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The impact of barometric pressure changes on oral health in light aircraft pilots: - literature review

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Abstract

Introduction:

Flights in light aircraft without pressurized cabins expose the human body to rapid changes in atmospheric pressure, which may negatively affect dental health. Due to its structure and gas content, the oral cavity is particularly susceptible to hypobaric conditions occurring at high altitudes.

Materials and Methods:

This study is based on a review of the literature available in the PubMed, Google Scholar, Medline, and ClinicalTrials.gov databases. Scientific publications from 1996 to 2024 concerning barodontalgia and dental materials subjected to pressure changes were included.

Results:

Barodontalgia may pose a significant risk to pilots and passengers of small aircraft. Changes in atmospheric pressure can lead to tooth, sinus, ear, and facial pain, as well as micro-damage to fillings and prosthetic restorations. Additionally, the presence of undetected inflammatory foci increases the risk of pain symptoms.

Conclusions:
Flights in non-pressurized cabin conditions can adversely affect the oral cavity and surrounding structures. Regular dental check-ups are recommended for individuals exposed to barodontalgia, as well as avoiding flights shortly after dental treatment and using durable materials resistant to pressure changes.

Keywords: barodontalgia, barotrauma, dental pain, barosinusitis, baroparesis

1. Introduction

Recreational and civil aviation are rapidly expanding, with a growing number of individuals obtaining pilot licenses or utilizing services provided by so-called general aviation, which includes light and ultralight aircraft. Small aircraft that lack pressurized cabins typically operate at altitudes between 1,000 and 5,000 meters, where the absence of pressure stabilization exposes the human body to barometric fluctuations [1]. The oral cavity, which contains air, fluids, and tissues with varying sensitivity to compression, is particularly vulnerable to such conditions. During flight in a non-pressurized aircraft, atmospheric pressure decreases with altitude, resulting in hypoxia (hypobaria) and a significant reduction in air humidity [2,3]. These environmental factors may negatively impact the oral mucosa, dental health, periodontal tissues, and paranasal sinuses, promoting the development of inflammation, mucosal dryness, and hypersensitivity [4]. Although mid-altitude flights without pressure control pose a unique physiological challenge, their effects on the stomatognathic system are often overlooked [5].

2. Materials and Methods

To conduct a comprehensive review of the impact of light aircraft flights on the oral cavity, articles from the PubMed, Scopus, Google Scholar, Medline, and ClinicalTrials.gov databases were analyzed. The following keywords were used in the search: barodontalgia, barosinusitis, barotrauma, facial baroparesis, ear barotrauma, and the effect of pressure changes on dental materials. Studies published between 1996 and 2024 were included. Additionally, reference lists of selected articles were reviewed to identify other relevant sources.

3. Results

3.1 Barodontalgia and Dental Barotrauma – Characteristics and Occurrence

Barodontalgia, formerly known as "aviator's toothache," refers to dental pain caused by changes in ambient pressure. It most commonly affects divers (9.8%) and aviators (5.8%), with higher incidence rates reported among civilians compared to military personnel. Cases of barodontalgia have been documented at altitudes as low as 610–1524 meters. While relatively rare, the condition can be severe enough to suddenly incapacitate flight crew members, posing a potential threat to flight safety [6,7,8]. Dental barotrauma includes all mechanical dental damage associated with atmospheric pressure changes, such as tooth fractures or compromised restorations. It most frequently occurs in teeth with leaky fillings or secondary caries. Pressure fluctuations can also reduce the retention of fillings and orthodontic appliances [6,8,9]. Barodontalgia specifically refers to pain in the oral cavity triggered by atmospheric pressure changes. It may be direct—of dental origin (e.g., pulpitis, caries, incomplete root canal treatment, periapical infections)—or indirect, linked to non-dental conditions like barosinusitis or middle ear problems [1,4]. Symptoms usually manifest as acute, sharp pain during ascent or descent. Pain intensity often correlates with the duration of pressure exposure [2,4]. The pain typically subsides upon return to baseline altitude but can persist for up to three days post-flight if it originates from periapical areas [10]. Indirect pain accounts for approximately 20% of cases. Pain of dental origin most frequently arises from recent dental treatments (up to 30% of cases), deep caries, leaky restorations (4–50%), and pulpitis (7–22%) [7]. The pain is most commonly located in the upper dental arch (up to 56% of cases), particularly in the first molars—both upper and lower—each accounting for about 30% of cases [11]. An interesting finding is that barodontalgia appears more frequently in pressurized aircraft (7.3%) compared to non-pressurized ones (3.2%), likely due to the fact that cabin pressure in pressurized aircraft is still lower than sea-level atmospheric pressure [6].

3.2 The Impact of Pressure Changes on Fillings and Prosthetic Restorations

Sudden volume changes in gases trapped in cavities or microgaps beneath restorations can cause leakage, particularly affecting composite materials and temporary cements. For crowns and bridges, there is a risk of micromovement and mechanical damage, potentially compromising their stability and clinical longevity [10]. Studies have shown that atmospheric pressure changes ranging from 0 to 5 atmospheres significantly weaken adhesive bonds, encouraging the formation of microcracks and voids. Particularly adverse effects are observed under low-pressure conditions equivalent to altitudes around 10,000 meters. In such conditions, marginal adaptation deteriorates, as demonstrated in a comparative study between traditional composites (65 ± 9.18%) and bulk-fill materials (98 ± 2.69%) [12]. These findings indicate that traditional composites offer greater durability. Another factor that may contribute to barodontalgia is the use of excessively thick calcium hydroxide liners, which gradually resorb and create voids under the filling. These microspaces can lead to pain during pressure changes [3]. In a study by Lyons and colleagues, the effects of simulated pressure cycles on the sealing ability of all-ceramic crowns cemented with different types of luting agents—zinc phosphate, glass ionomer, and resin cements—were evaluated. The researchers concluded that resin cements demonstrated the highest resistance to pressure changes, likely due to their elasticity and ability to penetrate dentinal tubules, reducing the risk of microleakage [13].

3.3. Barosinusitis

Understanding the mechanism behind barosinusitis—an inflammation of the paranasal sinuses caused by changes in atmospheric pressure—is largely based on Boyle’s Law. This physical law states that at a constant temperature, the volume of a gas is inversely proportional to its pressure. In practical terms, this means that as external pressure increases, the volume of trapped gas decreases, and vice versa. This principle is especially relevant to air-filled spaces in the human body, such as the paranasal sinuses. The sinuses are air-filled cavities located within the bones of the facial skeleton. They are connected to the nasal cavity via narrow passages called sinus ostia. The external walls of the sinuses are rigid and bony, whereas the inner lining is composed of more flexible mucous membrane. Under normal physiological conditions, changes in atmospheric pressure—such as those occurring during airplane takeoff or landing—trigger a rapid exchange of air between the sinuses and the nasal cavity, thereby equalizing the internal sinus pressure. This process protects anatomical structures and maintains proper mucosal function. Problems arise when the sinus ostia are not functioning properly, due to either anatomical variations or pathological conditions. These can include naturally narrow ostia or temporary blockages from mucosal swelling, inflammation, infection, allergies, or trauma. In such cases, air exchange between the sinuses and nasal cavity becomes restricted or completely obstructed. When ambient pressure changes, the air trapped inside the sinuses cannot adjust in volume, resulting in either a vacuum (negative pressure) or overpressure (positive pressure) within the sinus. This pressure imbalance can stretch or collapse the mucous membrane lining the sinus, leading to mechanical damage such as microtears, congestion, swelling, and even hemorrhage, which in turn triggers an inflammatory cascade [14]. Barotrauma most commonly occurs during rapid descent in flight or diving, when a partial vacuum forms inside the sinus cavity. Aviation and diving studies indicate that decompression-related barosinusitis during descent and increased gravitational force is twice as frequent as sinus barotrauma caused by ascent, compression, or reverse pressure. In most cases, this condition exacerbates pre-existing dental pathologies [7,15]. Individuals with a history of middle ear or sinus barotrauma are more susceptible to recurrent episodes. Common risk factors for barosinusitis include allergic rhinitis, bacterial sinusitis, viral upper respiratory infections, nasal polyps, and idiopathic sinus congestion. There is no proven correlation between sinus barotrauma and a deviated nasal septum, alcohol consumption, or tobacco use. Pain remains the most prevalent symptom, typically affecting the frontal sinuses. Referred tooth pain may occur when the maxillary sinuses are involved [14]. Due to the close anatomical relationship between the maxillary sinuses and the roots of the upper molars, dental infections can easily spread to the sinuses. Odontogenic sinusitis accounts for 5% to as much as 40% of all maxillary sinusitis cases [16]. Barosinusitis presents as sudden, sharp facial or head pain, most often localized in the frontal region, less commonly in the temporal, occipital, or retrobulbar areas. Nosebleeds or serosanguinous nasal discharge may also occur. In some cases, neurological symptoms arise due to irritation of the trigeminal nerve, especially its ophthalmic branch [17]. Diagnosis of odontogenic sinusitis involves a thorough medical history, clinical examination, and imaging studies. Although panoramic and periapical X-rays are routinely used, cone-beam computed tomography (CBCT) offers the highest diagnostic accuracy [18]. Treatment typically begins with pharmacotherapy, including local and systemic glucocorticoids and mucosal decongestants. In resistant or chronic cases, functional endoscopic sinus surgery (FESS) is performed to remove the source of infection and restore proper drainage [19]. Prevention should include early detection and treatment of dental conditions, particularly in the upper molars, as well as avoiding low-retention dental materials that may increase the risk of barometric complications.

3.4. Ear Barotrauma

Ear barotrauma during air travel is an inflammatory injury to the middle ear caused by a pressure differential between the air in the middle ear and the external atmosphere. It usually occurs during descent, and less commonly during ascent. The primary cause is Eustachian tube dysfunction, often due to an upper respiratory tract infection, which impairs the ability to equalize pressure between the middle ear and the environment [20]. The Eustachian tube, connecting the middle ear to the nasopharynx, typically opens during yawning or swallowing, allowing for pressure equalization. However, during rapid increases in external pressure (e.g., during landing), if the tube is blocked—by infection, allergy, or congestion—the pressure in the middle ear remains relatively lower. This causes the eardrum to retract inward. Stretching and deformation of the eardrum result in ear pain (otalgia), a sensation of ear fullness, and hearing loss. In severe cases, the eardrum may rupture, ossicles may be damaged, fluid may accumulate in the middle ear cavity, or a perilymph fistula may form, allowing communication between the middle and inner ear. In small aircraft, if a pilot experiences blocked ears, they may ascend again slightly to allow more time for pressure equalization using auto-pressure techniques such as yawning, swallowing, chewing gum, or performing the Valsalva maneuver (forceful exhalation with nose and mouth closed), and then resume a gradual descent. Ear barotrauma can be prevented with decongestants. Oral pseudoephedrine has been shown to reduce ear pain in adults with recurrent flight-related ear discomfort. However, using nasal spray with oxymetazoline 30 minutes before descent has not shown statistically significant improvement in adults [21].

3.5 Facial Baroparesis

Facial baroparesis is a rare but clinically significant phenomenon involving transient neuropathy of the trigeminal nerve (V5) or facial nerve (V7) caused by sudden changes in atmospheric pressure. It can occur during airplane flights, diving, or exposure to hypobaric environments. The underlying mechanism is a failure of anatomical structures to adapt to rapid pressure changes, most often associated with Eustachian tube dysfunction and individual anatomical predispositions. Trigeminal nerve (V5) neuropathy typically involves two of its branches—the maxillary (V2) and mandibular (V3) nerves. The maxillary nerve runs along the wall of the maxillary sinus, an air-filled cavity connected to the nasal passage. Pressure changes within the sinus, especially during barosinusitis, may compress the nerve and produce neurological symptoms. Similarly, the inferior alveolar nerve, a branch of the mandibular nerve, may be vulnerable to barotrauma within its bony canal in the mandible. The facial nerve (V7), responsible for motor innervation of the facial muscles, runs through the facial nerve canal (Fallopian canal) in the temporal bone, making it particularly susceptible to pressure-related damage. Approximately 20–57% of individuals have dehiscence (a partial opening) of the facial canal's bony wall, leaving the nerve directly exposed to pressure changes from the middle ear. If this is accompanied by Eustachian tube dysfunction, which prevents proper pressure equalization between the middle ear and the external environment, barotrauma may lead to compression of the facial nerve. The clinical presentation of baroparesis depends on which nerve is affected. Facial nerve involvement manifests as unilateral facial muscle weakness, drooping of the mouth corner, and difficulty closing the eyelid, typically without pain or inflammatory symptoms. Trigeminal nerve neuropathy may result in paresthesia, numbness, tingling, or pain in the cheek, lips, jaw, or orbital area, depending on the branch involved. Notably, symptoms have an abrupt onset—usually during ascent or descent in flight—and are transient, resolving within minutes to hours. Though rare, this phenomenon should be considered in the differential diagnosis of sudden facial nerve palsy, especially in patients presenting with symptoms shortly after flying. In typical cases, no pharmacological treatment is necessary—only clinical observation. [21,22]

3.6 The Importance of Preventive Dental Care in Pilots

For pilots, divers, and others routinely exposed to atmospheric pressure changes, regular dental prophylaxis is critically important. These individuals should undergo periodic dental check-ups, including radiographic evaluations and pulp vitality tests. Dentists should be aware of the potential effects of hypobaric and hyperbaric conditions on the oral cavity and apply appropriate diagnostic and therapeutic procedures. Guidelines recommend that personnel exposed to pressure variations, including pilots, have annual dental examinations. It is also advised to avoid flying for at least 24 hours after dental treatment and at least 72 hours following oral surgery—ideally extending to 7 days. In high-risk patients, conservative procedures such as pulp capping or pulpotomy are generally discouraged due to the risk of gas entrapment under changing pressures. In such cases, full endodontic (root canal) treatment is the preferred approach. [25] During dental assessments of aircrew or diving personnel, particular attention should be paid to fractured or leaking fillings, secondary carious lesions, and incomplete root canal treatments. Before placing new restorations, a thorough diagnosis is essential to rule out pulp necrosis, especially in teeth with substantial hard tissue loss. Cold sensitivity tests and periapical radiographs are useful tools for evaluating pulp and periapical tissue status. [6,7,24]

4. Conclusions

Dental barotrauma, or injury induced by atmospheric pressure changes, differs significantly in frequency and nature between light aircraft pilots and those flying commercial or military planes. Among light aircraft pilots—whose planes typically lack pressurized cabins—dental barotrauma is relatively uncommon. This is mainly because these aircraft operate at lower altitudes (usually between 1,000 and 3,000 meters), where pressure changes are more gradual and less extreme. [20,24] Moreover, the absence of cabin pressurization means that cabin pressure aligns with ambient pressure, allowing the body, including the oral cavity, to adapt more naturally to environmental changes. In contrast, commercial and military pilots are at higher risk for dental barotrauma. In commercial aircraft, cabin pressure is artificially maintained at the equivalent of an altitude of about 1,800–2,400 meters, while cruising altitudes can reach 10,000–12,000 meters. [15] This pressure differential can cause rapid and significant changes, particularly during takeoff and landing, posing a risk to structures containing trapped air, such as teeth with faulty fillings or carious lesions. [5,7] Military pilots, although also exposed to extreme altitudes and pressure shifts, typically undergo more rigorous dental and medical screening, enabling early detection of potential barodontal sources. [1] As a result, the actual incidence of barotrauma in this group is relatively well controlled despite their greater exposure. [3] Dental barotrauma in light aircraft pilots is therefore less common and usually milder. [2] However, the risk increases in the presence of predisposing factors such as deep caries, leaking restorations, pulp necrosis, or recent dental procedures. [7,8] Even minor pressure variations may trigger pain or discomfort under such conditions. Among commercial pilots, barodontalgia symptoms are more frequently reported, including tooth pain, filling dislodgement, and in-flight tooth fractures. [5,8] Military pilots also experience dental barotrauma, but stricter dental fitness standards and regular examinations help reduce the frequency of such incidents. [3]

Disclosure

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