

Prevalence of Barodontalgia among pilots and divers in Saudi Arabia and Kuwait

Wadha Al-Hajri,* BDS

Ebtissam Al-Madi,** BDS, MSc

الألم السني الطيراني هو الألم السني المرافق لتغيرات الضغط الجوي. ويعتبر شائعاً عند الطيارين والغواصين الذين يتعرضون لتغيرات الضغط أثناء عملهم. تهدف هذه الدراسة إلى قياس معدل حدوث الألم السني المرافق لتغيرات الضغط الجوي عند الطيارين الحربيين للطائرات الحربية والغواصين العاملين في القاعدة البحرية ومدارس الغوص في المملكة العربية السعودية والكويت. تم توزيع حوالي ٣٥٠ استبيان على الطيارين والغواصين. شملت الأسئلة معلومات شخصيه وأسئلة لتحديد حدوث الألم السني خلال الطيران أو الغوص. بلغت نسبة الأجابه ٧٢,٨% في المملكة العربية السعودية و ٨٠% في الكويت. نسبة حدوث الألم على الأقل في فترة واحدة خلال الممارسة بلغت ٣٣,٦% و أعلن عدد أكبر من الطيارين (٤٩,٦%) حدوث الألم مقارنة بما أعلن عنه الغواصين (١٧,٣%). نسبة حدوث الألم عند الأقالع بالنسبة للطيارين ٣٠,٤% و عند الهبوط ١٩,٣% أما الغواصين فكانت النسبة أعلى عند الغوص ١٣,٩% مقارنة بالعودة للسطح ٣,٦%. أرتفعت نسبة حدوث الألم عند الطيارين مع زيادة الارتفاع ما بين ١١,٠٠٠-٢٠,٠٠٠ قدم (٣٣٠٠-٦٠٠٠ م) أما بالنسبة للغواصين فكان نسبة حدوث الألم أكبر عند زيادة العمق ٦٠-٨٠ قدم (١٨-٢٤) م. نسبة حدوث النكس في الألم بعد المعالجة ١٦,٤% بالنسبة للطيارين و ٢٥% بالنسبة للغواصين أثناء الممارسة. يمكن الاستنتاج بأن الألم السني المرافق لتغيرات الضغط الجوي يعتبر شائعاً في مجتمعنا, ونسبة حدوثه مرتفعة (٣٣,٦%) بشكل عام. ونسبة حدوث الألم عند الطيارين أعلى منها عند الغواصين. كما أنه أكثر شيوعاً أثناء الصعود أثناء الطيران و أثناء النزول عند الغوص. أما بالنسبة لنكس الألم بعد المعالجة فكانت قليلة.

Barodontalgia is defined as tooth pain occurring with changes in pressure environment. It commonly affects pilots and divers, as they are frequently subjected to barometric pressure changes during their work. **AIM:** To measure the prevalence of barodontalgia among pilots flying non-commercial war planes and divers practicing in air bases, naval bases and diving schools in Saudi Arabia and Kuwait. **MATERIAL AND METHODS:** Three-hundred and fifty questionnaires consisting of demographic data and questions about the occurrence of tooth pain during flying or diving were distributed among pilots and divers. **RESULTS:** There was a response rate of 72.8% in Saudi Arabia and 80% in Kuwait. Almost thirty-four percent of the sample experienced barodontalgia at one point in time during their practice. More pilots had an occurrence of pain while flying (49.6%) than did divers while diving (17.3%). Pilots had higher incidence of pain while ascending (30.4%) than descending (19.3%), while divers had higher incidence of pain while diving (13.9%) than resurfacing to sea level (3.6%). The highest percentage of tooth pain occurred in pilots while flying at an altitude that ranged from 11,000 - 20,000 ft (3300 - 6000 m) and with divers while diving with a depth that ranged from 60 - 80 ft (18 - 24 m). Recurrence of tooth pain after treatment occurred in 16.4% of pilots and 25.0% of divers during their practice. **CONCLUSIONS:** Barodontalgia is common in Saudi Arabia and Kuwait with a prevalence rate as high as 33.6%. Pilots reported high occurrence than divers. It was common on ascent while flying and descent while diving. Recurrence of pain after treatment was not frequent.

INTRODUCTION

Subjects exposed to a sudden reduction or increase of ambient pressure sometimes complain of toothaches.¹ This problem was first reported in pilots and was called aerodontalgia.² More recently, dental pain has also been reported during diving³ and the more general term barodontalgia was introduced to include both conditions, whether produced by an increase or

decrease in barometric pressure.^{4,5} Barodontalgia is essentially dental pain provoked by atmospheric pressure changes which usually disappear when the affected person reaches normal pressure zone again.⁶

During the 1940s, large numbers of military pilots were subjected to major barometric changes in unpressurized air craft. In some cases the variations in atmospheric pressure experienced in flight caused severe dental pain. Incapacitation due to this pain was a serious problem and stimulated research into barodontalgia.⁷

The incidence of barodontalgia in aircrew has been reported to vary from 0.26% to 8%.^{1,2,6,8,9} The US Army air force reported a 1.63% prevalence of

Received 3 October 2005; Revised 21 May 2006

Accepted 12 June 2006

*Intern

College of Dentistry, King Saud University
P.O.Box 495, Dhahran Airport 31932, KSA
alhajri20055@hotmail.com

**Assistant Professor

Department of Restorative Dental Sciences
College of Dentistry, King Saud University
ealmadi@yahoo.com

barodontalgia among 12,000 subjects undergoing decompression tests after World War II,¹⁰ while Harvey, in 1947, identified only 0.8% incidence of toothaches in a sample of 5,711 persons taking decompression tests.⁹ Barodontalgia has been known to occur across a broad range of altitudes during flying, having been reported at altitudes as low as 5000 feet and as high as 35000 feet but is more common between 9000 and 27000 feet.⁶ Barodontalgia is more common on ascent,⁶ and it was shown that the onset of pain occurred at altitudes ranging from 5,000 to 15,000 ft.⁴ Barodontalgia is not limited to any particular age group.⁶

The causes of barodontalgia have been investigated for many years. In general, barodontalgia is a condition intimately related to pre-existing dental pathology.⁶ Several factors have been speculated to make teeth susceptible to barodontalgia such as inability of gases within the tooth to expand to adjust internal pressure when exposed to external pressures by diving or flying,¹¹ circulatory disturbances in an abnormal pulp,⁷ nearness of caries to the pulpal tissue,⁴ dilation of pulpal vessels during decreases in pressure, and pulpal hyperemia.⁴ Precipitating factors that contribute to barodontalgia include inadequately filled root canals, chronic pulpitis resulting from insufficient base materials, untreated caries, and periapical abscesses in which gas had been generated.⁴ Referred pain from unerupted or partially erupted third molars, new and recurrent caries or restorations, intra-treatment endodontic symptoms, dental and periodontal cysts, abscesses or "cracked tooth" and from aerotitis media may complicate the diagnosis of barodontalgia.¹²

The diagnosis of barodontalgia should be considered if a patient complains of dental pain during diving or flying.¹³ A complete and thorough dental

history and examination should be performed. A hypobaric chamber is an ideal environment that may be used for reproducing the conditions of barometric pressure and hypoxia that flight personnel have to withstand at different altitudes, and their effects.¹⁴ If dental examination fails to identify the problem then an examination by a physician would be appropriate to examine the sinuses or even to evaluate the potential that the pain was referred from the heart.¹³

Treatment of barodontalgia is similar to therapy rendered for pain of dental origin at ground level. Prevention of barodontalgia is based on maintenance of higher standards in preventive and restorative dentistry.⁶

No information regarding barodontalgia in the Gulf region have been reported to date. The aim of the present study was to measure the prevalence of barodontalgia among pilots and divers in selected bases and centers in Saudi Arabia and Kuwait.

MATERIAL AND METHODS

The study population consisted of pilots and divers working in selected centers in Saudi Arabia and Kuwait. The group of pilots targeted were those flying non-commercial war planes, practicing in King AbdulAziz Air Base (KAAB) in Dhahran, King Khaled Air Base (KKAB) in Khamis Mishaet, Saudi Arabia and Hammad Al-Jabir Air Base in Kuwait. The divers targeted in this study were those practicing in King Abdulaziz Naval Base (KANB) in Jubail and the Al-Sharq Diving School in Al-Khobar, Saudi Arabia and the Kuwait Diving School in Kuwait.

A questionnaire was developed in English and Arabic and distributed among all pilots and divers present during the research period between November 2004 to April 2005. The survey contained inquiries about age, type of practice (pilot or diver or both) and years of experience.

Questions about the occurrence of tooth pain during flight or diving were presented as well as inquiries regarding whether the pain was during ascending or descending (pilots), diving or resurfacing to sea level (divers), the altitude or depth at which the pain occurred, whether they had visited a dentist to treat the pain or not, what the dentist diagnosed the pain as, what kind of treatment was rendered at the dental office, and if they had any recurrence of the pain after treatment. The questionnaire was designed in Arabic and a pre-test questionnaire was done on 20 subjects. A translation of the questionnaire was devised to be presented to non-arabic speaking divers.

A total of 350 questionnaires each were distributed, with 50 questionnaires to KAAB, KKAB, KANB, and Hammad Al-Jabir Air Base and the Kuwait Diving School in Kuwait, and 100 questionnaires to Al-Sharq Diving School in Al-Khobar.

The collected data were analyzed using the Statistical Package for Social Science (SPSS) program version 10. Descriptive statistics were performed and Chi-square test was used to determine the relationship of pain among pilots and divers.

RESULTS

Two hundred and sixty-two subjects responded from both Saudi Arabia and Kuwait. The response rate was 72.8% (182) in Saudi Arabia and 80% (80) in Kuwait. The distribution of pilots and divers is shown in Table 1. The age of the pilots and divers ranged between 25 and 36 years with the mean age of 33 years. About 42.9% of the respondents were under thirty years of age. Distribution regarding years of experience showed that 39.3% had 7-12 years of experience, while 36.3% had only 1-6 years of practice, and 24.2% had more than 13 years of practice.

Table 1. Distribution pilots and divers

Place of employment	Number of pilots and divers included in study	Percent%
K.A.A.B * & K.K.A.B**	101	38.4%
K.A.N.B***	13	5.0%
Diving School in Al-Khobar	68	26.0%
Hammad Al-Jabir Air Base in Kuwait	34	13.0%
Diving School in Kuwait	46	17.6%
Total	262	100%

*King Abdulaziz Air Base in Dhahran, Eastern Province, Saudi Arabia

**King Khaled Air Base in Khamis Moshayet, Southern Province, Saudi Arabia

***King Abdulaziz Naval Base in Jubail, Eastern Province, Saudi Arabia

This study showed that 33.6 % of the sample had incidence of barodontalgia at least at one point in time during their activities. Significantly more pilots had an occurrence of pain while flying (49.6%) than did divers while diving (17.3%) ($P < 0.0001$). For individuals that were both pilots and dived (10) as a hobby, the prevalence rose to 40.0 %.

Most of the participants (21.4%) indicated that they had experienced pain while flying and diving several years previously, while 7.3% indicated that they had pain one year previously and only 5% indicated they felt pain while flying and diving several months previously.

Pilots had a higher incidence of pain while ascending (31.2%) than descending (19.2%), while divers had a higher incidence of pain while diving (13.4%) than when resurfacing to sea level (3.9%).

The highest percentage of tooth pain with pilots was while flying with an altitude that ranged from 11.000 - 20.000 ft (33000 – 6000 m) and with divers while diving at a depth that ranged from 60 - 80 ft (18 – 24 m) as illustrated in Table 2.

A total of 81.8% of pilots and divers visited their dentists after they had tooth pain. The diagnosis that was rendered by

Table 2. The incidence of occurrence of barodontalgia versus altitude and depth

Altitudes	No. of pilots	%	Depth	No of divers	%
Below 10,000 ft (3000 m)	25	18.5%	60-80 ft (18-24 m)	95	74.8%
11,000-20,000 ft (3300-6000 m)	44	32.5%	81-100 ft (24-30 m)	16	12.6%
21,000-30,000 ft (6300-9000 m)	37	27.4%	101-120 ft (30-36 m)	5	3.9%
31,000-40,000 ft (9300-12000 m)	29	21.5%	121-130 ft (36-39 m)	11	8.6%
Total	135	100%	Total	127	100%

their dentists is shown in Figure 1. The types of treatment provided are shown in Figure 2. Restorative treatment was provided significantly more than any other treatment ($P<0.0001$), as was root canal therapy ($P=0.007$). Recurrence of tooth pain after treatment occurred in 16.4% in pilots and 25.0% in divers during their practice.

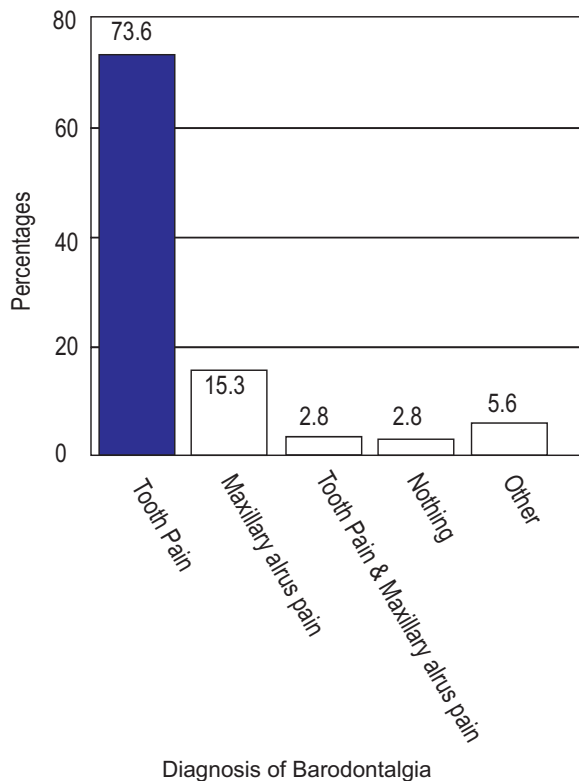


Fig. 1. The percentage of the various etiological factors of barodontalgia

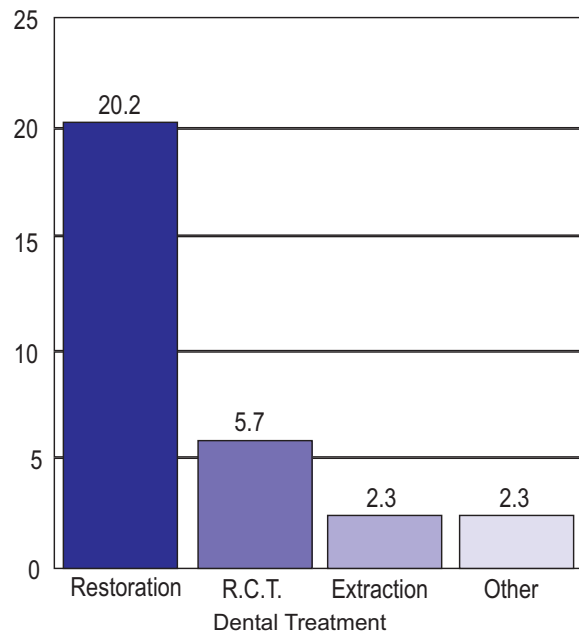


Fig. 2. Percentage of dental treatment rendered (does not add up to 100% as not all subjects had treatment or they may have had more than one treatment).

DISCUSSION

This study was conducted to measure the incidence of barodontalgia among pilots and divers in Saudi Arabia and Kuwait. The study design depended on questionnaires distributed to the target population inquiring about incidence, nature of the incident and the treatment rendered, as this was a pioneer study in this field in the area, and preliminary data was required about the incidence of this phenomenon before more elaborate studies can be designed.

The data showed that there was a high incidence of barodontalgia (49.6%) among pilots. This rate was higher than that reported by Surgeon General Australian Defence Force, Health Policy Directive No. 411 (SGADF-HPD411),⁶ Hodges⁴ and Gonzalez-Santiago et al.¹⁴ This difference in rate may be related to difference in study design and different societies. Although all flight personnel are initially examined and treated dentally before flying, poor oral hygiene, maintenance

and recall may be factors that significantly increased prevalence of barodontalgia during subsequent flights. An in-depth investigation of the factors leading to the high significance of barodontalgia is required.

There was no correlation between either the age of the pilots or divers and their age. Similar results were reported by SGADF-HPD411.⁶

Higher prevalence of barodontalgia was reported among pilots (49.6%) than among divers (17.3%). This could be due to higher pressure changes that pilots are exposed to during flying than divers are during diving. The prevalence among pilots was more common with an altitude that ranged from 11,000 - 20,000 feet. Similar results were reported by Kollman,¹ Hodges,⁴ and the SGADF-HPD411.⁶

Not surprisingly, the prevalence among pilots was common on ascent in the study. Similar finding had been reported in SGADF-HPD411.⁶ Furthermore, it had been suggested that pain on ascent was associated with an inflamed tooth, while pain on descent was associated with a necrotic tooth.¹⁵ This seemed logical in this population as they had undoubtedly been dentally examined at some point before flying and it was unlikely that dental decay could progress to lead to necrosis in a short period of time.

The pain was mostly diagnosed as tooth pain (73.6%). This is in contrast to Kollman, who found the most common pain was earache (2.27%) followed by pain from teeth and from the paranasal sinuses at 0.26% and 0.18%, respectively.¹ This difference could be attributed to the fact that many centers internationally have flight surgeons as the primary health personnel performing the diagnosis, whereas in this study all pilots and divers reported to a dentist who was expected to be more adept at diagnosing dental pain.

Most of the pilots and divers included in our study had restorative treatment done after reporting to the dental office. It may be that their complaint was an obvious one that could have been apparent on ground level and not present a diagnostic difficulty. If this were the case, proper diagnosis and treatment could have prevented the problem in the first place.

In this study, recurrence of pain after treatment was reported by a relatively smaller groups of pilots and divers at 16.4% and 25% respectively, which indicated that proper diagnosis was done. For the cases in which there was recurrence, the causes might be non-odontogenic pain or another offending tooth than was treated. Many cases of recurrence need further investigations that may involve leaking restorations and periapical pathology which were beyond the scope of our study.

In this study, no clinical examination was conducted. Correlation of the information obtained from the questionnaires with clinical findings obtained from examination could provide more specific results in term of incidence and causes of barodontalgia.

Our sample was a convenient one targeting pilots flying non-commercial war planes. No attempt was made to specify the type of planes as this was considered classified information and this could limit any attempt to generalize pilots flying different kind of war planes. Also all types of divers were considered in this study, and no attempt was made to specify which kind of diving equipment was used. The safety of aircrew and diving personnel can be comprised by barodontalgia as the intensity of pain is often such that effective performance is not possible.⁶ Distractions during critical flights or dives, or abortion of important missions can occur as a result of pain during a flight or dive.

CONCLUSION

Prevalence of barodontalgia was higher (33.6%) in Saudi Arabia and Kuwait. Pilots reported higher incidence than divers. It was common on ascent while flying and descent while diving. Recurrence of pain after treatment was uncommon.

RECOMMENDATIONS

The prevalence of barodontalgia was higher in Saudi Arabia and Kuwait when compared to reports from other countries. It is a phenomenon that should not be dismissed as unimportant, as it can pose a serious safety risk to divers, submariners, pilots and airline passengers.¹¹ Federation Dentaire Internationale (FDI) recommends an annual check-up for divers, submariners and pilots, with oral hygiene instructions from dentists familiar with their dental requirements.¹¹ It is therefore recommended that dental services in clinics servicing pilots and divers (air and naval bases) in Saudi Arabia and Kuwait should be organized to provide regular check-ups, treatment and oral hygiene education for this population. Also, based on the results of this study and within its limitations, it is recommended that more studies specific to air flight and diving centres be performed to realize the full extent of the problem, the factors affecting the incidence, preventive measures in the form of increased awareness among pilots and divers to the importance of therapy and maintenance, differential diagnosis and methods of diagnosis and treatment.

ACKNOWLEDGMENTS

The authors would like to express their thanks to all those who participated in this study and their families for their help and support, and to Dr. Nazeer Khan for his assistance in the statistical analysis. Sincere thanks and appreciation is

given to (Retired) Major Birjes Al-Otobi from K.A.A.B in Dhahran, Dr. Abdullah Al-Hajri, the former Minister of Kuwait and General Yossef Al-Dhwayan, the Kuwait Air Force Commander, for their great cooperation in facilitating the questionnaires distribution among the pilots and divers.

REFERENCES

1. Kollmann W. Incidence and possible causes of dental pain during simulated high altitude flight. *J Endod* 1993; 19(3): 154-159.
2. DeVoe K, Motley HL. Aerodontalgia. *Dent Dig* 1945; 51:16-18.
3. Shiller WR. Aerodontalgia under hyperbaric conditions. An analysis of forty-five case histories. *Oral Surg Oral Med Oral Pathol* 1965; 20:694-697.
4. Hodges FR. Barodontalgia at 12,000 feet. *J Am Dent Assoc* 1978; 97(1):66-68.
5. Rauch JW. Barodontalgia - Dental pain related to ambient pressure change. *Gen Dent* 1985;313-315.
6. Surgeon General Australian Defense Force (SGADF) Health Policy Directive No 411. Aviation and Diving - Dental Considerations. 20 April 1995. p. 5 (electronic version) retrieved Sept 10th 2005 from <http://www.defense.gov.au/dpe/dhs/infocentre/publications/directives/HPD411.pdf>
7. Senia E.S, Cunningham KW, Marx RE. The diagnosis dilemma of barodontalgia. Report of two cases. *Oral Surg Oral Med Oral Pathol* 1985; 60(2):212-217.
8. Orban B, Ritchey BT. Toothache under conditions simulating high altitude flight. *J Am Dent Assoc* 1945; 32:145-180.
9. Harvey W. Dental pain while flying or during decompression tests. *Br Dent J* 1947; 82:113.
10. Bureau of Medicine and Surgery News Letter, Vol 6, No. 1, 1946.
11. Robichaud R, McNally ME. Barodontalgia as a differential diagnosis: Symptoms and findings. *J Can Dent Assoc* 2005; 71(1): 39-42.

12. The Online Journal of Dentistry and Oral Medicine. www.epub.org.br/ojdom/vol04n04.htm
13. Stein, LA. (electronic version) The rarest barotrauma. *Alert Diver* 1993; Sept/Oct
14. Gonzalez-Santiago MM, Martinez-Sahuquillo-Marquez A, Bullon-Fernandez P. Incidence of barodontalgias and their relation to oral/dental condition in personnel with responsibility in military flight. *Med Oral* 2004; 9:92-105.
15. O'Brien DM. (ed) Flight Surgeon's Guide. 1995 ed. In: Ch.12 Aerospace Dentistry- Odontalgia- Barodontalgia. USAF School of Aerospace Medicine retrieved Sept 10th 2005 from: http://wwwsam.brooks.af.mil/af/files/fsguide/html/Chapter_12.html#Odontalgia