

Aerospace Dentistry: Challenges, Innovations, and Future Directions in Oral Healthcare During Spaceflight – A review

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Abstract

Aerospace dentistry is an emerging field addressing the unique challenges of maintaining oral health in aviation and space environments. Alterations in barometric pressure, microgravity, radiation exposure and restricted dental care are significant variables affecting the physiology of the oral cavity and the development of diseases. It is well known in aviation medicine that latent dental diseases emerge as barodontalgia or may even cause odontocrexia under pressure changes. This includes pulpitis, apical periodontitis and imperfect restorations. These findings highlight the need for effective pre-flight dental screening and quality restorative care. Reduced saliva flow, changes in the oral flora, and fluid changes to the cranium are all frequent during spaceflight and may predispose astronauts to dental disease. Major emergencies are unlikely due to meticulous selection criteria. Current knowledge is primarily acquired from short-duration missions and simulation research, which limits our understanding of long-term repercussions.

Furthermore, the lack of onboard dental specialists and communication delays create considerable impediments to rapid intervention.

Emerging technologies, like as artificial intelligence and tele-dentistry, show promise for improving diagnostic accuracy, treatment planning, and remote care delivery, yet their use in space remains a mystery. Furthermore, traditional dental materials may not work adequately in space, necessitating the creation of radiation-resistant, lightweight, and user-friendly alternatives.

Preventive dentistry is vital, with a focus on tailored oral care protocols, salivary diagnostics, and biofilm management measures. Future research should focus long-duration missions, autonomous care systems, and space-compatible advancements to assure good oral health in deep space exploration.

Keywords: Aerospace Dentistry, Microgravity, Barodontalgia, Artificial Intelligence in Dentistry, Preventive Oral Health

Introduction

From the earliest days, humanity has looked to the stars with awe, sparking dreams of exploration and adventure. Now that space travel is no longer just a dream but a reality, keeping astronauts healthy has become a top priority. Beyond fitness and nutrition, even dental care plays a crucial role. This is where aeronautical dentistry comes in—an emerging field that tackles the unique oral health challenges astronauts face while living and working in space.

Aeronautical (aerospace) dentistry is the study of the prevention and treatment of oral diseases resulting from exposure to extreme environments such as microgravity, hypergravity, and radiation. These conditions include not only dental caries and periodontal disease but also barodontalgia, fractures of dental structures, salivary gland dysfunction, and potential radiation-induced oral malignancies. This field is relevant to astronauts, spaceflight participants, and high performance aviation workers^{1,2,3}. It is now designated as a specialized discipline that maintains, protects and enhances oral health of mission-specific and non-mission personnel through preventive treatment and environment-specific dental management^{2,4}.

A comparable word that is commonly mistaken with aeronautical dentistry is aviation dentistry, which predominantly deals with the general oral and dental health of pilots and crews. It is concerned with the diagnosis, prevention, and treatment of oral and maxillofacial disorders, especially those affected by variations in ambient air pressure during flight (5). Fluctuations of the gravitational forces are known to have a deep impact on oral physiology, mainly through fluid redistributions, bone metabolism and salivary function. Cephalad fluid fluctuations in microgravity settings observed during space missions can cause face edema

and are linked to periodontal abnormalities and changes in mouth microbial ecology^{1,6}. On the other hand, exposure to barometric pressure changes in flight situations can cause barodontalgia and affect the durability of dental restorations due to the expansion and contraction of entrapped gas^{7,8}.

Thus, aeronautical dentistry is mainly concentrated on preventive care, management of dental emergencies in microgravity and the effects of radiation and prolonged isolation, whereas aviation dentistry centers primarily on the prevention of dental pain induced by pressure, sinus related complications and maintenance of oral fitness in aircrew to avoid in-flight incidents^{7,9}. This article intends to discuss the effects of different gravity situations on dental health and to emphasize the major differences between aeronautical and aviation dentistry.

Methods and Methodology

To review the literature, Studies were selected from PubMed, Scopus, Web of Science, and Google Scholar without restrictions on publication year, to provide a comprehensive overview of current knowledge on aeronautical dentistry relevant to routine dental practice. The review focuses on evaluating the differences between aeronautical and aviation dentistry. The search terms included: “Aeronautical dentistry,” “Astronauts,” “Aviation Dentistry,” “spaceflight,” “microgravity” “Barodontalgia,” The research encompassed, Case reports, laboratory studies, clinical studies, and systematic reviews

Physiological Challenges Under Altered Gravitational Conditions

Environmental and Gravitational Changes

Environmental variables in aviation and spaceflight are caused by variations in the structure of the atmosphere and in the force of gravity. Earth’s atmosphere consists of five layers, troposphere, stratosphere, mesosphere,

thermosphere, and exosphere, each with unique temperature gradients that affect climatic conditions at various altitudes¹⁰. The primary effect of these atmospheric changes on exterior exposure is by the shift in pressure and gravity. While these atmospheric variations primarily determine external exposure, their physiological impact is largely mediated through changes in pressure and gravity.

The human body is also affected more directly by the forces of gravity during flight. Humans live under 1-G on Earth. However, during aviation and especially during space missions, people are subjected to hypergravity and microgravity. During the rocket launch astronauts may be

exposed to hypergravity forces in excess of 3 G that compromise cardiovascular function due to reduced brain perfusion. This can result in less oxygen to the brain with visual abnormalities such as graying out, tunnel vision or momentary loss of consciousness¹¹.

Systemic Effects of Microgravity on Human Physiology

Microgravity induces widespread physiological changes affecting multiple organ systems, as summarized in Table X. These include skeletal demineralization, muscle atrophy, cardiovascular deconditioning, immune dysregulation, and neuro-ocular alterations, which collectively influence overall health during spaceflight.

Table :1

System	Effects in Microgravity	Mechanism / Cause	Clinical / Functional Impact
Musculoskeletal System	Muscle atrophy, ↓ bone density (osteopenia/osteoporosis)	Reduced mechanical loading, decreased osteoblastic activity, ↑ osteoclast activity	Weakness, fracture risk, difficulty walking post-return
Cardiovascular System	Fluid shift to upper body, ↓ plasma volume, cardiac deconditioning	Lack of gravity → cephalad fluid shift; reduced workload on heart	Orthostatic hypotension, dizziness, reduced exercise tolerance
Neurovestibular System	Space motion sickness, disorientation	Altered vestibular input (inner ear mismatch)	Nausea, vomiting, impaired coordination
Hematologic System	“Space anemia” (↓ RBC mass)	Reduced erythropoiesis, increased RBC destruction	Fatigue, reduced oxygen-carrying capacity
Immune System	Immune dysregulation	Altered cytokine function, stress hormone changes	Increased infection susceptibility, viral reactivation
Endocrine System	Hormonal imbalance (cortisol, insulin, ADH changes)	Stress response + altered fluid/electrolyte balance	Metabolic disturbances, insulin resistance
Renal System	Increased urine output initially, kidney stone risk	Fluid redistribution, calcium release from bones	Dehydration risk, nephrolithiasis
Gastrointestinal System	Reduced appetite, altered	Fluid shifts, altered circadian	Nutritional deficiencies,

	digestion	rhythm	weight loss
Ocular System	Vision changes (SANS – Spaceflight Associated Neuro-ocular Syndrome)	Increased intracranial pressure, fluid shifts	Blurred vision, optic disc edema
Respiratory System	Altered lung ventilation distribution	No gravity-dependent lung zones	Generally mild impact but altered gas exchange patterns
Skin/Integumentary	Skin thinning, delayed wound healing	Reduced mechanical stress, immune changes	Increased injury risk, slower recovery
Psychological / CNS	Stress, sleep disorders, isolation effects	Confinement, circadian disruption, workload	Anxiety, depression, cognitive changes

Implications for Oral Health

Exposure to microgravity affects the oral cavity through several interconnected processes, extending these systemic impacts to oral health. A notable alteration is skeletal demineralization, which impacts the alveolar bone crucial for dental support. Evidence suggests that even non-weight-bearing craniofacial bones, including the maxilla and mandible, undergo significant bone loss in microgravity, which may compromise periodontal integrity and increase tooth mobility^{12,3}. Moreover, changes in salivary composition—especially diminished antimicrobial elements—coupled with heightened dental calculus buildup, exacerbate gingival inflammation and increase the likelihood of periodontal disease¹⁴. This is further intensified by immunological dysregulation noted in microgravity, which increases vulnerability to oral infections and promotes periodontal deterioration¹⁵.

Fluid Redistribution and Craniofacial Effects

Fluid redistribution is a known physiological response to microgravity. Normally, under the influence of gravity, about 60 per cent of bodily fluids are pooled in the lower extremities. In contrast, the lack of gravity leads to a redistribution of fluid to the head and upper body, with greater accumulation of fluid in the craniofacial region^{11,16}. Such change is frequently associated with

face puffiness, a feeling of fullness in the head, and elevations in both intracranial and cerebrospinal fluid (CSF) pressures.

These changes are closely related to spaceflight-associated neuro-ocular syndrome (SANS), which is characterized by observations including optic disc edema, globe flattening, and visual abnormalities (17,18). Besides these neuro-ocular consequences, the rise in craniofacial vascular and interstitial pressures may have ramifications for oral tissues. Increased intra-cranial and vascular pressure is thought to affect pulpal blood flow and raise intrapulpal pressure within the stiff constraints of the pulp chamber, particularly in teeth with pre-existing restorations or damaged pulp condition. Clinically, this may show as increased dental sensitivity or pain³.

In addition, the combined effects of fluid redistribution and vascular changes may predispose to pressure-related dental discomfort, akin to barodontalgia in changing environmental conditions³. Although direct causative evidence is scarce, current findings show a reasonable relationship between microgravity-induced fluid changes and abnormalities of oral physiology. Furthermore, the combined effects of fluid redistribution and vascular alterations may predispose individuals to pressure-related

dental pain, resembling barodontalgia under changing environmental conditions³. Although direct causal evidence remains limited, current findings support a plausible link between microgravity-induced fluid shifts and alterations in dental physiology.

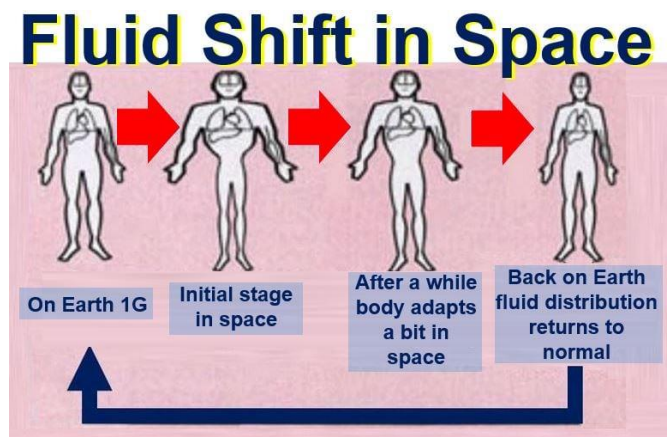


Figure 1

Dental Considerations in Altered Pressure and Microgravity Environments

Effects of Atmospheric Pressure on Oral Health

Exposure to high-altitude situations causes a gradual drop in barometric pressure, which has profound consequences for oral tissues. At about 18,000 feet, air pressure is about half that of sea level, and at 33,000 feet, it is one-quarter. Even though aircraft cabins are pressurized, people are nevertheless vulnerable to relative pressure variations. Boyle's law states that the volume of a gas is inversely proportional to ambient pressure; thus, decreasing pressure at altitude causes gases to expand within bodily cavities.

When gas expansion happens naturally in the mouth cavity, it is usually safe. However, when gases become trapped within tooth structures or adjacent tissues, it can cause pain, discomfort, and functional impairment. This is especially important in the presence of pre-existing dental pathology, as pressure changes might aggravate underlying problems^{7,19}.

Barodontalgia and Related Conditions

Barodontalgia refers to pressure-induced dental pain and is considered a symptom rather than a disease entity. It commonly arises due to the exacerbation of latent oral pathology under changing pressure conditions. Predisposing factors include pulpitis, pulpal necrosis, apical periodontitis, periodontal pockets, carious lesions, and defective restorations.^{20,21}

Barodontalgia can be classified into two main types:

- **Direct barodontalgia** – originating from pulpal or periapical pathology
- **Indirect barodontalgia** – occurring secondary to conditions such as barotitis media or barosinusitis

A more detailed classification proposed by **Ferjentsik and Aker (1982)** categorizes barodontalgia into four types based on the source and nature of pain:

1. **Type I** – Acute pulpitis (sharp pain during ascent)
2. **Type II** – Chronic pulpitis (dull pain during ascent)
3. **Type III** – Necrotic pulp (pain during descent)
4. **Type IV** – Periapical pathology (persistent pain, often severe)

The condition develops through two principal mechanisms:

1. **Intra-dental pressure changes** resulting from carious lesions, microleakage, or structural defects within the tooth.
2. **Expansion of trapped gases** within dental tissues or restorations, consistent with Boyle's Law, where decreasing ambient pressure at altitude leads to gas expansion. This may occur in deep carious lesions, dental abscesses, voids beneath restorations, or poorly sealed endodontic treatments, resulting in pain and functional impairment.

Additionally, during ascent, reduced ambient pressure may facilitate the release of dissolved gases from the bloodstream, leading to bubble formation within the pulp

tissue, which can stimulate nociceptors and produce pain^{7,22}.

Clinical implications include

- Sudden onset tooth pain during ascent or descent
- Fracture of restorations or teeth (barotrauma-related)
- Risk of in-flight emergencies for pilots and divers
- Diagnostic challenges due to absence of symptoms at ground level

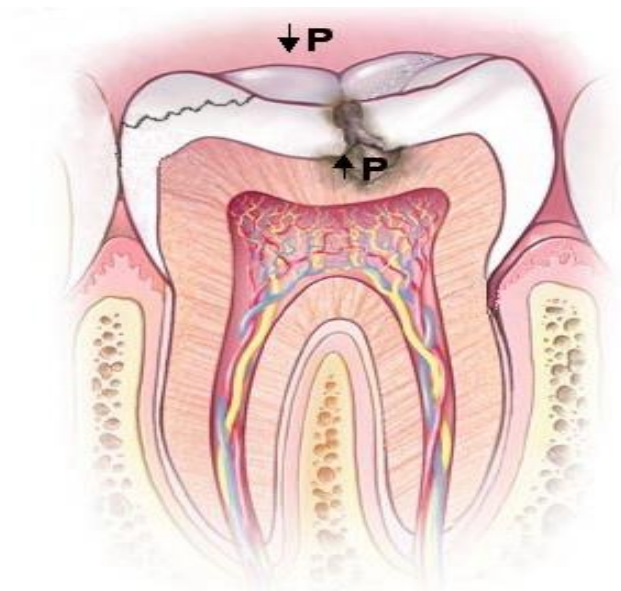


Figure 2

Odontocrexia (Barometric Tooth Fracture)

Odontocrexia, also known as barometric tooth explosion, is an identical condition in which gases trapped beneath poor restorations or within carious lesions expand at lower air pressure, causing structural loss of the tooth. Calder and Ramsey (1983) coined the phrase to describe the physical disturbance of teeth caused by leaking restorations when subjected to barometric pressure changes. According to clinical observations made by Ferjentsik and Aker (1982)²⁰, such damage is more usually connected with improperly restored teeth or untreated carious diseases.

The underlying mechanism involves the expansion of entrapped gases in accordance with Boyle's law, which states that a decrease in external pressure causes an

increase in gas volume. This expansion causes internal stresses in the tooth structure, resulting in cusp fracture, complete tooth fracture, crown dislodgement due to pressure changes within luting cements, and failure of porcelain-fused-to-metal restorations, as discussed by Kollmann (1993) and Ferjentsik and Aker (1982)^{20,22}. Posterior teeth are particularly vulnerable, especially those with substantial restorations. Studies have revealed that mesio-occluso-distal (MOD) restorations considerably impair tooth structure, with mandibular first molars being particularly vulnerable to fracture; thus, cuspal coverage restorations are advised (Lakshmi et al.). Additional research suggests that even minor microleakage at the tooth-restoration interface can allow air to enter and become trapped, increasing vulnerability to pressure-induced injury. According to Ferjentsik and Aker (1982)²⁰, repeated exposure to changing pressure conditions, such as those found in pilots, divers, or astronauts, may worsen this risk by producing cyclic stress fatigue within both the restorative material and tooth structure.

Furthermore, changes in restorative materials affect the prevalence of odontocrexia. Materials with poor marginal adaptability or lower compressive strength are more likely to fail during pressure fluctuations, while adhesive restorative procedures that provide superior sealing ability may lessen the chance of gas entrapment and subsequent expansion, as proposed by Kollmann (1993)²².

Further research supports these findings, demonstrating that preexisting microleakage, faulty restorations, and recurring caries considerably increase the incidence of odontocrexia in high-altitude environments^{19,23}.

Head and Face Barotrauma

Boyle's Law states that the volume of a gas at constant temperature changes inversely with pressure. Changes in

the pressure of the air around us can cause changes in the amount of gas inside our bodies. These changes can cause barotrauma, which is common when we fly, dive, or use hyperbaric oxygen treatment^{24,25}. Head and facial barotrauma includes disorders including external otitic barotrauma, barotitis medium, barosinusitis, barotrauma-related headache, dental barotrauma, and barodontalgia^{20,22}.

External otitic barotrauma occurs when a sealed air pocket forms in the external auditory canal, which is commonly caused by an obstruction, such as earplugs or cerumen, that prevents pressure equalization. During descent, the pressure differential can cause epithelial peeling, discomfort, and subepithelial bleeding. The most frequent altitude-related barotrauma is barotitis medium, which occurs when the Eustachian tube fails to equalize middle ear pressure. This causes tympanic membrane retraction, vascular engorgement, bleeding, and transudation. Clinical signs range from mild discomfort to severe pain, tinnitus, vertigo, nausea, and transient hearing loss, with higher vulnerability in people with upper respiratory tract infections or allergies²⁵⁻²⁷.

Barosinusitis develops when a blockage in the sinus ostia hinders pressure equilibration, resulting in a relative negative pressure (vacuum effect) within the sinus cavity. This causes mucosal edema, submucosal hematoma, and discomfort, which may be followed by epistaxis. Compression or irritation of trigeminal nerve branches can cause referred facial discomfort or numbness, with a higher incidence observed during descent²⁸. Barotrauma-related headaches, including "airplane headache," have been linked to rapid pressure fluctuations in the paranasal sinuses. These headaches are hypothesized to be caused by stimulation of ethmoidal nerve endings and activation of the trigemino-vascular system, and often manifest as

intense, unilateral orbital or supraorbital pain during ascent or descent²⁹.

In dentistry, both barotitis medium and barosinusitis can mimic odontogenic pain, a condition known as indirect barodontalgia^{20,22}. Furthermore, some studies indicate a probable link between craniofacial morphology, malocclusion, and Eustachian tube dysfunction; however, present evidence does not support the routine use of dental splints for prevention or management²⁷.

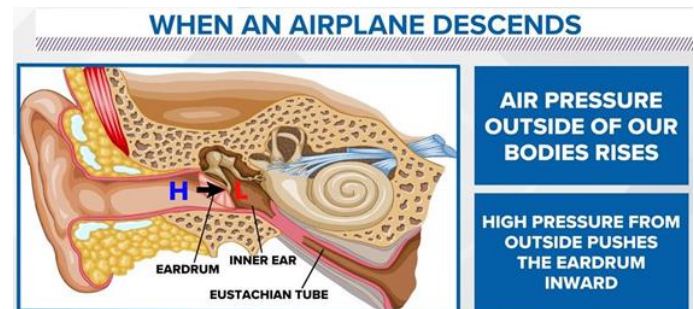


Figure 3

Impact of Microgravity on Jaw Bone Density and Tooth Support

Microgravity impairs skeletal homeostasis due to the lack of mechanical loading. This causes disuse atrophy and gradual bone loss, which resembles osteoporosis. Bone mineral density falls at a rate of around 1-2% per month, owing to decreased osteoblastic activity and increasing osteoclastic resorption^{2,30}.

In the craniofacial region, both the maxilla and mandible are affected, with considerable losses in alveolar bone density found under simulated microgravity settings³¹. Because alveolar bone is necessary for tooth support, degradation can jeopardize periodontal stability, increase tooth mobility, and disrupt osseointegration.

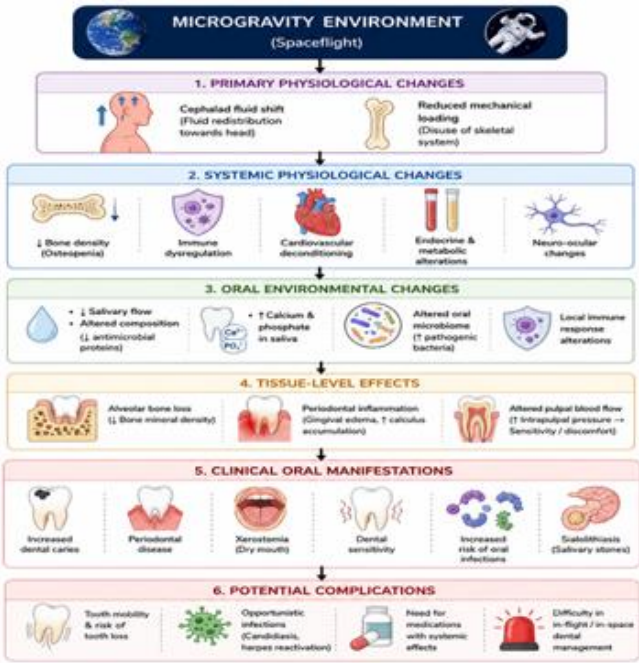


Figure 1: Pathophysiological pathway of oral health alterations in microgravity.

Figure:4

Salivary changes

Immune difficulties, including as infections and immunodeficiency, constitute significant challenges in spaceflight. Brown et al.³² found changes in saliva content during microgravity, showing complicated physiological adaptability. Rai et al.³³ found that head-down tilt reduced salivary flow, sodium, and potassium while increasing calcium and phosphate due to bone resorption and oxidative stress, predisposing astronauts to xerostomia and salivary stone formation. Microgravity also affects taste perception, raising the threshold for capsaicin and lowering it for sodium chloride³¹. Salivary secretion and the oral microbiome are dramatically impacted³⁴. Salivary pH and flow were observed to remain steady, however there was a shift toward disease-associated bacteria with fewer commensals, whereas microgravity influenced biofilm activity by increasing bacterial adhesion, structural complexity, and resistance. Furthermore, several microbes show increased virulence and altered gene expression, which increases their pathogenic potential³⁵. Reduced gland activity, bone

resorption, and environmental variables all increase the likelihood of salivary stone development³⁶. Low fluid intake reduces plasma volume and salivary flow, whereas high salivary electrolytes and proteins in simulated microgravity indicate dehydration, muscle breakdown, and bone mineral loss. Saliva is also being investigated as a diagnostic medium, with International Space Station studies indicating increased antimicrobial proteins (IgA, lysozyme, and LL-37) and changed cortisol-to-DHEA ratios, which suggest stress and immunological regulation³⁵. Clinically, xerostomia, which is increased by poor fluid intake, hypoxia, and breathing compressed gases^{37,38}, raises the risk of dental caries, periodontal disease, opportunistic infections, and sialolithiasis.

COMPARATIVE ANALYSIS

BETWEEN

AERONAUTICAL DENTISTRY & AVIATION DENTISTRY

ASPECT	AERONAUTICAL DENTISTRY	AVIATION DENTISTRY
Definition	Focuses on dental conditions caused by barometric pressure changes during flight (Zadik, 2009 ⁹ ; Ferjentsik & Aker, 1982 ²)	Deals with oral health in space environment including microgravity and radiation (Reddy et al., 2015 ⁵ ; Rai et al., 2015 ⁹)
Environment	High altitude with pressure fluctuations (Lyons & O'Brien, 1997 ⁷)	Microgravity, radiation, confined spacecraft (Williams et al., 2009 ⁶)
Primary Population	Pilots, aircrew, frequent flyers (Lyons & O'Brien, 1997 ⁷)	Astronauts and space travelers (Putcha et al., 1999 ⁸)
Main Etiological Factor	Barometric pressure imbalance affecting teeth (Kollmann, 1993 ³)	Microgravity-induced systemic physiological changes (Williams et al., 2009 ⁶)
Key Condition	Barodontalgia (tooth pain due to pressure changes) (Zadik, 2009 ⁹)	Bone loss, immune changes, altered saliva (Kahn et al., 2012 ⁴)
Pathophysiology	Gas expansion/contraction → pulpal pressure changes → pain (Kollmann, 1993 ³)	Fluid shift + bone demineralization → oral health compromise (Williams et al., 2009 ⁶)
Clinical Manifestations	Pain during ascent/descent, pulpitis, odontocrexia (Ferjentsik & Aker, 1982 ²)	Increased infection risk, delayed healing, difficulty in procedures (Reddy et al., 2015 ⁵)
Onset Trigger	Rapid altitude change (take-off/landing) (Zadik, 2009 ⁹)	Prolonged exposure to space environment (Williams et al., 2009 ⁶)
Operational Impact	Can impair pilot performance and compromise flight safety (Lyons & O'Brien, 1997 ⁷)	Medical emergencies difficult to manage in space missions (Putcha et al., 1999 ⁸)
Preventive Focus	Pre-flight dental check-ups and elimination of faulty restorations (Rai et al., 2010 ¹⁰)	Pre-mission elimination of all potential oral disease sources (Reddy et al., 2015 ⁵)
Nature of Field	Well-established and preventive-oriented (Zadik, 2009 ⁹)	Emerging field linked to space exploration (Reddy et al., 2015 ⁵)

Figure:5

Future Perspectives and Research Gaps

Despite growing interest in aerospace medicine, **aerospace dentistry remains insufficiently explored**, with multiple critical gaps that must be addressed to support safe and effective long-duration space missions.

Need for Long-Duration Mission Studies

Most existing research on oral health in space comes from short-duration missions, analog environments, or simulation-based investigations, which limits our understanding of long-term consequences.

A comprehensive review by Del Fabbro et al. (2025)³⁹ demonstrates the scarcity of high-quality human studies and emphasizes that existing data on oral alterations during spaceflight are limited and diverse.

Similarly, Moussa, Goldsmith, and Komarova (2022)⁴⁰ said that existing risk estimates for dental issues are primarily based on short missions and may not correctly reflect hazards in deep-space missions such as Moon or Mars expeditions.

Furthermore, Castro et al. (2020)⁴¹ reported that long-term exposure (up to 18-24 months) to microgravity, radiation, and stress may cause changes in oral microbiota, increased anaerobic bacterial load, and systemic physiological changes, emphasizing the importance of longitudinal in-flight studies.

Future research must therefore prioritize long-term missions to assess cumulative impacts on oral tissues, salivary biomarkers, and disease development.

Integration of AI and Tele-Dentistry in Space

The main hurdles to dental care in space are the absence of onboard dental specialists and communication lags with Earth.

Recent developments imply Artificial Intelligence (AI) can greatly increase diagnostic capabilities. The study of AI in dentistry suggests that it is useful in interpreting radiographs, detecting lesions and planning treatment.

However, present models have limitations in task specificity and a lack of generalization to different scenarios⁴².

Broader considerations of AI in dentistry have concentrated on its potential in clinical decision making, teaching, and telehealth⁴³.

However, there is a lack of space-specific validation of AI systems and tele-dentistry platforms. Future work should concentrate on:

- Astronauts' autonomous diagnostic tools
- AI-supported treatment planning in microgravity
- Robust tele-dentistry systems that are tolerant to communication delays

Development of Space-Compatible Dental Materials

Earth-based dental materials are not built for microgravity, radiation, and limited resources in space.

The extraterrestrial environment presents physiological and operational problems that may impact material handling, stability, and therapeutic performance, according to Kachouei et al.⁴⁴

Blue et al. (2019)⁴⁵ found that space radiation degrades pharmaceutical stability, suggesting dental biomaterials may be affected.

The need is clear:

- Biocompatible and radiation-resistant materials
- Materials with low aerosol production
- Provides simple, user-friendly methods for novices.

Dental materials should be tested in virtual and real space in future study.

Preventive Dentistry Models for Astronauts

Since it is impracticable to do major dental surgeries in space, prevention is the cornerstone of aerospace dentistry.

A recent systematic analysis by Almeida et al. (2025)⁴⁶ found alterations in salivary biomarkers, microbial makeup and immunological responses that may

predispose astronauts to oral illnesses during long missions.

Likewise, Simundi et al. (2025)⁴⁷ highlighted the significance of biofilm management, antibacterial measures, and customized preventive tactics suited to microgravity circumstances.

But there are no established prevention models. Future directions should be:

- Comprehensive pre-flight dental screening protocols
- Customized oral hygiene routines
- Use of saliva diagnostics and biomarkers for monitoring
- Development of closed-loop preventative care systems for extended missions

Case Reports

Documented clinical evidence from aviation and aerospace medicine highlights that latent dental pathology may become symptomatic under altered barometric and gravitational conditions. Ferjentsik and Aker (1982)¹¹ reported multiple cases of barodontalgia in military aircrew, where asymptomatic teeth became acutely painful during ascent or descent. These cases were later associated with underlying pulpitis, pulpal necrosis, or apical periodontitis, emphasizing the role of pre-existing occult dental disease.

Zadik (2009)⁷ described similar episodes of in-flight dental pain linked to carious lesions and defective restorations, where pressure changes likely caused gas expansion within microleakage spaces, triggering acute pain during flight. These findings reinforced the importance of high-quality restorative integrity in preventing aviation-related dental emergencies.

Cases of odontocrexia (barometric tooth fracture) have also been reported in relation to rapid altitude variation. Kollmann (1993)²² and Calder and Ramsey (1983) documented structural failure of heavily restored

posterior teeth, particularly mesio-occluso-distal (MOD) restorations, attributed to expansion of trapped gases under reduced ambient pressure.

Although severe odontogenic emergencies in spaceflight are rare due to strict NASA and ESA screening protocols, ISS-based observational data suggest mild oral discomfort, facial fullness, and altered oral sensitivity in astronauts, likely related to cephalad fluid shifts and microgravity-induced physiological changes^{48,49}. No major dental emergencies have been reported during International Space Station missions, largely due to rigorous pre-flight dental clearance procedures.

Conclusion

Aeronautical (aerospace) dentistry is a developing field that addresses oral health challenges arising from exposure to altered gravity and atmospheric pressure in aviation and space environments. Evidence shows that aviation-related barometric changes can trigger conditions such as barodontalgia, odontocrexia, and barosinusitis, particularly in teeth with pre-existing pathology or defective restorations. In contrast, spaceflight microgravity produces systemic effects including alveolar bone loss, salivary alterations, immune dysregulation, and cephalad fluid shifts, all of which may compromise periodontal health and overall oral stability. Findings from NASA and ESA, including ISS-based studies, demonstrate measurable changes in salivary biomarkers, microbial profiles, and immune function, confirming the biological impact of long-duration space exposure on oral physiology. Although severe dental emergencies are rare due to strict pre-mission screening, reported aviation cases highlight that latent dental disease can become symptomatic under environmental stress.

Overall, preventive dentistry remains the cornerstone of care in both aviation and aerospace settings. Strengthening pre-mission screening, improving

restorative quality, and advancing space-adapted dental strategies are essential as human space exploration expands

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