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Review Article

Challenges in dentistry at high altitude

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ABSTRACT

Elevated levels of oxidative stresses at higher altitudes can result in numerous adverse health-related events that have been observed most commonly in individuals who are routine flyers, airline crew members and pilots. Pathophysiological processes occurring at high altitudes also can lead to serious effects on oral health. Since much is yet to be known about this subject, this aspect is often neglected. Aviation dentistry as a whole comprises the evaluation, principles of prevention, treatment of diseases, disorders or conditions related to the oral cavity and adjoining areas or adjacent and associated structures and the impact they cause on people who travel or on aircrew members. It also deals with certain flight restrictions that maybe needed. Dental professionals should be aware of the various oral hazards and ways to prevent or treat them. The present review focuses on the various aspects of aviation dentistry and the different ways by which a dentist can contribute in the prevention of oral diseases at higher altitudes.

1. Introduction

Aviation dentistry focuses particularly on the prevention of illnesses linked to changes in atmospheric pressure at high altitudes and addresses the oral and dental health condition of aircrew members and frequent flyers.[1] Despite the low atmospheric pressure outside, air-cycle machines and outflow valves keep the pressure within the aircraft high while in the air. A decrease in either air pressure or density could jeopardize dental treatment, which is a crucial component of overall health.[2]

1.1. Barodontalgia

In an otherwise unaffected tooth, barodontalgia (previously known as aerodontalgia) refers to dental pain that is triggered by a shift in barometric pressure. It can be severe enough to impair judgment, incapacitate, and force an early end to flights and altitude-chamber simulations.[3] It occurs due to inability of the closed chamber to adjust to the internal pressure due to trapped gases. Pain typically has a sharp or squeezing quality.[4] When pain is felt during ascend, it is caused by vital pulp tissue, and when felt while descend, it is caused by pulp necrosis or facial barotrauma. Periapical disease is associated with pain that is experienced during both ascent and descent.[1]

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Strohaver provided an explanation for the pathophysiology of barodontalgia in 1972. He advocated for the distinction between direct and indirect forms. In the case of direct barodontalgia, the affected tooth is directly impacted by reduced air pressure, whereas in the case of indirect barodontalgia, pain is caused by stimulation of the superior alveolar nerves during maxillary barosinusitis. In the direct type, pain is mild to severe, localized during takeoff, and the patient is able to recognize the affected teeth. In the indirect form, posterior teeth are involved, and the pain is dull, poorly defined, and starts upon landing.[5]

Boyle Mariotte's law, which states that the volume of a gas is inversely proportional to the pressure applied to it at constant temperature, can be used to explain barodontalgia, which can occur at high or low ambient pressures. A pathophysiological cause for tooth pain during flight has been postulated, based on this physical law. Dental pain is caused by a sensitive, unpleasant stimulation that is induced during ascent or descent by the dilatation or contraction of gas trapped in the pulp or tissues around the teeth.[6]

Barodontalgia has been linked to majority of common oral pathologies, including dental caries, poor dental restorations, pulpitis, pulp necrosis, apical periodontitis (jawbone cysts and granulomas), periodontal pockets, impacted teeth, and mucus retention cysts. Parafunctional habits (bruxism), low temperature, decreased oxygen content, and dryness are few of the contributing elements.[7] However, pulpitis is thought to be the primary factor causing barodontalgia. There have been a number of theories put up to explain the mechanism underlying pulpitis with barodontalgia:

1. Direct ischaemia brought on by the inflammatory process itself.[8]
2. Indirect ischaemia caused by an increase in intra-pulpal pressure resulting from vasodilation and fluid diffusion into the tissue.[9]
3. The outcome of intra-pulpal gas expansion. Acids, bases, and enzymes in the inflamed tissue produce gas as a byproduct.[10]
4. Gas leakage through the vessels because of decreased gas solubility.[11]

A generally accepted classification of barodontalgia was developed by Ferjentsik and Aker[12] has been summarized in Table 1. The classification system has 4 classes is based mainly on the underlying causes and clinical symptoms along with the recommended line of treatment in each class.

2. Head and Face Barotrauma

A disease known as barotrauma, which affects tissues, is brought on by a difference in pressure between a gas space inside the body and fluid around it.[3] Flying, scuba diving, or receiving hyperbaric oxygen therapy ca

n all result in barotrauma.[13] As a result, in this instance, flying at great altitudes lowers air pressure. It includes ailments like oral barotrauma, external otitic barotrauma, barosinusitis, barotrauma-related migraines, and barodontalgia.[3] Barotrauma, a term used to describe the acute inflammation of the sinus and middle ear cavities, is caused by pressure-volume fluctuations linked to changing atmospheric pressure.[14] Trigeminal nerve branches can get compressed, which can cause subsequent pain and numbness.[3]

2.1. Odontocrexis

Barometric tooth explosion is another name for this condition. When exposed to a high altitude environment, preexisting leaky restorations or recurrent carious lesions underlying restorations might induce tooth explosion. Accidental gas expansion that was trapped beneath the restorations was considered a common source of harm.[15]

2.2. Dental considerations

In keeping with the adage "Prevention is better than cure," particular attention must be given to dental problem prevention and oral health maintenance. Military and airline employees are more likely to be lured by high-energy snacks and sugary drinks due to the nature of their jobs, which often involves missed meals and time zone shifts.[16] Additionally, their daily oral self-care tasks may be neglected due to the erratic nature of their shifts and time zone changes. It is the duty of dentists to inform their patients about the value of eating a balanced diet and to encourage them to practice strict oral hygiene.

2.3. Restorative dentistry

In-flight dental restorative fracture has been linked to three high-altitude flight environmental factors:

1. Lower barometric pressure: When barometric pressure changes, an air void inserted in a dental restoration explodes.[17]
2. Higher percentage of oxygen: Oxidation during pure oxygen breathing may result in electrochemical corrosion of the dental amalgam restoration.[18]
3. Low temperature: Intense cold of the high-altitude environment and cold oxygen inhaled may cause the amalgam material to thermally contract differently from hard tooth tissue by up to 2.5 times.[17]

Due to unintended gaps between the tooth and restoration walls, Calder & Ramsey compared the decompression strength of composite resin and amalgam restorations and found that amalgam restorations had a higher prevalence of dental fractures than composite resin restorations did. The authors also discovered that amalgam restorations

Table 1:

Class	Chief Complaint	Clinical Findings	Diagnosis	Treatment
Class I	Sharp momentary pain during ascent decompression), being asymptomatic on descent (compression) and afterwards.	Caries or restoration with inadequate base. Tooth is vital. Radiograph shows no periapical pathosis.	Acute Pulpitis	Zinc oxide - Eugenol temporary dressing followed by permanent restoration after two weeks. Endodontics if symptoms of irreversible pulpitis.
Class II	Dull throbbing pain during ascent (decompression), being asymptomatic on descent (compression) and afterwards.	Deep caries or restoration. Tooth is vital/non vital. Radiograph shows no periapical pathosis	Chronic Pulpitis	Root canal therapy or Extraction if non-restorable.
Class III	Dull throbbing pain during descent (compression); being asymptomatic on ascent (decompression) and afterwards.	Caries or restoration. Tooth is non-vital. Radiograph shows periapical pathosis	Necrotic Pulp	Root canal therapy or Extraction of unrestorable tooth.
Class IV	Severe persistent pain after ascent (decompression) or descent (compression)	Caries or restoration. Tooth is non-vital. Radiograph shows definite periapical pathosis	Periapical Abscess or Cyst	Root canal therapy and/or surgery or Extraction of unrestorable tooth.

with unfavorable gaps and differential thermal shrinkage in low-temperature, high-altitude environments can cause excruciating pain brought on by variations in barometric pressure.[19] In order to avoid pain and tooth fractures occurring due to changes in barometric pressure, composite resins are therefore preferred for dental restorations in aircrew members.

Mesio-occluso-distal restorations were found to be a significant risk factor for tooth fractures in a study conducted on fracture patterns of posterior teeth. Mandibular first molars were found to be at risk in this investigation, and cuspal coverage restorations may be viewed as a justified preventive measure.[20]

Although there is evidence to support the indirect pulp capping technique for treating deep carious lesions in the general population[21] (in which leathery/softened and wet pulpal dentine is not removed but sealed), it is not advised for aircrews who are regularly exposed to barometric pressure changes. The treating dentist must carefully inspect the cavity floor and rule out penetration to the pulp chamber once the carious tissue has been removed. Before the cavity is reconstructed, a protective cavity liner (such as glass ionomer cement) should be applied.[3]

2.4. Endodontics

In order to avoid subacute pulpitis or silent pulp necrosis and any potential repercussions associated to barometric pressure, Rossi advised against direct pulp capping in aircrew patients and recommended endodontic treatment in suspected cases of pulp chamber invasion.[22]

The dentist must properly apply temporary restoration in place when doing multi-visit endodontic treatment. Additionally, he or she must teach the patient to recognize when the temporary restoration has been dislodged. If left untreated, root canal infections can result in subcutaneous emphysema and leakage of intracanal infected substance to the periradicular tissues.[23]

2.5. Prosthetic dentistry

Complete denture retention maybe compromised under low barometric pressure.[24] Pressure variations in the cement layer's microtubules in crowns cause a reduction in the retention of the crown.[25] Most frequently, microleakage causes the cement layers beneath the crowns to weaken.[26]

Every effort should be made to improve prosthetic device retention when treating aircrews. Implant-supported prostheses favor removal prostheses in terms of retention and other factors (such as speech).[3]

A study found that using either zinc phosphate cement or glass ionomer cement for the crown's cementation impaired the retention of full cast crowns to extracted teeth during pressure cycling. When cementing crowns and permanent partial dentures for patients who are likely to be exposed to pressure cycling, dentists should consider about using resin cement.[27]

A fixed dental prosthesis is possible with dental implants inserted directly into the jaw. The primary stability of an implant is influenced by the quality and amount of the local bone, which is also one of the major factors affecting implant survival rates. The posterior maxilla's bone height is increased after a sinus lift bone grafting technique, making it better suited for implant rehabilitation. Barotrauma to the paranasal sinuses, on the other hand, is one of the most typical flight-related illnesses.[28] Long-term sinus membrane irritation results in the creation of granulomatous tissue, which can, in severe cases, result in soft tissue polyps in the sinus cavity as well as halitosis, a bad taste in the mouth.[29] Due to pressure fluctuations during flying, a flight restriction is therefore necessary following maxillary sinus augmentation surgery.[30]

2.6. Oral surgery

There are many different reasons why tooth extractions are carried out. According to several experimental research studies, intraoral pressure variations during flight have a negative effect on the healing process in the initial stages after extraction.[31] The blood clot that forms within hours of a tooth extraction or other oral procedures may be dissolved by these pressure fluctuations. Dissolution of the clot may cause severe intraoral bleeding and impair daily activities, including speech.[28]

The dentist must rule out oroantral communication before extracting an upper posterior tooth. Oroantral communication can result in sinusitis and other negative effects when exposed to a situation where the pressure changes.[32] The typical restricted period following tooth extractions is 24-72 hours to allow for symptomatic alleviation, the cessation of medication, and the stabilization of the blood clot. As variations in pressure might impede wound healing in cases of oroantral communication, grounding should be advocated until healing is visible.[28]

2.7. Periodontal health

The chemical composition of saliva as well as its flow rate may be impacted by the relative physiological reactions to long-term stress and workload in unfavorable environmental conditions. Salivary cortisol, potassium, and glucose concentrations have been found to be considerably higher among aircrew members.[33] It has been demonstrated that during flying, immunoglobulin A levels in saliva (perhaps used as a measure for saliva water volume) drastically decline.[28]

Periodontal problems are more likely to develop as salivary volume decreases.[24] Poor dental hygiene, anxiety, and fatigue from flying are risk factors for flying personnel. Potential long-term effects of xerostomia include periodontal disease and dental caries.[33] To promote salivation and prevent dry mouth, it is advised to consume more liquids. Artificial saliva substitutes may be prescribed in extreme circumstances.

2.8. Temporomandibular joint

Etiological factors of temporomandibular joint disorders (TMDs) are multifaceted and include stress brought on by microgravity circumstances and irregular sleep patterns. TMDs are linked to abnormalities in melatonin secretion and cortisol regulation. These occurrences are likely explained by the increased activation of the stress hormone system brought on by conscious pain perception.[34] Another factor that might harm the temporomandibular joint irreversibly is bruxism (i.e. excessive clenching of the jaw or grinding of teeth).[35] Research has demonstrated that bruxism is unquestionably more common in pilots than in non-pilots.[28]

2.9. Flight restrictions

When interference with the aircrew member's ability to fly is detected, a patient's flight is restricted (grounded). Drug use and unfavorable medical circumstances can lead to incapacitation. While some antibiotics might cause diarrhea, some drugs, such as opiates, can lead to drowsiness or make it difficult to concentrate. Additionally, an illness that necessitates the use of antibiotics is a direct cause for the grounding of aircrew personnel.[3]

After tooth extraction or other oral/periodontal surgery, intra-oral pressure changes might remove the blood clot and produce bleeding, which interferes with proper function.[3] Because pressure shifts might impede the healing of such wounds in cases of oroantral communication, grounding should be advised until healing is seen.[32]

The typical limitation period is 24 to 72 hours, or until symptoms go away, the drug is stopped (or at the very least, until it is confirmed that there is no diarrhea), the blood clot stabilizes, etc. The dentist should instruct the flight crew to ground themselves until the patient has pain relief and can sleep soundly because oral pain frequently interferes with sleep.[3] Therefore, it makes sense to book an ambulatory dental appointment for a date with enough time before the following scheduled travel.

2.10. Prevention

For aircrews in particular, early identification of oral disease that is initially apparent and occult is crucial. Secondary caries lesions, restorations with poor retention, and defective (fractured or cracked) restorations should also receive attention. To rule out occult pulp necrosis in teeth with prior extensive restorations, cold-test should be performed and periapical radiographs should be taken.[36] Panoramic radiographs may be helpful for both recording and identifying other concealed dental diseases.

Dentists should watch for indicators of teeth attrition because bruxism is reported to be very common among aircrews in various reports. Researchers have hypothesized that in-flight dangers such G-forces, vibrations, or centrifugal forces are to blame for the greater occurrence of jaw parafunctional activity in aircrew members.[37] Other aspects of the workplace, like unpredictable shifts, have also been linked to bruxism. The long-term effects of bruxism include periodontal disease, TMJ dysfunction, tooth abrasion, headaches, and facial myalgia, especially in the morning.[28]

Prior to each flight, a comprehensive medical and dental examination should be performed in order to prevent the development of barodontalgia. Additionally, following restorative dental work, flying should be postponed for at least 24 hours. Should air travel be unavoidable, the patient ought to be prepared with a potent analgesic. Furthermore, the patient should not engage in any activity that could

expose them to fluctuations in atmospheric pressure, such as diving or mountaineering.[38]

3. Conclusion

The number of passengers flying has increased, which has resulted in a rise in the need for aircrew members. As a result, the topic of aviation dentistry has to be given more attention. To maintain the wellbeing of both passengers and crew, it is vital to promote diagnostic tools and treatment recommendations within the aviation sector. Any area of aerospace medicine that receives special attention will allow specialists to advance and use their knowledge and expertise.

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None.

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