ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 6, pp. 17339-17342, June, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

AVIATION DENTISTRY: EFFECT OF MICROGRAVITY ON TEETH AND ORAL CAVITY- A REVIEW

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DOI: http://dx.doi.org/10.24327/ijrsr.2017.0806.0334

ARTICLE INFO

Article History:

Received 17th March, 2017
Received in revised form 21st April, 2017
Accepted 05th May, 2017
Published online 28th June, 2017

Key Words:

Aviation, Dentistry, microgravity, Teeth, Oral cavity

ABSTRACT

Aviation dentistry is an emerging science which studies the impact of flying on the status of teeth. The main purpose is to understand how flying affects dental health and to prevent disorders associated with changes in atmospheric pressure. As the number of air crew members have increased from past decades, aviation dentistry has attained importance since it deals with maintaining the good oral health of the air passengers. The aim of this paper is about the role of aviation dentistry and effect of microgravity on teeth and oral cavity.

INTRODUCTION

Introduction to space environment throughout flight has significant medical and health implications in air crew members. Human physiological adjustment to the environment of space is a tackle faced in the progress of human space flight. Advances in aerospace technology in the 20th century provided human beings with an opportunity to move across a micro gravitational surrounding, and this gap will increase in the present century. Aeronautic dentistry is branch of dentistry which deals with the study of dental aspect in aeronautic environment. This superspecilization branch in dentistry is not only important for clinical examination of oral cavity treatment but also from forensic or legal point of view. [1]

There is reduction in air pressure and air density at higher altitude [2]. The reduced air pressure has various negative effects on aviators. Aircraft regulates pressure and temperature by means of air cycle machines and outflow valves [3].

Dental practice and education are developing with technological advancements. The sophisticated development in the airlines industry and air travel now being the chief mode of transport, particular interest must be paid toward the crew members and air travelers. [4]

A person in flight is subjected to reduced air pressure. The gas present within the body tends to expand. In cases where the gas can communicate with the external environment (e.g. nose, mouth etc.) the pressure gets dissolute. When there is no outlet for the gas, the pressure builds up, leading to pain, discomfort and impaired organ function. [5]

Dental barotraumas is observed among military personnel than in civilian air passengers or flyers [6].

Proper diagnosis of the pain should be made, to treat barodontalgia at an earlier stage. Sometimes, barodontalgia go unnoticed due to carelessness [7]. There should be better knowledge on aviation dentistry among both dentists and air crew members to manage and treat the pain caused due to the reduced air pressure in higher altitudes.

Effect of Microgravity on Teeth and Oralcavity

Barodontalgia*:* Barodontalgia is defined as an oral pain caused by a change in barometric pressure in an or otherwise asymptomatic organ. Boyle's Law may be used to explain the phenomenon of barodontalgia [8]. Aircrew members have been reported to be more susceptible to quite few flight induced oral pathologic conditions including barodontalgia. When in unpressurized airplane cabins a person reaches high altitudes, as the outside pressure decreases, there will be an increase in volume of gases. This will creates a problem in tooth chamber and canal, because the gases cannot expand or contract in a way desired to regulate the internal pressure equivalent to the external pressure [9]. Barodontalgia has been reported to occur

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across a broad range of altitude, as low as 5000 feet and as high as 35000 feet but is more common between 9000 and 27000 feet. [9, 10]

The classification of barodontalgia was given by Ferjentsik and Aker in 1982. It is mainly based on the original causes and clinical symptoms [11]

Table 1 Classification of barodontalgia

Class	Cause	Symptom
I	Irreversible pulpitis	Sharp pain on ascent
II	Reversible pulpitis	Dull pain on ascent
III	Necrotic pulp	Dull pain on descent
IV	Periapical pathology	Severe ersistent pain on ascent or descent

***Barotrauma**:* Barotraumas deals with the physical damage or trauma caused to the body tissue due to a difference in pressure between a gas space inside the body and the surrounding fluid. [11] It is usually taking place in scuba divers, air travelers, hyperbaric oxygen therapy, or after the explosion due to the shock waves. It involves different situations such as external otitic barotraumas, barotitis media, barosinusitis, barotraumas related headaches, dental barotraumas, and barodontalgia. Barotrauma refers to the acute inflammation of the sinus and middle ear cavities while barosinusitis is an inflammation of the paranasal air sinuses. [12]

***Odontocrexis**:* Calder and Ramsey studied tooth fractures caused by a high-altitude environment. The term` Odontocrexis`, which was coined by Calder and Ramsey to describe the physical disruption of teeth with leaking restoration are caused by barometric pressure changes. [13, 14, 15]This condition is also known as barometric tooth explosion. The Preexisting leaked restoration or recurrent caries lesions underneath restorations can cause tooth explosion when exposed to high altitude environment. Common source of damage was the unintentional expansion of gas which is intent below the restorations. [16, 17]

***Dental Caries**:* The Prevalence of caries increases in microgravity. In absence of gravity changes occur in the amount of saliva that protects the dental tissue. The amount of saliva of astronauts is decreased in microgravity condition than in earth atmosphere because the activity of submandibular muscles decreases and also the composition of saliva is modified by the minor amounts of protective substance antioxidants. There is noticeable change in the composition of saliva and development of caries increases the virulence of pathogens in the absence of gravity. There is a general decrease in immune system which causes the enamel at risk of tooth decay. [18]

***Periodontium**:* The increase in virulence of pathogens and lowered immunity due to an increase in the free radicals has a negative effect on periodontium which leads to higher prevalence of periodontal disease among astronauts. Microgravity affects the process of bone remodeling. Experiments show a 20% decrease of osteoblastic markers such as alkaline phosphatase, osteocalcin, and procollagen three months from the alterations of the conditions of gravity and on the other hand increased level of markers of osteoclast activity as cathespin and metalloproteinase 8 and 9. There is a loss of balance in the process of bone remodeling, resulting in the less bone formation and increased resorption [18] .As there is increase in altitude there is a decrease in bone density. The effect of bone loss which occurs due to demineralization in microgravity environment is about 1-2% per month in flight. During space flight the bone mineral density decrease in weight bearing bones this can be a reason for the fracture of the jaw bones. [19]

***Dental Implants**:* A study was conducted to evaluate the peri-implant bone changes around a dental implant placed in a French astronaut who had spent 6 months in Russia`s Mir space station. Measurements were taken by 2 examiners before the flight, after the flight and following a recovery period. Periapical radiograph were taken and it is found that the peri-implant bone level remained same after 6 months in microgravity and implant continued to function without complications [19, 20, 21].

***Restorative Dentistry**:* It has been suggested (Joseph, Gell, Carr, Shelesnyak, 1943 and others) that dental pain while flying may be caused in a filled tooth by the expansion of air entrapped while inserting the filling, so that pressure is exerted on the pulp via the dentinal tubules. Changes in temperature while flying may cause dental pain or have a deleterious effect on filling. Armstrong and Huber in America in 1937 observed that temperature of differential thermal contraction is seen in amalgam restoration at a low temperature of a high altitude environment in comparison to tooth hard tissue. [22]

***Oral Surgery**:* After the extraction of maxillary teeth surgeons should always rule out the oroantral communications as it might lead to sinusitis when exposed to a pressure changing environment. [23]

***Prosthesis**:* Retention of dentures is based on atmospheric pressure, adhesion and gravity. This implies for both maxillary and mandibular dentures. Reduced barometric pressure can impair the retention of complete denture [24]. In crowns, pressure changes occur in microtubules of the cement layer, which result in a reduced retention of the crown [7]. A study showed that the retention of full cast crowns to extracted teeth was reduced after pressure cycling, if the crowns were cemented with either zinc phosphate cement or glass ionomer cement. Dentists should consider using resin cement when they cement crowns and fixed partial dentures for patients, such as divers, who are likely to be exposed to pressure cycling [25].

***TMJ**:* Morphological and histological studies of the temporomandibular joint have revealed that it is not suited for stress bearing and if subjected to prolonged and increased stress as frequently happens in certain parafunctional oral habits, the spasmatic hyperactivity of the mandibular musculature may initiate degenerative changes in the joint through abnormal pressure on the fibrous tissue of the articular disc. [26]

***Oral Bacteria**:* Humans suffer immune-suppression with prolonged space flight. Bacteria become less susceptible to antimicrobial agents in microgravity. The development of biofilm increases the resistance of bacteria to antibiotics, thereby enhancing their chances of survival in hostile environments and becoming more infectious and dangerous to human health. [19, 21]

***Saliva**:* During microgravity the flow of saliva is reduced due to altered fluid distribution and fluid imbalance which leads to

xerostomia. Increased bone resorptions contribute significantly to raise the salivary state of saturation with respect to the calcium salts, namely, calcium oxalate and calcium phosphate. Environmental and dietary factors may adversely affect salivary composition and increase stone formation risk during space flight. [27, 28]

***Immune System**:* Immune system altered in astronauts exposed to the condition of long -term space flight; isolation, containment, microgravity, radiation, microbial contamination, sleeps disruption and insufficient nutrition. Humans, in space there is evidence of immune compromise, reactivation of latent virus infection, probable development of a pre malignant and malignant conditions. As microgravity promotes the growth of bacteria and altered immune system it can cause the reactivation of latent virus infection in astronauts. [23]

***Prevention and Recommendations**:* Caries excavations and restorations should be done before air travel. Leaky restorations should be replaced. During the restoration of a carious tooth, a thorough examination of the floor of the cavity should be done to rule out any penetration leading to the pulp chamber. In such cases a protective cavity liner should be applied (e.g. glassionomer cement). During multi-visit endodontic treatment, the temporary restoration must be placed properly. When oroantral communication is diagnosed; referral to an oral surgeon for its closure is indicated [29, 30]. Cuspal coverage crowns could also be a preventive measure. Resin cements are preferred for cementation, as they give better retention. During flight, chewing gum or candy will increase salivation and prevent dryness in the mouth [30]. Barodontalgia is not common, yet it can pose a severe safety risk to divers, submariners, pilots and airline passengers. One clinical benefit of barodontalgia is that it may help a dentist locate early caries, leaking restorations and periodontal abnormalities. The Placement of a zinc oxide eugenol (ZOE) base was found to prevent barodontalgia when reversible pulpitis was the underlying cause. All ill fitting crowns should be replaced with a good cementing medium, active periodontal lesion treatment and completion of endodontic treatment should be done. It is sometimes recommended that if we are unable to complete the treatment before deep sea diving or flight, extraction may be the treatment of choice. Also removable dentures are not recommended rather a FPD or an implant is indicated. [7]

CONCLUSION

Aviation dentistry plays an important role in maintaining the oral health of aircrew personnel. The oral health is equally important as compared to the general health of an astronaut. The studies and research conducted in this field is very limited to explain the exact cause of barodontalgia in microgravity. Now a day's aviation dentistry has attained a good scope due to the increased number of air passengers .Dentist should be very cautious before carrying out certain dental procedures like surgical procedures, endodontic and prosthetic treatments in order to avoid complications. In astronauts pre flight check up can help in early diagnosing and treating the oral disease.

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How to cite this article:

Thara Bhavani M.S *et al*.2017, Aviation Dentistry: Effect of Microgravity on Teeth and oral Cavity- A Review. *Int J Recent Sci Res.* 8(6), pp. 17339-17342. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0806.0334

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