Barodontalgia among SLAF air crew

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Abstract— *Barodontalgia, a dental pain evoked by a change in barometric pressure in an otherwise asymptomatic tooth, may be severe enough to cause in-flight vertigo, incapacitation, and premature cessation of flights and altitude-chamber simulations. The purpose of this study was to assess the current in-flight incidence of barodontalgia, and to identify the associated dental pathologies and etiological factors.*

A total of 40 questionnaires were e-mailed to fighter, helicopter, and transport aircrews of the Sri Lankan Air Force. They were asked to report whether they had ever suffered from a toothache during flight. If a positive answer was reported, the subject was interviewed and his dental file was reviewed to obtain details about the incidence.

There were 31 (77.5%) aircrew members who responded. Out of those, 4(12.9%) reported at least 1 case of barodontalgia; their mean age ± SD was 29.7 ± 7.3 yr and the occurrence by aircraft platform were 6.45% of fighter, 3.2% of helicopter, and 3.2% of transport respondents. Many of the cases originated from vital and/ or inflamed pulp (40.7%), whereas the other cases were due to pulp necrosis or peri-apical periodontitis (18.5%) and barosinusitis (18.5%). None of the patients reported premature mission termination due to dental pain.

Even with modern dental care, military aircrews from all the flight platforms may occasionally experience barodontalgia. 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.

***Keywords*— Pulpitis, Peri-apical Periodontitis, Barosinusitis, Barotraumas**

I. INTRODUCTION

The numbers of air passengers, pilots, and professional and amateur self-contained underwater breathing apparatus (SCUBA) divers are ever increasing in the present day world; dental surgeons may encounter conditions that require immediate dental treatment. One of these conditions is barodontalgia. 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." Goldhush (1955) defined barodontalgia as an oral (dental or nondental) pain caused by a change in barometric pressure in an otherwise asymptomatic organ. 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. The importance of understanding, preventing and, where necessary, treating barodontalgia is especially obvious when considering pilots of war aircraft. In the diving environment, this pain is commonly called "tooth squeeze," and the previous name "aerodontalgia," was used regarding its feature in flight. Barodontalgia may be severe enough to cause in-flight vertigo, incapacitation, and premature cessation of flights and altitude-chamber simulations (Eidelman, 1981; Kollmann,1993; Senia,1985; & Hanna,1985).

Most of the available data regarding barodontalgia is derived from high-altitude chamber simulations rather than actual flights. Data from altitude chamber simulations that took place in the U.S. Air Force in the early 1940s revealed that barodontalgia incidence was between 0.74% and 2%, was ranked fifth in the physiological complaints of the trainees, and third as a causative factor of premature cessation of the simulation (Kennebeck *et al*,1946). Between 0.23% and 0.3% of U.S. Air Force trainees suffered from barodontalgia during altitude-chamber simulations in 1964 and 1965, respectively (Hanna,1985). Similarly, Kollmann reported cases of barodontalgia in 0.26% of altitude-chamber simulations in the German Luftwaffe during the 1980s .B Rai *et al*(2010) reported that Almost 20.6% of the sample experienced barodontalgia at one point in time during their practice. More pilots had an occurrence of pain while flying. Pilots had higher incidence of pain while ascending than descending. The highest percentage of tooth pain occurred in pilots while flying at an altitude that ranged from 11,000 to 20,000 ft. Recurrence of tooth pain after treatment occurred in few pilots. In further they observe that barodontalgia is common in India with a high prevalence rate. Pilots reported high occurrence and it was common on ascent while flying and descent (Zadik *et al*,2007). They found that air crew of the Israeli Air Force reported at least 1 case of barodontalgia during

their study. The purpose of this study was to evaluate the current in-flight incidence of barodontalgia among Sri Lankan military aircrew members, as well as the pathologic etiologies associated with this phenomenon.

II. METHODOLOGY

The author targeted air crew from different flying squadrons of fighter, transporter and helicopter for the study. The questionnaire included a brief introduction that described the purposes of the study and stated that the participation in the study was voluntary. Later, the subjects were asked to report whether they had ever suffered from a toothache in flight during their entire aviation career. Positive cases were orally interviewed and the subject's dental files were checked, revealing details about the incidence such as age at the event, altitudes when it appeared, repeated events, diagnosis, and treatment.

Only cases of dental pain that had originally initiated during flight were included in the study. Cases of pain that had begun on the ground and continued in the air were excluded. It is worth mentioning that the questionnaire did not state that those reporting toothache would be subject to oral interview and dental history review. There was no follow-up on the non-responders and no second attempt to re-send the questionnaire to the non-responders was made due to the time limitation.

III. RESULTS

There were 31 (77.5%) aircrew members who responded. Out of those, 4(12.9%) reported at least 1 case of barodontalgia; their mean age ± SD was 29.7 ± 7.3 yr and the occurrence by aircraft platform were 6.45% of fighter, 3.2% of helicopter, and 3.2% of transport respondents. Many of the cases originated from vital and/ or inflamed pulp (40.7%), whereas the other cases were due to pulp necrosis or peri-apical periodontitis (18.5%) and barosinusitis (18.5%). None of the patients reported premature mission termination due to dental pain.

IV. DISCUSSION

In general, barotrauma is defined as pressure-induced damage that can occur both at high and low pressures. The pathology of barotrauma is directly related to Boyle's law, which states that, if temperature remains constant, the volume of a fixed mass of an ideal gas is inversely proportional to the pressure of the gas. As pressure increases, the volume of a confined gas decreases. Vice versa, volume increases as pressure decreases. Pain during ascent can indicate the presence of a disease of vital pulp tissue (pulpitis). Pain during descent can be indicative of pulp necrosis or facial barotraumas .Pressure differences occur in the human body when a gas-filled cavity cannot communicate with the exterior and pressure cannot be equalized. Clinically, the resulting pressure difference between the gas-filled cavity and the exterior environment can lead to pain, oedema, or vascular gas embolism. This type of pain often occurs in the lungs, the middle ear, or the maxillary sinus (barosinusitis). In the majority of cases, barosinusitis develops in the presence of acute or chronic maxillary sinusitis. Headaches, numbness, or dental pain in the region of the maxillary posterior teeth occurs as a result of a difference in pressure.

V. PATHOGENESIS

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. The common etiologic pathologies for pain were faulty dental restorations and dental caries without pulp involvement (29.2%), necrotic pulp/periapical inflammation (27.8%), vital pulp pathology (13.9%) and recent dental treatment A("post operative barodontalgia";11.1%). Barosinusitis was the main cause of origin in pain 9.7% of cases (6 Kennebeck *et al*, 1946). Kollman (1993) has reported three important hypotheses to explain this phenomenon:

1. Expansion of trapped air bubbles under a root filling or against dentin that activates nociceptors;
2. Stimulation of nociceptors in the maxillary sinuses, with pain referred to the teeth
3. Stimulation of nerve endings in a chronically inflamed pulp.

Several hypothesis regarding pathogenesis of barodontalgia have been proposed, direct ischemia resulting from the inflammation (Kennebeck *et al* 1946), indirect ischemia resulting from intrapulpal increased pressure as a result of the vasodilatation and fluid diffusion (Harvey, 1947), the result of intrapulpal gas expansion. The gas is a by-product of acids, bases, and enzymes in the inflamed tissue (Levy ,1943), hyperemia in the pulp canal system caused by decompression (Orban, 1946). Sinusitis may also contribute to barodontalgia, although it may not be related to any tooth pathology. For example, Holowaty (1996) described a patient as having pain in his left infraorbital area, as well as in the maxillary left canine and maxillary left first molar during flight.Although no tooth pathology was present, the patient did have mild congestion in his left maxillary sinus, probably with a referred pain in his maxillary teeth.

Barosinusitis is distinguishable from barodontalgia, as the former will always occur on descent, whereas the latter always begins on ascent (Rauch ,1985). Today there is no consensus over any particular etiological hypothesis and further studies are to be conducted regarding the pathogenesis of barodontalgia.

A. Barodontalgia in divers

Scuba diving is one of the popular sports in the world. Thus, it is important for dentists to be aware of dental-related problems that may arise for scuba divers. Pain has been reported to appear at depths ranging from 33feet to 80 feet.

Pain due to barodontalgia in diving conditions affects more commonly the upper teeth than lower teeth (Jagger *et al* 2009), and vast majority of episodes appeared upon descent (Al-Hajri & Al-Madi, 2006). Appearance of barosinusitis is usually upon descent, whereas barodontalgia is usually precipitated upon ascent (Zadik ,2009). The features (i.e., affecting upper teeth more and appearing upon descent) may indicate a greater role for maxillary sinus pathology in the etiology of in-diving barotrauma; however,further research is needed to confirm that.

B. 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 the improvement of oral health. Upper and lower teeth are found to be equally affected. The most affected intraoral areas are posterior upper (50.0%) and lower (37.5%) dentitions (Sipahi *et al* ,2007), with upper first molar (30.8%) and lower first molar (30.8%) the most affected teeth (Gonzalez *et al,* 2004). Most episodes were characterized as sharp (76.9%) and localized (76.9%) rather than dull (23.1%) and diffuse (23.1%) (Gonzalez *et al,* 2004). In-flight barodontalgia has been reported to occur at altitudes of 3,000-25,000 feet (Al-Hajri & Al-Madi, 2006). The pain may cease on returning to approximate onset level of 3,000- 10,000 feet (Gonzalez *et al,* 2004) or ground atmospheric level, but in many cases (61.5%) (Zadik, 2009), such as when pain is caused by periapical disease, it has been reported to last as long as three days (Zadik ,2006).

C. Classification

Barodontalgia is classified as pulp/periapical-related (''direct'') barodontalgia and barotitis/ barosinusitis induced (''indirect'') barodontalgia (Robichaud, 2005). The currently accepted classification of barodontalgia consists of 4 classes according to pulp/periapical condition and symptoms (Ferjentsik,,1982 & Ingle, 1994).

Class	Cause	Symptoms
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	Severe persistent pain on ascent or descent

D. 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, impacted teeth (Stewart *et al,*1945). Diagnosis begins with the identification of the offending tooth, which could be any tooth with existing restoration or endodontic treatment and/or adjacent anatomical structures (eg, maxillary sinus). The history is of greater importance. Data regarding recent dental treatments, on-ground preceding symptoms (swelling, sensitivity to cold, percussion), and pain onset/ cessation (on ascent or descent) and the nature of the pain (sharp, dull) can direct practitioners toward the offending tooth. The presence or absence of a (faulty) restoration is a good starting point for dental examination.

In facial barotraumas, barodontalgia is not a symptom of a pre-existing disease but of a pressure change– induced (new) pathologic condition. The term facial barotrauma generally refers to barometric-related trauma to facial cavities, including barotitis media (middle ear barotrauma), external otitic barotraumas, barosinusitis (sinus barotrauma), and dental barotrauma. Referred pain from extra oral facial barotraumas (barotitis media, external otitic barotraumas, and barosinusitis) can be displayed as a toothache and should therefore appear in the differential diagnosis list of barodontalgia. Finally, in cases of oral pain during diving, dentists should rule out pain caused by the constantly forward-postured and clasped mandible (masticatory muscles contraction) needed to hold the breathing mouthpiece in position.

V. PREVENTION AND RECOMMENDATIONS

Barodontalgia is not common, yet it can pose a severe safety risk to divers, submariners, pilots and airline passengers. The Fédération dentaire internationale (FDI) has divided barodontalgia into 4 groups from moderate to severe (Goethe *et al*, 1989), and have listed out a description of clinical symptom, findings and therapy. FDI also recommends an annual check up for divers, submariners and pilots, with oral hygiene instructions from dentists. Also, patients should not dive or fly in non pressurized cabins within 24 hours of a dental treatment requiring anesthetic or 7 days following a surgical treatment. One of the easiest ways to avoid barodontalgia is to maintain good oral health. When dealing with patients involved in diving or aviation, dentists should pay attention to areas of dentin exposure, caries, fractured cusps, fillings and periapical pathology. If a patient arrives in the office complaining of symptoms of barodontalgia, the examiner should establish whether there is a history of recent flying or diving. Examination should include an estimate of the age of restorations in the suspected area, screening for caries and poor-quality restorations, a percussion test on suspected teeth, an evaluation of the response to electrical stimulation or heat and cold, as well as a radiographic examination. 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. This is attributed to the well known sedative affects of ZOE. It is also suggested

that when treating people who are subjected to large pressure changes, it is best to avoid procedures such as capping of an exposed pulp. Rather, endodontic treatment is indicated. Recent studies (Khanna, 2010) have shown that environmental pressure cycling affected the retention of crowns cemented with zinc phosphate and glass ionomer cement. Dental surgeons should consider cementing fixed prosthesis with resin cements for patients who are exposed to marked variations in environmental pressure, such as divers and submariners during escape drills. Endodontically treated teeth that have been open for endodontic treatment and temporarily sealed have been report to be explode on deep sea diving known as Odonto crexis, full porcelain crowns have been reported to shatter at a dive of 65 ft, 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 bridge or an implant is indicated.

VI. CONCLUSION

A problem in clinical diagnosis is that it is difficult to differentiate between barosinusitis and barodontalgia on the basis of maxillary pain. Since the aetiology of barodontalgia is still not completely understood, current dental treatment recommendations for flying and diving personnel are often based on statistical data. A further problem is that barodontalgia can occur irrespective of the type of pressure change, that is, during an increase or a decrease in pressure, and can persist even after pressure equalisation. Possible causative or contributing factors, which, however, are a matter of some controversy, include dentogenic infections, sinusitis, differences in the expansion behaviour of dental enamel and pulp, and pressure-induced movement of fluids from exposed dentine to the pulp. It is evident from the available literature that barodontalgia has been neglected in dental education and research in the recent years. Dentists, while treating pilot and diver patients, should use the data available for analysing the causes of barodontalgia. The incidence of in-flight barodontalgia and the incidence among divers, has found to be similar to that found about five decades before, hence better efforts are needed for further augmentation of speculative as well as hands-on knowledge of barodontalgia.

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