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Barodontalgia : The Dental Distress – An Overview

Medical Science

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Dr. Ipsita Maity — Department of Conservative Dentistry & Endodontics Guru Nanak Institute of Dental Sciences and Research, Kolkata.

Dr. Preeti Goel — Department of Prosthodontics, Crown and Bridge Guru Nanak Institute of Dental Sciences and Research, Kolkata.

ABSTRACT

Barodontalgia is the oral (dental or non-dental) pain due to changes in the barometric pressure by altitude variations. It is one of the important clinical entities which present with such overlapping signs and symptoms, that in normal clinical setup the pain due to barodontalgia goes unnoticed. Barodontalgia is characterized by exposure to a pressure gradient, such as that experienced by underwater divers, aviation personnel and air travellers. Contemporary classification, prevalence, incidence, features, etiology, and diagnosis of this entity are presented related to flight and diving conditions. This form of dental pain is generally marked by a predisposing dental pathology such as acute or chronic periapical infection, caries, deep or failing restorations, residual dental cysts, sinusitis or a history of recent surgery. The key to avoid barodontalgia is good oral health. Clinicians must pay close attention to areas of dentin exposure, caries, fractured cusps, the integrity of restorations and periapical pathology in those at risk. This review article provides the information concerning the etiology, pathogenesis and manifestations of barodontalgia, as well as important clinical considerations for its management.

Introduction

Shortly after the innovation of the flight at the beginning of twentieth century, in-flight physiologic and pathologic phenomena began to be reported. In recent times, with increasing number of air passengers, pilots, professional and leisure Self-contained underwater breathing apparatus (SCUBA) divers, dentists may encounter related oral conditions that require immediate treatment. One of these conditions is barodontalgia.[1]

A complaint about dental pain due to barometric change may pose diagnostic challenge to the dental practitioners. Barodontalgia, which commonly affects air crew and aircraft passengers as well as underwater divers, is pain or trauma affecting teeth due to variations in pressure gradients.[2]

An explanation of barodontalgia comes from the Boyle's Law, stating that "At a given temperature, the volume of a gas is inversely proportional to the ambient pressure." [3]

When a person descends deeper underneath the water surface, pressure exerted on the diver by the water increases and reduces the volume of gases in walled spaces such as teeth and sinuses. Similarly when a person climbs to high altitudes particularly in flight, outside pressure decreases, permitting the volume of gases to increase. A problem arises when the enclosed gases cannot expand or contract to adjust the internal pressure to correspond to the outside pressure.[4]

Although rare, in-diving or in-flight barodontalgia has been recognized as a potential cause of diver or aircrew-member vertigo and sudden incapacitation, which could jeopardize the safety of diving or flight.[5,6] The importance of understanding, preventing and where necessary, treating barodontalgia is especially evident when considering pilots of high performance aircraft. In the past, barodontalgia was especially problematic for travellers during military flights where cabins were not sufficiently pressurized. Currently, and of particular relevance to the general public, are effects occurring during normal commercial flights and recreational diving. These range from a simple sharp or squeezing tooth pain to rupture of the alveolar mucosa. The phenomenon begins to occur at an altitude of approximately three thousand meter [m] and at a water depth of ten m where the ambient pressures are 0.75 and 1 atmosphere, respectively.[3,7]

More than six decades have passed since the introduction of the concept of barodontalgia, still there is a lack of knowledge in the literature regarding this issue. Moreover, barodontalgia does not have sufficient space in literature. Despite the rarity of this phenomenon, barodontalgia is of interest for dental practitioners. Hence this article reviews the literature regarding the concept of barodontalgia, its etiology, pathogenesis, diagnosis and prevention.

Definition

Barodontalgia is an oral (dental or non-dental) pain caused by a change in barometric pressure in an otherwise asymptomatic organ.[8] In a diving environment, this pain is commonly known as ''tooth squeeze.''

During World War II, tooth pain experienced by air crew in flight was given the name *aerodontalgia*. Later, with the appearance of the SCUBA divers, many in-flight manifestations caused by barometric changes were found to be associated with diving as well. Consequently, the prefix was changed to ''baro''.[8]

Classification [1,6]

Barodontalgia is subgrouped into direct (dental induced) and indirect (non-dental induced) pain.

Direct Barodontalgia	Indirect Barodontalgia
Pulp/periapical pathosis related barodontalgia.	Barotitis/barosinusitis-induced barodontalgia.

The currently accepted classification of direct barodontalgia consists of four classes. The Federation dentaire internationale (FDI) has classified direct barodontalgia into four groups, relating only to pulp and periapical conditions and symptoms, whereas the former classification, established in the 1940s, consisted of three groups and included pulp pathologies as well as other possible causes of barodontalgia such as barosinusitis, barotitis media, and partially erupted teeth.

Class	Cause	Symptoms
I	Nonreversible pulpitis	Sharp momentary pain on ascent
II	Reversible pulpitis	Dull throbbing pain on ascent
III	Necrotic pulp	Dull throbbing pain on descent
IV	Peri-apical pathosis	Severe persistent pain on ascent and descent

Prevalence and Incidence [6]

Barodontalgia has been experienced on one or more occasions by 9.2%-21.6% of American and Australian SCUBA divers. It was most prevalent in the third decade of life and without gender preference. An additional 16.8% and 27.2% of divers suffered from "jaw pain" and "sinus pain," respectively. Among military

divers (all male), an incidence of 17.3% was reported. In-flight barodontalgia affects 11.0% of military aircrews with a rate of five episodes/1,000 flights. The current weighted incidence of barodontalgia during flight is similar to the reported incidence (9.5%) from the first half of the twentieth century.[1] Such an incidence study for Indian population has not been reported yet.

Etiology

Barodontalgia is a symptom rather than a pathological condition and in most cases, reflects a flare-up of pre-existing oral disease, hence most common oral pathologies have been reported as possible sources of barodontalgia.[4] The cause of barodontalgia has been investigated for many years. Kollman refers to three important hypotheses to explain this phenomenon: First, expansion of trapped air bubbles under a root filling or against dentin that activates nociceptors; Second, stimulation of nociceptors in the maxillary sinuses, with pain referred to the teeth; Third, stimulation of nerve endings in a chronically inflamed pulp.[9] He strongly supports the last two hypotheses and states that, for the latter, histologic evidence shows that chronic pulpal inflammation can still be present even when a thin dentin layer covers the pulp, for example, as in a deep cavity preparation.

Clinically, people affected by barodontalgia were found to have one or more of the following: deep caries, restorations, acute or chronic periapical infection, residual dental cysts, sinusitis and a history of recent surgery. Sinusitis may also contribute to barodontalgia, although it may not be related to any tooth pathology.[7]

Pathogenesis

Several hypothesis regarding pathogenesis of barodontalgia have been proposed since 1940.

1. Direct ischemia resulting from the inflammation.[1]
2. Indirect ischemia resulting from increased intra-pulpal pressure as a result of the vasodilatation and fluid diffusion.[10]
3. The result of intra-pulpal gas expansion. The gas is a by-product of acids, bases and enzymes in the inflamed tissue.[1]
4. The result of gas leakage through the vessels because of barometric- related reduced gas solubility. This theory, offered by Orban and Ritchey [1940], was based on a histologic view of gas bubbles on sectioned teeth that were extracted after barodontalgia. Bergin[1949] accepted the solubility theory, but Lyon et al [1999] rejected that theory because the authors had seen gas bubbles only in six out of seventy five teeth. Another argument against the solubility theory is the possibility that the gas bubbles that they had seen were artefacts because of an inadequate fixation of the histological preparations.[1,11]
5. Hyperaemia in the pulp canal system caused by decompression. This theory was also offered by Orban et al [1946].
6. Changes in barometric pressure in the cases of defective restorations may force oral fluids to be sucked from the inner dentin tubules, thus causing sensitivity or pain in the pulp chamber.

Moreover, defective restorations may cause pulp inflammation, causing barodontalgia indirectly. The old myth that pain is caused by "air that is trapped beneath a poorly filled dental cavity" and expands on ascent is still popular[12], although unproven. During restorative treatments, Devoe and Motley (1945) created "trapped air" under restorations in eight patients by placing a loose pellet of cotton in the cleansed pulpal floor of the cavity. The restorative material was then placed over the cotton. None of the patients reported pain in high-altitude exposures.

Currently, there is no consensus about the pathogenesis underlying pulp-related barodontalgia. However, a healthy pulp is unaffected by barometric change.[8]

Regarding barodontalgia in endodontically treated tooth, it was offered that pain may be generated because of the expansion of trapped air bubbles under the root filling.[3] Barodontalgia due to apical periodontitis or impacted teeth is probably caused by the elevated pressure within the bony lesion or tooth crypt, respectively.[13]

Underwater Diving

Pain has been reported to appear at depths ranging from thirty three feet to eighty feet. The changes are more significant during diving because each descent of ten meter elevates the pressure by another one atmosphere.[14] Pain due to barodontalgia in diving conditions affects more commonly the upper teeth than lower teeth, and vast majority of episodes appeared upon descent. [4]

The most common way for air from the pressurized tanks to enter a tooth is by being forced in through carious lesions or defective margins. As atmospheric pressure decreases during ascent, trapped gases may expand and enter dentin tubules, thereby stimulating nociceptors in the pulp or causing the movement of pulp chamber contents through the apex of the tooth, also causing pain.[7] In their study, Calder and Ramsey [1983][15] mentioned that the physical properties of the gas mixture used during deep sea diving may contribute to barodontalgia. In scuba tanks, oxygen is natural diluent gas, nitrogen, is replaced by helium, resulting in a gas of lower viscosity. This gas can enter tissues, including teeth, and can sometimes become trapped in closed spaces, such as the pulp chamber and root canal. There are two mechanisms by which gases can be trapped in spaces: if there is a space between a tooth and restoration, gas may be forced into it during an increase in pressure; and dissolved gas may diffuse from tissues into spaces as pressure decreases. Consistent with Boyle's Law, trapped gas will expand and the resulting stress may cause tooth fracture. This process has been called *odontecrexis*, a Greek word meaning tooth explosion.[7]

Barodontalgia in Pilots

In recent times, the occurrence of in-flight dental manifestations of pressure changes are relatively low (compared to five decades before) because of the current pressurization measures taken in airplane cabins, high quality dental care and improvement of oral health. However, because the pressure inside airplane cabins corresponds to pressures at altitudes of 5,000 to 10,000 ft, barodontalgia still may occur during commercial as well as non-pressurized helicopter flights. Rapid ascent (eg, 4,000 ft/min), which is related to more acute circulatory changes than slower ascent (in which the physiologic mechanisms could compensate), is related to a higher occurrence rate of barodontalgia.[4]

Upper and lower teeth are found to be equally affected. The most affected intraoral areas are posterior upper and lower dentitions with upper first molar and lower first molar being the most affected teeth .[4] In-flight barodontalgia has been reported to occur at altitudes of 3,000-25,000 feet.[4,13]

Clinical Presentation

Although understanding the aetiology of barodontalgia is of great importance, its physical manifestations also deserve some attention. In their study, Goethe and co-workers [1989] attempted to identify early and late damages due to barodontalgia.

The physiologic and pathologic phenomena related to barometric changes can occur during flights and dives as well as during mountain climbing and in hyperbaric chambers or other environmental pressure scenarios.[1]

Whether the pain occurs during ascent or descent (in both flying and diving) depends entirely on the related pathology. Generally, pain on ascent is related to vital pulp disease (ie, pulpitis) and pain on descent to pulp necrosis or facial barotrauma (i.e.

barometric related trauma to facial cavities). Pain related to periapical disease can appear during ascent as well as descent. Thus, most cases of barodontalgia happened during ascent. The nature of the pain also depends on the related pathology. The pain usually ceases when returning to onset level or ground atmospheric level but can last longer if caused by periapical disease or facial barotrauma.[13,16]

Diagnosis

Barodontalgia is a symptom rather than a pathologic condition itself. Most of the common oral pathologies have been reported as possible sources of barodontalgia including dental caries, defective tooth restoration, pulpitis, pulp necrosis, apical periodontitis, periodontal pockets and impacted teeth.[4,7] Previous studies have documented the difficulty of obtaining a definitive diagnosis of the causative pathology of barodontalgia because of the need to identify the offending tooth, which could be any tooth with existing restoration or endodontic treatment and/or adjacent anatomical structures (eg, maxillary sinus). Moreover, practitioners cannot reproduce the pain trigger factor (ie, barometric pressure change) with ordinary dental facilities, and, even in a diagnostic altitude-chamber simulation (which has been offered as a diagnostic aid method), it is sometimes impossible to reproduce the pain.[17] Therefore, the history is of even greater importance. Data regarding recent dental treatments, on-ground preceeding symptoms (swelling, sensitivity to cold, percussion, and so on), and pain onset/ceassation (on ascent or descent) and the nature of the pain (sharp, dull, beating, and so on) can direct practitioners toward the offending tooth. In addition, because a significant number of barodontalgia cases involved teeth with faulty restorations, the presence or absence of a (faulty) restoration is a good starting point for dental examination.[1]

The clinician is advised to look for faulty restorations (including dislodged restorations over a vital pulp) and secondary carious lesions, to perform vitality test and needed periapical radiographs, and to rule out sinusitis in episodes of pain in the upper posterior region and pain originated from the temporomandibular joint or masticatory muscles in episodes of in-diving oral pain.

Differential Diagnosis

In most cases, barodontalgia is an exacerbation of pre-existing subclinical oral diseases, except, in four cases, where barodontalgia is a pressure change–induced (new) pathologic condition. These conditions are facial barotraumas. Barotrauma is a pathologic response to changes in barometric pressure that occur during flying, diving or hyperbaric oxygen therapy.The term facial barotraumas generally refers to barometric-related trauma to facial cavities, including barotitis media (middle ear barotrauma), external otitic barotrauma, barosinusitis (sinus barotrauma), and dental barotrauma.[1,18]

Barotitis media is a traumatic inflammation in the middle ear space produced by a pressure differential between the air in the tympanic cavity and that of the surrounding atmosphere. External otitic barotraumas is caused by injury to the lining mucosa of the external ear canal. Barosinusitis is an inflammation of one or more of the paranasal sinuses produced by the development of a pressure difference (usually negative) between the air in the sinus cavity and that of the surrounding atmosphere.[1] Dental barotrauma refers to the dental mechanical alterations that relate to barometric pressure changes (eg, fracture of teeth [also called barodontocrexis], deterioration, and reduced retention of restoration). This kind of fracture of tooth or restoration, like on-ground dental fracture, can be followed by pain.

Referred pain from extraoral facial barotrauma (barotitis media, external otitic barotraumas, and barosinusitis) can be manifested as a toothache and should therefore appear in the differential diagnosis list of barodontalgia.[1,19,20]

Finally, in cases of oral pain during diving, dentists should rule out pain caused by the continuously forward-postured and clenched mandible (masticatory muscles contraction) needed to hold the breathing mouthpiece in position. There is a controversy whether SCUBA divers are at risk for temporomandibular dysfunction.[21]

Prevention and Recommendations

Although barodontalgia is rare, yet it can pose a severe safety risk to divers, submariners, pilots and airline passengers. The key feature in the prevention of barodontalgia is good oral health.[3] Periodic oral and dental examinations, including periapical radiographs and vitality tests, are recommended for the prevention of barodontalgia in high-risk populations (e.g., aircrews, divers). In addition, screening panoramic radiographs are recommended for these populations at 3-5-year intervals. Special attention needs to be paid for faulty restorations, secondary carious lesions, and signs of attrition and periapical pathosis.[8] Although routine dental restorative treatment does not require grounding, recent restorative treatment was reported as a major cause of barodontalgia.[8] Therefore, twenty four to seventy two hours of grounding is an effective means for preventing postoperative barodontalgia. It is reasonable that ambulatory dental appointments should be scheduled for a date with a sufficient time interval before the next planned flight or dive. At the time of planning treatment, dentists must notify their aircrew or diver patients and patients planning a flight or dive about the postoperative flight consequences and restrictions.[1] Rossi (1995) recommends the grounding of military aircrews from the time of diagnosing to the completion of endodontic treatment.[9]

Most of the previously published guidelines dictated a more interventional/non-conservative approach of treating aircrews for eliminating the potential of acute symptoms in flight.[9] For example, in the World War II era, for the aircrew patients all pulpless teeth were removed and all metallic restorations were replaced with non-metallic (plastic) restorations "in order to minimize the pressure in the pulp chamber that may produce odontalgia". Rossi (1995) contraindicated direct pulp capping in aircrew patients and recommended endodontic treatment in each case of suspected invasion to the pulp chamber in order to prevent sub-acute pulpitis or silent pulp necrosis and their potential barometric pressure-related consequences. During restorative treatment to aircrew or diver patients, after carious tissue is removed, the clinician has to carefully examine the cavity floor and rule out penetration to the pulp chamber. A protective cavity liner/base (with zinc oxide eugenol the chosen material) should be applied before the tooth is restored.[3,9]

Endodontically treated teeth that have been temporarily sealed reported to explode on deep sea diving, full porcelain crowns have been reported to shatter at a dive of sixty five feet. Hence meticulous oral health advice should be given to the divers, all carious lesions should be restored, 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 FDP [Fixed Dental Prosthesis] or an implant is indicated. Also, patients should not dive or fly in non-pressurized cabins seven days following a surgical treatment.[3,4,7,22]

Conclusion

The present article is aimed at upgrading information regarding barodontalgia. According to the literature, barodontalgia is a rather rare phenomenon, as the incidence of barodontalgia

may be underestimated. It appears that controversy still exists as to the exact aetiology of barodontalgia and the mechanisms of the pain. Nevertheless, research has provided useful ways to anticipate, recognize and treat the phenomenon. Agreement has been reached on two factors: the influence of a pressure gradient and some sort of pathology in oral tissues or sinuses must both be present to result in symptoms of barodontalgia. Certain populations have been specifically identified as having a high risk for barodontalgia. Dentists will be able to provide more efficient diagnosis and care by referring to FDI guidelines. Although its occurrence has been known for some time, more research to improve the understanding of barodontalgia would be useful for those providing care. However, a richer understanding of diagnosis and treatment challenges would undoubtedly be gained from research broadened to include recreational divers and civilian aviators.

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