

## Barotrauma in Dentistry

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### ABSTRACT

Changes in air pressure during activities like flying or diving can lead to physical injury causing barotrauma or tooth pain called barodontalgia. These changes can exacerbate the pre-existing pathology. Such incidence is more common during epidemics and pandemics associated with respiratory problem like corona virus outbreaks. A dental surgeon needs to be well aware of such association so as to identify the pre-disposed individual and take necessary precaution while treating them.

**Keywords:** Barotrauma, Dentistry

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### INTRODUCTION

Barotrauma refers to the physical injury caused by an extreme or rapid change in the air pressure. This type of damage is more common in enclosed areas like middle ear, sinus cavities, lungs etc. In oral cavity, teeth with caries or presence of an inflamed or necrotic pulp and those with inadequate restoration can be affected. Such conditions can develop into barodontalgia, which is pressure associated tooth pain (previously called aerodontalgia) or odonto-crexis, which is fracturing of teeth or slackening or fracturing of restorations [1]. Although rare, barodontalgia can be a potential cause of vertigo and sudden incapacitation in divers or aircrew members that can jeopardies the safety of flights or diving. The aim of this article is to review the current and the past knowledge, and to combine them to generate awareness about barotrauma and in particular about barodontalgia.

### Epidemiology

The incidence of barotrauma, as per the definitions set by ARDS net protocol, ranges from 4.8% to 11%. Furthermore, the evidence shows that the rate of barotrauma increases during severe acute respiratory syndrome (SARS), Middle East respiratory syndrome

and coronavirus outbreaks [2] Barodontalgia has been shown to affect around 9.2% to 21.6% of American and Australian scuba divers. Among the military divers an incidence of 17.3% has been reported [3], Rai B, et al. in their study, have shown that 20.6% of Indian pilots have had an experience of barodontalgia while flying [4].

The presence of several tooth pathologies has been implemented as concomitant factor in causation of barodontalgia. These include pathologies like faulty dental restorations and dental caries without the involvement of pulp (29.2%), pulpal necrosis or presence of periapical inflammation (27.8%), pathologies associated with vital pulp (13.9%) and recent dental treatment - postoperative barodontalgia (11.1%). The existence of barosinusitis can also cause pain in 9.7% of cases [5]. Furthermore, Shillen in 1965 detailed that the healthy pulp tissue can also exhibit pain when atmospheric pressure is increased to a level corresponding to the depth of 100 fsw (foot sea water). Intraorally, barotrauma is seen most commonly in upper posteriors (50.0%) and lower dentitions (37.5%), with upper and lower first molar being the most affected teeth. The intensity of the pain ranges from severe (75.0%) to moderately severe (25.0%). In three-fourth of the cases the pain is generally sharp and localized while in one-fourth it is dull and diffuse. Dental barotraumias have generally been reported at a height of 18,000 feet or higher. The comparison of atmospheric pressure changes during flight and diving indicate that during flight the barometric changes are less significant, while during diving much more momentous effects are noted [6]. It has been reported that barodontalgia can be seen at an altitude of 600-1500 meters during flying, but during diving a depth of 10-25 meters can also produce

tooth pain due to change in atmospheric pressure [7]. The pain due barotrauma has been shown to cease on returning to approximate levels of 3,000-10,000 feet or at ground atmospheric level, but in many cases (61.5% the in study by Zadik Y et al), such as when the pain is caused by periapical disease or by facial barotrauma, it can last up to 3 days after landing [5].

Due to such effect of atmospheric changes on teeth, during World War II, it was recommended that all pulpless teeth in aircrew workers should be extracted, the metallic restoration should be replaced with plastic restorations so as to minimize the pressure in pulp chamber that produces barodontalgia. Current trends have shown that the incidence of barodontalgia has reduced in comparison to that seen in 20th century owing to current compression of air chambers, that produces a pressure corresponding to an altitude of 5,000 to 10,000 feet.

### Pathophysiology

Barotrauma is pressure-induced damage that can occur both at high and low pressure. The pathophysiology of barotrauma can be explained with Boyle's law, which states that as the temperature remains constant the volume of a fixed mass of gas is inversely proportional to pressure of gas and vice versa. Thus as the pressure changes are seen during flying or diving, the changes in the volume of gas are also seen. These pressure differences in human body, if not equalized, can lead to pain, edema or vascular gas embolisms in enclosed organ like middle ear cavity, maxillary sinus, chest, teeth etc[8]. Barotraumas in chest can even lead to pneumomediastinum and in such cases the peak airway pressure is the main risk factor for barotraumas [9].

The exact pathophysiology for barodontalgia is still unknown. Authors like Carlson et al based on their animal experiments have concluded that there is a fluid moment in dentinal tubules in a direction from the dentin towards the pulp under an increased pressure that produces sharp localized pain [10]. Kollman has reported that there are three important hypotheses for pain induction due to pressure changes:

The expansion of trapped air bubbles under a root filling or against dentin can activate the nociceptors.

The nociceptors in the maxillary sinuses can be stimulated which cause referred pain to the teeth.

The nerve endings in a chronically inflamed pulp can be stimulated.

Various other authors have suggested that the stimulation of nerve ending in a tooth with pulpal inflammation can cause pain. Pulpitis has been considered as the main cause of barodontalgia from 1940 till now. Barodontalgia can be a result of direct ischemia in inflamed pulp or indirect ischemia due to vasodilatation and fluid diffusion which can lead to increased intra-pulpal pressure or due to the formation of pulpal gases as a by-product of acid-base and enzymatic reactions in pulp that can cause intra pulpal

expansion thus by leading to pain. Although, gas bubbles were thought of as one of the main reason of pain due to pressure changes. Lyon et al rejected this hypothesis and found that these bubbles were found only in 6 out of the 75 teeth studied. Furthermore, it has been suggested that these bubbles were found due to faulty fixation of tooth sections. Several theories have been also put forward to explain the causation of barodontalgia. It has been hypothesized that extreme cold at high altitude and cold oxygen inhaled by the pilots can cause toothache but it has been seen that flight temperature cause only a slight drop in tooth temperature. It was noted that the tooth temperature in lower canine was around 22.80C, while the pain is noted when tooth temperature reduced to 120C using iced water. Orban has theorized that, at a height of around 38000 ft. in a dog model, pulpal pain is seen due to hyperemia caused due to decompression. It has also been suggested that the changes in barometric pressure in defective restoration can cause air entrapment beneath the restorations thus by leading to pain. However, Devoe and Motley created trapped air under restoration in 8 patients by placing restorations over cotton pellet but no one amongst them reported pain at high altitude [7].

### Differential Diagnosis

Pain in oral cavity and teeth can due to both the referred pain from surrounding areas or may be as a symptom of an existing pathology in teeth. These conditions have to be differentiated from the pain caused due to pressure changes. Such conditions include:

#### Facial Barotrauma (Indirect Barodontalgia)

Barodontalgia can be produced by pressure changes inducing pathologic condition related to trauma in facial cavities like barotitis media, external otitis barotraumas, and barosinusitis. Barotitis media occurs due to the inflammation of middle ear space produced due to pressure difference of air in tympanic cavity and surrounding atmosphere. External otitis barotraumas are caused due to the damage to lining of external ear canal. Furthermore, this should be differentiated from inner ear decompression syndrome, which occurs due to use of compressed gas mixture of helium and oxygen and is common in divers. Barosinusitis is inflammation of sinus because of pressure difference in sinus cavity and external atmosphere.<sup>19</sup> Baroparesis, which is pressure related palsy of facial or trigeminal nerve also needs to be differentiated from barodontalgia [8].

#### Tooth And Periapical Pathology (Direct Barodontalgia)

Barodontalgia can be a symptom rather than pathology itself. Exacerbation of pre-existing pathological conditions such as dental caries, defective tooth restoration, pulp necrosis, apical periodontitis, periodontal pocket, impacted teeth and mucous retention cyst needs to be differentiated.

**Diver's Mouth Syndrome** This condition refers to the pain in Temporo-mandibular joint in divers. Temporo-mandibular dysfunction is 26% more prevalent in divers and female divers are more prone to these. This

pain occurs due to prolonged biting on mouthpieces by the anterior teeth and as most mouthpieces do not provide support for posterior teeth and divers has to bring jaw forward for a long duration to provide support for mouthpiece, such disorders are common. this may cause pain in jaw bone or may exacerbate previously present pathology. This condition needs to be differentially diagnosed from barodontalgia. A custom-fitted mouthpiece could solve such kind of problems in divers [11-13].

### Clinical Features

#### Direct Barodontalgia

**Pulpal Diseases:** The pain due to pupal disease occurs during ascent and gets relieved on descent. Pain is sudden, sharp and penetrating in case of irreversible pulpitis and dull beating pain is seen in reversible or necrotic pulpitis [14-20]. This pain is usually associated with recent dental treatment and dental thermal sensitivity to cold or hot. On clinical examination there extensive dental caries and radiographically the carious lesion has reached pulp or is approaching it.

**Periapical Disease** Pain associated with periapical disease generally occurs at a high altitude (38,000 ft.) and can during both the ascent and descent. The pain in such cases may be continuous intense or dull beating and may be associated with swelling. On clinical examination the tooth is positive to percussion test and shows extensive caries or defective restoration. Radiographically the carious tooth is associated with periapical pathology.

#### Indirect Barodontalgia

Indirect barodontalgia can be caused by conditions like barosinusitis and barotitis media. The pain occurs during the descent and usually continues on ground. The pain generally occurs in premolar and molar area and can be exacerbated change in head position. There may be associated respiratory illness and radiographs may show opacity in sinuses when barosinusitis is suspected [21-23].

### Classification of Barodontalgia

Ferjentsik and Aker have classified barodontalgia based on the underlying cause and clinical symptoms [16].

CLASS	CAUSE	SYMPTOM
CLASS I	Irreversible pulpitis	Sharp pain on ascent
CLASS II	Reversible pulpitis	Dull pain on ascent
CLASS III	Necrotic pulp	Dull pain on descent
CLASS IV	Periapical pathology	Sharp persisting pain on ascent or descent

### Barodontalgia and Dentistry

**Operative dentistry** The destructive potential of necrotic pulp and carious lesions is commonly seen in routine life; also such lesions are susceptible to barometric pressure changes. Sognnaes recommended that in high-risk individuals such carious lesions should be removed. A thorough evaluation should be done after cavity preparation to rule out the pulp exposure.

Furthermore, use of protective cavity liner (like GIC) is recommended [13].

**Endodontics** Direct pulp capping is not recommended in cases that are prone to such conditions. Any potential perforation or invasion of pulp space needs to be treated with endodontic treatment and conservative treatment is not preferred. In multi-visit endodontic treatment, reinforced temporary restoration should be given in between the appointments as open unfilled canals can lead to facial emphysema and leakage of intra-canal infected material to periapical areas.<sup>24</sup> In high prone individuals vertical method of condensation in obturation is recommended [21].

**Prosthodontic** The retention of crown needs to be given much higher consideration than that in routine cases. Resin cements are preferred for luting purpose as experimental studies have shown least amount of micro-leakage in resin cements when subjected to pressure changes [22].

**Oral Surgery:** While extracting posterior teeth, proper care needs to be taken to prevent oro-antral communication. If such an exposure happens during extraction proper closure of oro-antral communication by oral surgeon is recommended as it can lead to sinusitis and pressure related consequences.<sup>13</sup>

### Flight Restrictions

Certain oral conditions and medications require grounding as they may interfere with flight potential of aircrew members. It is recommended that the staff should be grounded for around 24 to 72 hours or until the effect of medication ceases or till the symptoms subside [13] Rossi suggested that the military aircrew must be grounded from the time of diagnosis of endodontic treatment need to the stage the treatment is completed [13] Dental appointment should be scheduled with sufficient number of days before the next flight because recent restorative treatment are more prone to barometric changes. The grounding of aircrew is recommended in following conditions:

DISEASES	Acute infection with systemic symptoms (elevated temperature, malaise)
	Toothache related to sleepless night
Treatment/ Medications	Local anesthetics
	Tooth extraction
	Oral /periodontal surgery
	NSAIDS (e.g. ibuprofen, naproxen)
	Opiates (e.g. paracetamol with codeine, oxycodone)
	Systemic antimicrobial agent
	Dental related weakness or dizziness

### Treatment

Barotrauma induced pathology or any such symptoms arising from preexisting pathology require treatment as such pain may cause incapacitation of aircrew workers. In case of barotitis media the pressure changes can cause tympanic membrane retraction, hemorrhage or vascular engorgement leading to symptoms like pain, tinnitus,

and vertigo with nausea or deafness [19]. In such cases, Valsalva maneuver can provide relief. On ground treatment includes antihistamines and decongestant (topical or systemic). Prednisolone is given in resistant cases (40-60mg for 4 to 7 days) [7]. External otitis barotraumas are mostly caused by misuse of earphone plugs. Gibbons has reported that external otitis media is generally caused by expansion of air between the earphone plug and ear cavity, which can express itself as barodontalgia. Henceforth, proper adjustment of earphone should be done. Barosinusitis occurs due to the stress on sinus mucosal lining which result from pressure gradient in condition like upper respiratory tract inflammation [19,23]. This vacuum creation causes mucosal edema, submucosal hematomas and may cause epistaxis in severe cases. The management of such cases includes nasal decongestants, analgesics and occasionally antibiotics [7].

For tooth pathology induced barodontalgia, the recommendations include:

Maintenance of good oral hygiene.

Periodic dental examination.

Careful dental examination rule out any defective restoration or restoration with poor retention to the tooth structure.

Panoramic radiograph to be taken at a 5 month interval so as to check for dental pathologies.

24 to 72 hrs. grounding is suggested for aircrew workers after recent restorative procedure.

A protective layer of GIC liner should be applied before cavity is restored.

Reinforced temporary restoration should be used in between appointments.

Resin cements should be used for luting of crown [24].

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