Oro-Facial and Dental Problems in High Altitude: a Study on Aircrew of Bangladesh Air Force

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ABSTRACT

Background: Maintaining optimal dental health is vital for military aircrew to ensure performance and readiness, avoid complications during deployment in remote locations and minimize the risk of dental emergencies. High-altitude exposure poses unique physiological challenges that impact orofacial and dental health among aircrew members. Barotrauma presents several forms, including barodontalgia (altitude-induced dental pain), barosinusitis, barotitis, and odontocrexis (tooth explosion due to pressure fluctuations), each having its own clinical presentation and implications. This study aims to examine the prevalence and factors associated with aviation-induced orofacial and dental problems experienced by aircrew during high-altitude missions, develop preventive techniques, and promote awareness among aviators.

Methods: A descriptive, cross-sectional study was conducted in a Medical Squadron consisting of 169 aircrew ranging between the ages of 23 and 58 years. The Bangladesh Air Force (BAF) aircrew who visited the medical inspection department with complaints of orofacial and dental problems within a year were considered as study participants.

Results: The mean age of participants was 35.10 ± 9.009 years. The majority (67.46%) reported experiencing barotrauma, with barotrauma-induced sinusitis affecting 22.49% and barodontalgia impacting 30.59%. Pulpitis (20.71%) was the primary cause of barodontalgia. Furthermore, younger age and less flying experience were significantly associated with a higher incidence of barotrauma ($p < 0.05$).

Conclusion: The research explores that orofacial and dental issues linked to high altitude are a significant concern for young and less experienced aircrew, highlighting the pathophysiology and prevention of these problems.

Keywords: Orofacial Problem, Dental Problem, Aircrew, High Altitude, Barotrauma, Barodontalgia.

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INTRODUCTION

There are people who will "rise from the ground" frequently as pilot, flight crew and student pilot. Due to the increasing number of flying missions, aeromedical evacuation and training exercises, military aircrew members may experience an increase in oral pathological conditions associated to flying that need to be treated. Maintaining a healthy dental status is crucial for aircrew members to avoid in-flight incapacitation, discomfort, decreased performance and poor nutrition due to difficulty in chewing food. It also helps to prevent dental issues in remote areas like UN Mission areas where dental professionals are not readily available, as well as during military aircrew prolonged captivity. Unfavorable environmental impacts of aviation include high altitude, variations in air pressure, and gravitational (G) forces brought on by sudden high-speed flight maneuvers. Aircrew may develop substantial orofacial and dental diseases as a result of these events. In aerospace, the prevalence of caries rises.[1] Numerous examples of tooth fractures, dental restorations shattering, and intense or diffuse pain have been documented. Pressure applied to different nerves and their branches results in moderate pain. When one travels at high altitudes, like 18,000 feet and higher, the air pressure changes.[2,3] Compared to passengers or fliers on commercial aircraft, dental barotrauma is more common in military aircrew due to difference in cabin pressure.[4] Therefore, it is important to properly diagnose the pain in order to treat barodontalgia at earliest onset for ensuring their combat readiness. This study emphasizes the importance of specialized dental care, knowing the prevalence, related factors, and pathophysiology of arisen conditions and preventive strategies for those in the aviation field.

MATERIALS AND METHODS

This study was conducted at the Medical Squadron at BAF Base Zahurul Haque, Chattogram, from June 2022 to June 2023. The sample comprised 169 aircrew members aged 23–58 years. A semi-structured questionnaire collected data on demographics, flying experience, dental history, and in-flight symptoms. Verbal consent was obtained from all participants, and confidentiality was assured. Participants reporting dental pain underwent further clinical evaluation to identify dental risk factors, such as caries, restorations, and periodontal issues. Exclusion criteria included aircrew below 23 or above 58 years, as well as those with fewer than one flight per month.

RESULTS

The research included a sample of 169 aircrew, comprising 165 (97.63%) male participants and 04 (2.37%) female participants.

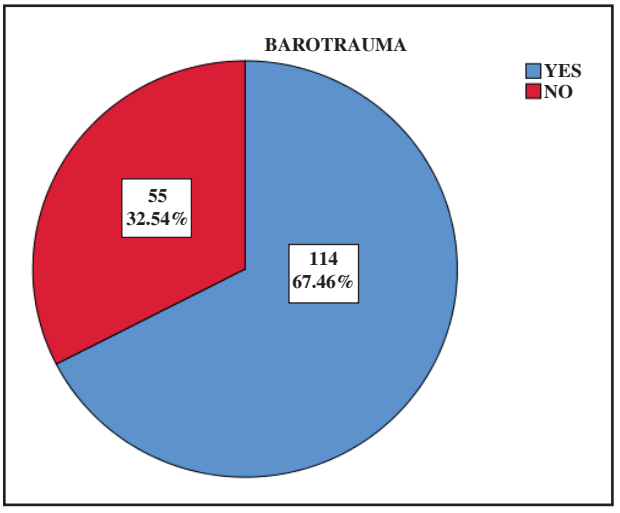

Fig-1: showing that 114 (67.46%) participants were affected by barotrauma. (n=169)

On intergroup comparison, the age of the pilots investigated ranged between 23 to 58 years, with maximum respondents aged between 23-28 years (31.4%, n=169). [Table-I]

TABLE-I: Distribution of study participants according to age group (n=169)

Age Group	Participants	Percent
23-28	53	31.4
28-33	32	18.9
34-38	31	18.3
39-43	20	11.8
44-48	16	9.5
49-53	10	5.9
54-58	7	4.1
Total	169	100.0

Notably, the maximal respondents had flying experience of less than 5 years (31.4%, n=169). [Table-II]

TABLE-II: Distribution of participants according to their flying experience (n=169).

Flying Experience in Year	Participants	Percent
<5	53	31.4
5-10	42	24.9
11-15	35	20.7
16-20	16	9.5
21-25	14	8.3
26-30	2	1.2
>30	7	4.1
Total	169	100.0

A maximum of 38 (22.49%) out of 169 aircrew experienced barotrauma-induced sinusitis. 52 participants had dental pain which is second most common effect and 11.24% participants had barotitis. [Fig-2]

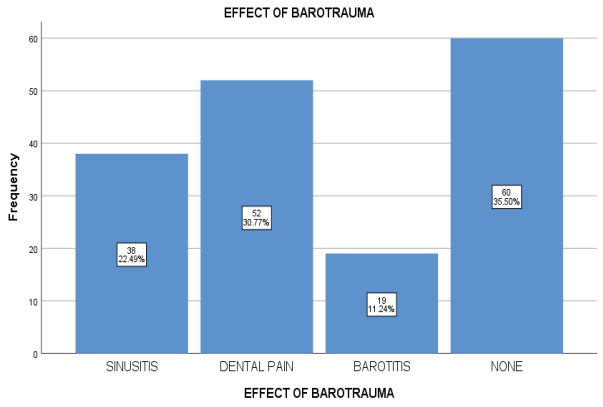

Fig-2: showing effects of barotrauma. (n=169)

Barodontalgia was reported by 52 pilots (30.59%).

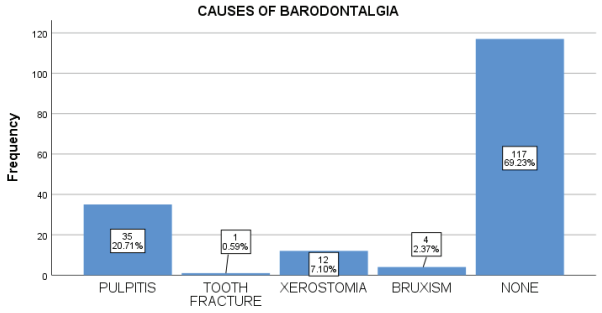

Fig-3: Distribution of participants by causes of barodontalgia. (n=169)

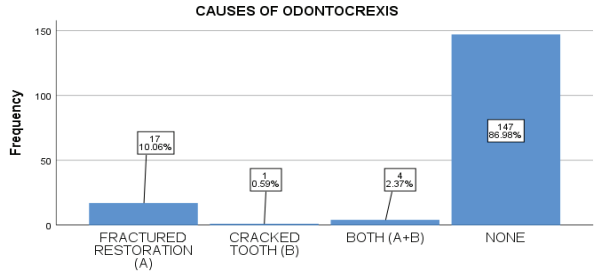

Fig-4: Distribution of participants according to causes of Odontocrexis. (n=169)

According to the study, 22 aircrew (13.02%) were diagnosed with odontocrexis, with the most common cause being fractured restoration (dental filling), affecting 17 individuals (10.06%). [Fig-

Barotrauma can have major effects that come from dental and non-dental causes.

TABLE-III: Table showing effects of barotrauma in dental consideration. (n=169)

EFFECTS WITH DENTAL CONSIDERATION			
		Frequency	Percent
Valid	PROSTHETIC FAILURE	2	1.2
	PERIODONTAL DEFECTS	15	8.9
	TMJ DISORDER	2	1.2
	RESTORATIVE FAILURE	12	7.1
	ENDODONTIC FAILURE	21	12.4
	NON-SPECIFIC EFFECTS	60	35.5
	NONE	57	33.7
	Total	169	100.0

Most people who suffer from barodontalgia reported feeling moderate pain (23 individuals, 13.60%), while 16 participants (09.46%) experienced severe pain. 13 aircrew reported mild pain, and the majority of aircrew (117 individuals, 69.23%) did not experience any pain.

TABLE-IV: Cross tabulation of age group and barotrauma in study participants. (n=169)

		BAROTRAUMA		Total	
		YES	NO		
AGE FOR GROUP	23-28	53	0	53	P=0.000
	28-33	32	0	32	
	34-38	29	2	31	
	39-43	0	20	20	
	44-48	0	16	16	
	49-53	0	10	10	
	54-58	0	7	7	
Total		114	56	169	

Age of aircrew was found significantly associated with barotrauma. (p=0.000) [TABLE-IV]

TABLE-V: Cross tabulation of flying experience and barotrauma in study participants. (n=16)

FLYING EXPERIENCE ACCORDING TO AGE GROUP	BAROTRAUMA		P-value
	Yes	No	
<5	53	0	0.000
5-10	42	0	
11-15	19	16	
16-20	0	16	
21-25	0	14	
26-30	0	2	
>30	0	7	

The flying experience of aircrew showed a significant association with the occurrence of barotrauma. (p=0.000) [TABLE-V]

DISCUSSION

The results of the research align with previous studies on the challenges experienced by pilots at high altitudes.[1,2,8] However, prior research focused more on passengers, civil aviators and aircrew of commercial airlines.[2] There is a lack of extensive research dedicated to studying oral health issues specifically among military aircrew.[3]

The strengths of our study are its sole emphasis on military aircrew, brief duration of symptoms, involving aviators undergoing comparatively high level of physical exertion and participants reported promptly to medical squadron without any negligence. To our knowledge, this is the first detailed review of aviation-related dental issues exclusively among BAF aircrew, addressing oral, facial, dental and non-dental impacts. Further research is proposed to enhance diagnosis, treatment, and prevention through increased awareness.

This study highlights that younger, less experienced aircrew are more susceptible to barotrauma, likely due to limited familiarity with managing high-altitude pressure changes and anatomical factors like more elastic Eustachian tubes. In contrast, experienced aircrew develop effective coping strategies over time. Barotrauma, affecting 67.46% of participants, commonly presents as barodontalgia, barosinusitis, or barotitis with significant implications for both oral health and operational readiness. These findings demand the need to understand barotrauma's mechanisms and impact on flight safety, which will be discussed below.

In our study barotrauma-induced sinusitis was reported by 38 participants (22.49%). Barotrauma often affects the ears and face due to altitude-related pressure changes. Barotitis occurs during descent when pressure differences create a vacuum in the middle ear, causing pain, vertigo, hearing loss, or eardrum rupture.9 Barosinusitis, or sinus squeeze, involves negative pressure in the paranasal sinuses, leading to inflammation and discomfort.[11, 12] This study showed, 11.24% participants had barotitis. Additionally, indirect

barodontalgia or aerosinusitis can trigger tooth pain when pressure affects the ethmoid nerves, potentially causing orbital or peri-orbital headaches.

However, the pain from these conditions can often be mistaken for dental or orofacial pain. This is because the sinuses and ears are located in close proximity to the teeth and jaw, leading to referred pain that can be felt in the mouth and face. Sinusitis can cause pressure and congestion in the sinuses, which can manifest as toothache or discomfort in the jaw. Similarly, barotitis can cause ear pain that radiates to the surrounding areas, giving the sensation of dental pain. It is important for healthcare providers to properly diagnose and treat these conditions to alleviate the pain and discomfort experienced by patients. To combat barotitis and barosinusitis, aircrew should be adopted in pressure-equalizing techniques such as the Valsalva maneuver.

In this study, barodontalgia was reported by 52 pilots (30.59%). It is a symptom and a form of barotrauma. It's a condition where variations in the external environment's barometric pressure can lead to oral pain. This issue may arise because of a tiny space left behind after a tooth has had a filling or a root canal. Dental caries, faulty tooth restorations, pulpitis, pulp necrosis, apical periodontitis, periodontal pockets, impacted teeth, and mucus retention cysts are common oral abnormalities that result in barodontalgia.[13] There are two possible causes for it: either carious activities or dental defects that result in pressure fluctuations within the tooth. It can also occur during ascent, when the pressure in the blood vessels decreases and bubbles begin to form in the pulp. In this study, total 7.10% participants were found having complain of xerostomia. Lack of saliva (xerostomia) may cause heightened oral sensitivity, making individuals more prone to perceiving barometric-related pain. Nerve endings in exposed dentin become more sensitive in xerostomic patients, potentially exacerbating pain during rapid pressure changes.[14] There are four classes in the currently recognized classification of direct barodontalgia based on the pulp/periapical state, position of aircraft and symptoms are shown below.

Class	Pathology	Features	Flight Position
I	Irreversible pulpitis	Sharp, momentary, transient pain	Ascent
II	Reversible pulpitis	Dull, throbbing pain	Ascent
III	Necrotic pulp	Dull, throbbing pain	Descent
IV	Periapical pathology	Severe, persistent pain	Both (Ascent and Descent)

This study found, 22 aircrew (13.02%) were diagnosed with odontocrexis. It has been reported that when exposed to fluctuations in air pressure, teeth with pre-existing leaky restorations or persistent carious lesions beneath restorations explode. This condition is also known as barometric tooth explosion, barodontocrexis or odontocrexis.[15] while suspended or residual carious lesions are unlikely to cause harm in everyday life, they appear to be very mild or symptomatic in an environment with changing pressure. All of the decayed teeth had either developed new cavities during restoration or had low-quality amalgam restorations with an insufficient clearance between the tooth and the amalgam.[16] Odontocrexis can cause intense pain, swallowing fractured teeth, or even aspirating them. One potential preventive approach would be to place cuspal covering crowns. Mesio-occluso-distal restorations were found to be a major predisposing factor to tooth fractures in a study on posterior teeth fractures.[17] mandibular first molar teeth were found to be at risk in this investigation; applying cuspal covering restorations may be viewed as a reasonable preventive intervention.

According to this study, 2 individuals (1.2%) had loosened crown prosthesis. Pressure

variations in the cement layer's microtubules within crowns lead to a decrease in the crown's retention. Microleakage mostly causes the cement layers under the crowns to weaken.[19] When cementing crowns and permanent partial dentures for patients—like divers—who are likely to be subjected to pressure cycling, dentists ought to think about using resin cement.[20]

In our study, 15 individuals (8.9%) were found having unhealthy periodontal health. A drop in oxygen levels during high-altitude flights can be harmful to teeth, fillings, gums, and the mouth. One typical grievance is xerostomia. The risk of periodontal disorders is higher when salivary content decreases.[21]

This study discovered that 12 participants (7.1%) experienced restoration defects. As pure oxygen contains a higher percentage of oxygen than other gases, it can lead to deterioration of dental amalgam restorations.[22] Differential thermal contraction between amalgam materials and tooth hard tissue is observed in low-temperature, high-altitude environments. Another contributing factor to the dislodging of dental restorations was excessive occlusal pressures. One of the causes of restorative failure was clenching or grinding of the teeth.[23]

This study found 21(12.4%) aircrew who need endodontic treatment. Root canal infections can cause subcutaneous emphysema and intracanal infected substance leaking into the peri radicular tissues if they are not treated.

In this study, 2 (1.2%) aircrew were having TMJ pain. TMJ disorders are complex conditions characterized by stress from adverse environments and irregular sleep patterns. Abnormalities in the control of cortisol and melatonin secretion are associated with TMDs. These events are probably explained by the stress hormone system being more activated due to conscious pain awareness. Condition that may cause irreversible damage to the temporomandibular joint is bruxism, which is defined as excessive jaw clenching or teeth grinding.[23] Studies have shown that there is no doubt that bruxism is more common in pilots than in non-pilots.[20,22,23]

It is important to rule out the possibility of an oroantral connection before extracting an upper posterior tooth. If it is affected, it may cause sinusitis and become harmful if subjected to pressure.[24] Such condition was not found in our study.

Preventing barotrauma, including barotitis, barosinusitis, odontocrexis and barodontalgia requires medical, dental, and operational strategies. Regular ENT and dental check-ups can identify issues like blocked sinuses, caries, or faulty restorations. Aircrews should be trained in pressure-equalizing techniques, such as the Valsalva maneuver and recommended to use nasal decongestants or antihistamines for sinus congestion before flight according to advice of flight surgeon.1 Prior to flights, it is essential to treat dental issues such cavities, leaking restorations, and pulp inflammation. High-quality restorative materials and cuspal covering crowns may help to avoid complications.[15] Temporary restorations during multi-visit treatments must be secured and cases of oroantral communication should be referred to oral surgeon. Aircrews should maintain good oral and sinus health, avoid flying with infections or unresolved dental issues, and use chewing gum or candies to prevent dry mouth. Targeted training for less experienced aircrews can enhance readiness and reduce altitude-related hazards.

CONCLUSION

Oral health is crucial for aviators' operational fitness, as lower air pressure and density at high

altitudes can compromise it. When treating aircrew, special care is needed for surgical, endodontic, prosthodontic, or restorative procedures along with ruling out non-dental originated orofacial pain. Integrating dental health to the physical requirements for flying is important for keeping flights safe.

In this study, distribution by gender was disproportionate as female aircrew were not sufficient comparing to male aircrew. Further study with more female participants can be performed in future to get many more information regarding orofacial and dental problems in high altitude.

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