas escaping through the Eustachian tube via either passive or active venting—which can be achieved by swallowing (Toynbee's Maneuver), yawning, or force—during the Valsalva maneuver. Impaired ability to equalize the pressure is directly related to Eustachian tube dysfunction, which may be due to anatomical variations such as: rare congenital malformations involving the palate; a middle ear disease such as otitis media with effusion (more common); cholesteatoma obstructing the inner orificium of the Eustachian tube; or any other condition that may narrow the lumen of the Eustachian tube or impair the mucociliar clearance due to edema or increased viscosity of mucus, typically resulting from an upper respiratory tract infection.

In the presence of Eustachian tube dysfunction at takeoff, the theoretical maximum pressure difference between the gas of the middle ear and the cabin is 261 mbar, which exceeds the capillary blood pressure.[5] It has, therefore, been suggested that the increased gas pressure in the middle ear may impede the blood flow into the vase nervorum of the facial nerve (ischemic neuropraxia) when the dehiscence area of the osseous facial canal is present. This theory has been supported by the fact that baroparesis disappears on descent, assuming that the relative overpressure of the middle ear becomes normalized. It is also backed by the observations of divers, in whom baroparesis of the facial nerve disappears following equalization of the middle ear by yawning or swallowing.[4,11,12] The theory is further supported by animal experiments with cats, where reversible neuropraxia on unexposed parts of the facial canal were induced by pressure in the range of 200 to 267 mbars.[20] Another study demonstrated that an elevation of middle ear pressure reduced the blood flow to the middle ear in guinea pigs. However, the reduction of blood supply to the facial nerve was not reduced significantly.[19] It has also been suggested that facial nerve palsy in aviation may be the result of elevated middle ear pressure transmitted through the fenestra of the chorda tympani to the facial nerve.[25] In the case report described by Wimmer and Ali, unilateral facial nerve paralysis was seen in a military jet fighter pilot.[25] Finding this diagnosis in an aviator, especially a military aviator, has important implications for flight safety, for avoiding unwarranted diagnostics, and for minimizing operational impact.

Based on autopsies, the incidence of facial nerve canal dehiscence is 50%, although the average dimensions of the dehiscence were measured to be less than 1 mm.[3] Studies using high resolution computer tomograms detected a facial nerve canal dehiscence in 30%, despite the well-known limitations due to high false negative and positive rates.[7] Overall, a dehiscent facial canal must therefore be considered a relatively normal condition.

However, facial nerve palsy in aviation is rare—despite it being well-known that many passengers have difficulty equalizing their middle ear pressure and may complain of otalgia. Moreover, neither the failure to perform the Valsalva maneuver nor the presence of otalgia are constant observations in the small population of published cases of facial nerve palsy during aviation (Table I).

Ischemic lesions are presumed to play a role in the pathology of Bell's palsy.[15] Oxygen saturation decreases significantly during air travel in normal individuals. S_pO_2 has been demonstrated to be 92% at a cruising altitude of 7129 ft (2173 m) compared to 98% at ground level. The onset of mild hypoxia after ascent may theoretically play an additional role in the threshold of facial nerve palsy in some individuals, most likely in combination with either anatomical preconditions regarding the function of the Eustachian tube, or anatomical variations of the facial canal. The buffer capacity of the mastoid may also play a role.

In conclusion, baro-palsy conditions during flight are rare, and the mechanism is still not well described or understood. However, PE tube insertion into the eardrum seems to prevent recurrent baro-induced facial nerve palsy. Further studies are needed.

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Authors and Affiliations: Sune Land Block, M.D., Ph.D., Jonas Hertz, M.D., and Mads Klokker, M.D., Assoc. Prof.; Department of Otorhinolaryngology Head & Neck Surgery and Audiology, Rigshospitalet, University Hospital of Copenhagen, Copenhagen, Denmark.

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