

## The Prevalence of Periodontal Pain Associated with Scuba Diving: A Questionnaire Study

### Research article

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### Abstract

**Aim:** The aim of the study was to evaluate the relationship between dental problems such as, periodontal pain, and scuba diving.

**Material and method:** A questionnaire study was conducted using a cross-sectional self-administered questionnaire in five dive centres in Kuwait. The questionnaire consisted of 31 (multiple-choice and open ended) questions in three sections, 1) covering the demographic data, diving experience, dental and periodontal profiles of the scuba divers; 2) the response of the diver regarding his or her visits to the dentist, 3) the type of the pain experienced during the dive and whether it was a shooting pain, tooth sensitivity, pulsating pain, dull ache, throbbing, or pressure pain. One final question related to the diver's response regarding visiting the dentist after a dental problem and the treatment provided. Data were entered and analyzed using SPSS, software v. 22 (IBM UK, Guildford).

**Results:** 170 questionnaires were handed out, 20 were not returned (88.2% response rate). 150 divers completed the questionnaire (104 Male [69.3%], 46 Female [30.7%], mean age  $32.3 \pm 7.2$  years) were included for analysis. Nine subjects (6.3%) experienced 'gum problems' with shooting pain ( $n = 4$ ) and tooth sensitivity ( $n = 3$ ) being the most common problems (Fig. 1). Pain symptoms were not, however dependent on age, gender, or the frequency of diving. Toothache was more prevalent in divers  $\leq 30$  years of age ( $n = 136$ ) (16.2%) with other types of pain e.g., headache (49%), sinus pain (32.2%), jaw pain (22.1%) also reported (Fig. 2).

**Conclusions:** Periodontal pain was an uncommon complication during diving, toothache was more prevalent in divers  $\leq 30$  years of age (16.2%). The other dental problems experienced by divers were headache (49%), sinus pain (32.2%), jaw pain (22.1%) and toothache (16.2%).

### Introduction

Diving has developed throughout the ages and SCUBA (Self-Contained Underwater Breathing Apparatus) diving is directly associated with the general health of the diver and dental problems, where the diver breaths in compressed gasses, or the effects of the surrounding pressure on the diver. During World War II, tooth pain experienced by

aircrews in flight was given the name aerodontalgia, namely pain related to flights and altitude [1-2]. However, this tooth-related pain was also observed in both aviators and divers and has been defined as barodontalgia [2,3-7]. Currently diving is a popular recreational sport and scuba diving has been directly associated with dental problems [8-13]. The effect of scuba diving on the hard and soft tissues of the oral cavity for example tooth pain, and

gum problems (Periodontal pain) has, however not been extensively documented in the literature and there appears to be limited data on the prevalence of gum problems (Periodontal pain). This paper attempts to understand the impact on scuba diving on the hard and soft tissues and create an awareness of the importance of divers being 'dentally fit' before diving.

## Material and Methods

### Aim

The aim of the project was to evaluate the effects of scuba diving on the oral cavity e.g., the effects on both hard and soft tissues, notably the effects on the soft tissues around the tooth (periodontium).

### Materials & Methods

The aim of the present study is to perform a cross-sectional self-administered questionnaire:

- 1) Primary aim: To evaluate the relation between (gum) periodontal pain and scuba diving
- 2) Secondary aim: To evaluate whether other dental problems are associated with pain during scuba diving

### Study Design

#### Inclusion criteria

Any diver who has certified open water training and above

#### Exclusion criteria

Divers aged <16 years

#### Null hypothesis

There is no relation between gum (periodontal) pain and scuba diving.

### Questionnaire Design

The questionnaire was designed to achieve the objectives in this study, which were: 1) the relation between gum (periodontal) pain and scuba diving; 2) any dental problems related to scuba diving. The questionnaire survey was conducted in English. For divers who did not speak or understand English, the questionnaire was translated into the Arabic language and retranslated back to English to maintain the accuracy of the translation of the questionnaire. The translation was done in collaboration with one of the staff members in the English department in Kuwait University. The questionnaire consisted of 31

questions on six pages. The questions were both multiple-choice and open-ended. The questionnaire was divided into three sections. Some questions were based on a previous study conducted by Jagger *et al.* [11] as well as several questions developed HS who is an experienced scuba diver to meet the aims of this study. The main outcome measures were the prevalence of orofacial pain and odontocrexis.

### 1. First section (prior to diving)

Questions 1 to 15 asked about the demographic data, diving experience, and the dental and periodontal profiles of the subjects.

### 2. Second section (during diving)

Questions 16 to 30 asked about the dental problems related with scuba diving; moreover, the divers were asked to indicate any dental problems, such as gum problems during diving. The divers indicate 1 = yes or 2 = no. If the diver reported pain, the following question asked about the type of pain experienced: A-Shooting; B-Tooth sensitivity; C-Pulsating pain; D-Dull ache; E-Throbbing; F-Pressure pain. Moreover, if dental pain is same as the periodontal pain, the diver should answer by yes or no or I do not know and if the diver indicates any pain, then the following question should be asked: "What type of pain did you experience?" (A-Sharp momentary pain on ascent; B-Dull throbbing pain on ascent; C-Dull throbbing pain on descent; D-Severe persistent pain on ascent and descent; F- Other; E-Not sure), filling fractures or dislodgment, crown dislodgment, headache, sinus pain, joint pain and dental problems when inserting the mouthpiece. All these questions were asked in Part Two of the questionnaire.

### 3. Third section (after diving)

The last question (31) was designed to evaluate the response of the diver regarding visiting the dentist after any dental problem and the kind of treatment given after indicating any problem related to scuba diving.

### Ethical Approval

After finalizing the questionnaire design, ethical approval was obtained from Queen Mary University of London. The questionnaire did not present any ethical concerns and was considered extremely low risk. Thus, it did not require the scrutiny of the full Research Ethics Committee (Reference QMERC1455a). Moreover, all questionnaires were anonymous, and all information was confidential.

## Pilot Phase

The questionnaire survey was conducted using cross-sectional self-administration. The questionnaires were distributed in one dive centre in Kuwait. Thirty divers in a period of three weeks helped with the final layout of the questionnaire by HS. All the divers fully understood all the questions, and the questionnaire was completed in 5-8 minutes

## Main Study

The self-administered questionnaires were distributed by HS to 170 divers at five dive centers in Kuwait in a period of six weeks from the 15<sup>th</sup> of July to the 30<sup>th</sup> of August. All respondents in the study population received the same questionnaire, either in English or in the Arabic version. Some questionnaires were kept in the dive centre for later completion. These were collected upon request one day or more to avoid any bias in completing the survey.

## Methodology: statistical analysis

The data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 22 (IBM UK, Guildford). Quantitative variables were described by mean, standard deviation, range and median. For categorical data, relative frequencies were used. Simple and crossed tables by gender, age group and number of dives per year were obtained. Missing data were coded as missing values and were not included in the analysis. A Chi square test was used as the association test between two categorical variables, such as comparing the prevalence of a specific symptom between groups. Moreover, the Kruskal-Wallis test was used to evaluate the homogeneity of the distributions of a variable, at least ordinal, through more than two groups of a categorical variable. The Significance level used in analysis was 5% ( $\alpha = 0.05$ ). The results of the Chi square test reached a statistical power of 0.83, at a 95% confidence level, in detecting significantly different proportions of 0.10–0.30 for a symptom between the two groups. A self-administered questionnaire with 31 questions was designed to investigate the effects of dental problems during the diving experience. The questionnaire had three sections namely 1) the demographic data, diving experience, dental and periodontal profiles of the scuba divers which had to be completed before diving, 2) a second section which was completed after diving and 3) the evaluation of the response of the diver regarding his or her visits to the dentist. For example, questions relating to

any dental problems related to scuba diving such as gum problems, dental pain (type and frequency) and whether the diver visited a dentist following a dental problem during the diving experience and the type of treatment provided. A pilot study was conducted (n=30) among Kuwaiti scuba divers in order to see if there were any problems in understanding the questions. The questionnaire was provided in both English and Arabic to enable the divers at the diving centres to be able to complete the project. Prior to the study the original questionnaire was translated into Arabic and translated back into English by an English-speaking Arabic speaker to validate the questionnaire.

## Results

### Overview

140 questionnaires were handed out to the scuba divers at the various centres, 20 questionnaires were not returned or were excluded from analysis due to age exclusion (n=2). The data from both the pilot and main studies were used for the final analysis (n=150) which included 104 Male (69.3%) and 46 Female (30.7%) scuba divers, aged  $32.3 \pm 7.2$  years (age range from 17 to 53 years). Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 22 (IBM UK, Guildford) and descriptive analysis including frequency distribution in the form of tables and figures.

Statistical analysis revealed that the periodontal pain is a very rare phenomenon. Nine subjects (6.3%) with 95% CI (2.3%–10.4%) Shooting pain (n = 4) and tooth sensitivity (n = 3) were the most common problems. These problems do not have any dependency on age, gender, or the frequency of diving. Toothache was more prevalent in divers younger than 30 years of age (n=136)(16.2%). The other prevalence of pain was high: headache (49%), sinus pain (32.2%), jaw pain (22.1%).

### Expertise of the Divers in the study (Q4)

The expertise in diving among the subjects was diverse:

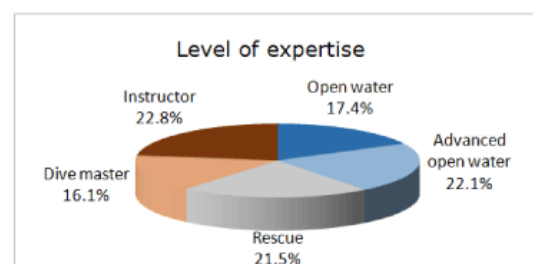


Figure 1: Level of diving expertise.

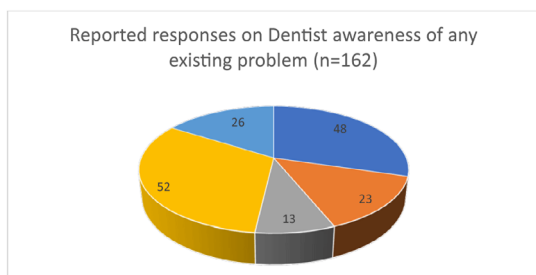


Figure 2: Dental problems reported by your dentist.

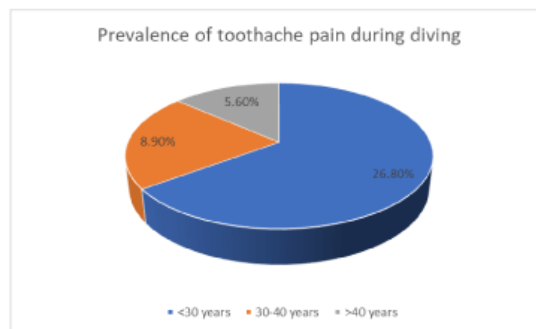


Figure 5: Prevalence of toothache age pain during diving (n=22).

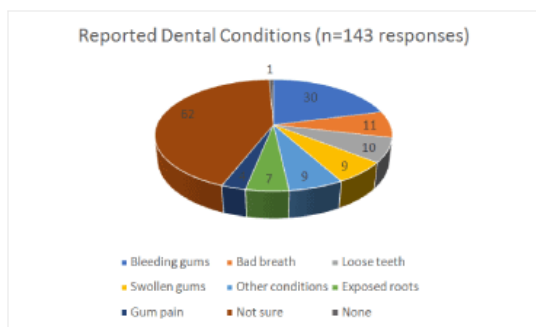


Figure 3: Participant reported dental conditions (n=143)..

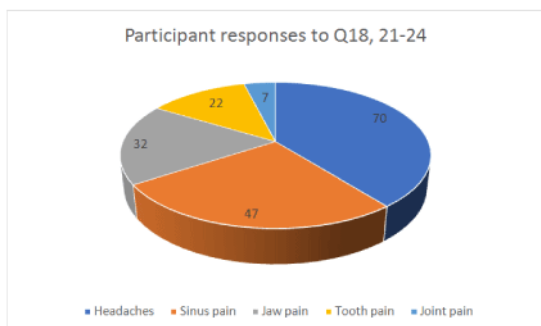


Figure 4: Type of pain experience during or after diving.

22.8% were instructors and 16.1% were dive masters. Both levels are professional. At the recreational level, 22.1% were advanced open water divers, 21.5% were rescue divers, and 17.4% were open water divers (Figure 1)

**Frequency of dives per year (Q5), dives completed in the last 10 years (Q6) and the breathing gas used during the dives (Q7)**

Most of the divers had carried out less than 50 dives (44.3%) or between 51 and 100 dives (35.6%) per year. They had cumulated an average of 200 dives in the last 10 years, but half the sample had less than 100 (median) dives in the previous decade. They mainly used compressed air (61.3%), air mixed with nitrox (20.7%) or nitrox alone (13.3%).

**Do you have a dentist (Q8) and were you informed by your Dentist of any dental problems such dental decay or gum problems (Q9).**

56% of the subjects (n = 84) indicated having a dentist and 43.6% (n = 65) reported that they did not have a dentist. The most common problems reported by their dentist were dental decay (33.1%, n=48), gum problems (15.9%, n=23), other conditions (9%, n=13), no non-dental problems were reported. 35.9% (n=52) of the participants indicated that they had not reported any problems to their dentist with 17.9% (n=26) indicating they were unsure of any dental problems (Figure 2).

**If your dentist recommended that you have any dental treatment, was an appointment made to complete the treatment before you went diving? (Q10)**

37.5% (n = 62) of the respondents indicated that an appointment was made for dental treatment with 43.1% (n = 54) indicating that no appointment was made before diving. 6.5% (n=10) stated that they made an appointment but were unsure whether this was before or after a dive. 6.3% (n=9) indicated that they made an appointment after a dive with 6.3% (n=9) unsure whether an appointment was made for treatment.

**Frequency of visits to a Dentist (annual/biannual) (Q11)**

The most usual responses were every six months: 35.6% (n = 53); and 33.5% (n = 50) every 12 months. One respondent never visited their dentist (0.7% [n=1]).

**Do you wear a denture (Q12) and do you dive with your denture in the mouth (Q13)**

130 divers (94.2%) reported that they did not have or wear any dentures, of those divers who wore dentures (n=8) only five divers answered that they did (3.6%) with three (2.2%) stated that they sometimes wore their

denture. The upper denture was the most usual denture worn (57.1%, n=4). The subjects usually wore their dentures while diving (71.4%, n=5).

#### **Do you have any of the following dental conditions? (Q14)**

When asked if they had any dental problems 145 divers responded to this question: 48.3% (n = 70) reported no dental problems and 45.5% (n = 66) responded with 'Yes they had dental problems'. Further responses to this question indicated that 47% (n=62) were unsure if they had any dental problems, 22.7% (n=30) indicated that they had bleeding gums, 8.3% (n=11) experienced bad breath, 7.6% (n=10) had loose teeth, 6.8% (n=9) had swollen gums, 6.8% (n=9) claimed to have other dental conditions, 3% (n=4) had gum pain and <1% (n=1) stated that they had no dental problems (Figure 3).

#### **Has your dentist told you that you have any of the following gum problems (Q. 15)**

Regarding having had a diagnosis of gum problems (periodontal disease) by a dentist, 17.3% (n=24) of the divers had been diagnosed with gingivitis and 10.1% (n=14) with severe gum disease (periodontitis) with 11.5% (n=16) being unsure. The highest number (54.6% [n = 67]) indicated that their own dentist had not informed them about any gum disease.

#### **Have you experienced any gum problems during diving and what type of pain did you experience? (Q16/Q17)**

Only nine subjects (6.3%) experienced any gum problems during diving which were mainly the following types of pain: shooting pain (44.4%, n = 4), tooth sensitivity (33.3%, n = 3), pressure pain (11.1%, n=1) and a dull ache (11.1%, n=1).

#### **Pain experienced during diving as well as any untoward events occurring during the dive (Q.18 to 30).**

Questions 18 -30 related to the pain experienced during diving as well as any untoward events occurring during the dive. Q18 required the participants to indicate whether they had experienced any toothache during the dive; 80.9% (n = 110) indicated that they did not experience any toothache; four divers were not sure (2.9%) and only 16.2% (n = 22) indicated that they experienced toothache whilst diving. Those divers who experienced toothache were also asked to indicate the position of the discomfort in the mouth during the dive (Q19); 47% (n=10) indicated that the pain

was located in the lower teeth, 33.3% (n=7) indicated that the pain was in the upper teeth, 14.3% (n=3) indicated that the pain was in both the upper and lower teeth; one participant (4.8%) was unsure of the position of the pain.

The divers were asked about the type of pain they experienced during the dive (Q20), of those who responded 33.3% (7) experienced severe persistent pain on both the ascent and descent aspects of the dive, 33.3% (n=7) experienced a dull throbbing pain on the descent, 19% (n=4) experienced a sharp momentary pain on the ascent, one participant (4.8%) experienced a dull throbbing pain on the ascent, one participant (n=4.8%) indicated a non-specific 'other' and one participant (4.8%) was unsure.

Questions 21-24 requested the divers to indicate whether they had any pain during and/or after the dive in: 1) in the teeth, 2) the jaw, 3) the sinus, 4) head pain [headaches] and 5) joint pain (elbows and knees). The results indicated that the divers experienced tooth pain 16.2% (n=22) as previously indicated above, jaw pain 22.1% (n = 32); sinus pain 32.2% (n = 47); headache(s) during or after diving 49% (n = 70); joint pain 4.7% (n = 7). Only two responses described the pain as a deep pain in the knee (Figure 4).

The participants were also asked to indicate whether that had experienced any other dental problem during the dive such a lost filling, broken or fractured tooth, dislodged crown, loss of a tooth or problems when inserting the mouthpiece (Q.25-30). The response for such occurrences were relatively low namely: a lost filling 4% (n = 6); tooth fracture 7% (n = 1), a dislodged crown 2.8% (n=4), tooth loss 1.4% (n = 2) and problems associated with the insertion of mouthpiece 4.2% (n = 6). There were several unsure responses in each of these categories (Q.25-27, 30 [3], Q29 [2]). Only two responses were recorded for the location of the problem (Q28) namely 1) front tooth and 2 unsure).

#### **If you experienced any dental problem during your dive, did you arrange an appointment with your dentist to treat the problem?(Q31)**

118 divers (83.7%) out of 141 divers responded that they had not made a dental appointment. 15 (10.6%) indicated that they had made an appointment, 6 (4.3%) were unsure as to whether they made a dental appointment with 2 (1.4%) proving a non-specific 'other' response. No further detail about the appointments was provided by the participants.

### Effect of independent factors

The effects of any independent factors were also analysed to determine whether these factors such as gender, age, or frequency of diving had any influence on the prevalence of gum pain in scuba divers. No statistical differences were observed for gender, age and the frequency of diving based on the statistical tests described in Section 2.8.

When comparing the prevalence of different symptoms (such as toothache, jaw pain, sinus pain, joint pain etc.) experienced by divers during the dive with gender, age group and the frequency of dives only the association between toothache and age was statistically significant ( $p=0.035$ ). Toothache pain during the dive appeared to be more frequent in the younger divers ( $\leq 30$  years of age) although the total sample size of those reporting toothache pain was relatively small ( $n=22$ ) (Figure 5).

### Discussion

The questionnaire design used in the present study was based on a previous study conducted by Jagger *et al.* [11] which included question relating to the prevalence of orofacial pain and odontocrexia (fractured teeth). In addition, some questions were adapted in the present study to determine whether 'gum problems' were an issue when diving. A self-administered questionnaire was distributed in five dive centres in Kuwait during a period of six weeks from 15th July to 30th August 2015. Prior to the final phase of the questionnaire, a pilot phase was conducted in one dive centre in Kuwait in a period of two weeks. The questionnaire was evaluated for the duration of time needed to answer and fully understand all the questions. The sample comprised 30 divers in the pilot phase. The main outcomes were that all the divers fully understood the questions, and they completed the questionnaire within 5–8 minutes. In the final phase, the study population comprised 150 divers (30 [pilot study] and 120 [main study]); 20 divers did not respond to the survey. The main reason of this 'drop out' was that the study took place during the summer months when all the divers in the dive centres were preoccupied with training and teaching divers from novices to more advanced diving skills. Ideally a clinical component with the self-administered questionnaire would have provided more information however due to the time constraints for both the investigator (HS) and the divers in the dive centres this was not possible.

Although one of the objectives of the study was to estimate the prevalence of gum problems (periodontal pain) during diving it was evident (within the limitations of the study) that periodontal pain was a rare phenomenon (6.3%; 95% CI [2.3%–10.4%]). Shooting pain and tooth sensitivity were the most common descriptors of the pain experienced within these divers ( $n = 9$ ). No statistical differences were therefore observed for gender, age and the frequency of diving for periodontal pain.

When evaluating other types of pain experienced by the divers when diving it was evident that headache(s) usually affected half of the divers in the sample (49%), followed by sinus pain (32.2%), jaw pain (22.1%), and toothache (16.2%). An interesting observation was that toothache pain was significantly more prevalent in divers  $\leq 30$  years (prevalence 26.8%) than divers  $\geq 30$  years of age. Other problems identified in the present study involved losing a filling (4%), dislodging a crown (2.8%), and losing a tooth (1.4%) during diving.

Our findings can be compared with those of previous studies, such as Jagger *et al.* [11] and Ranna *et al.* [9] who reported a prevalence of 44% for orofacial pain and 41% (dental problems) respectively. According to Jagger *et al.* [11] 21% of the respondents reported toothache pain, 27% reported sinus pain (40% F; 21.5% M), 16% reported jaw pain 16%, with 12% reporting other types of pain. Odontocrexia was reported in  $\leq 1\%$  of the respondents and Zanotta *et al.* [3]. Zanotta and Dagassan-Berndt [7] however, reported that the prevalence of problems in the dental area around 15%, with 10.2% of the participants suffering toothaches, tooth injures (6.3%) and temporomandibular joint problems related to the mouthpieces (11.3%) which was also reported by Hobson [13]. The reported discrepancies between the published studies may be due in part to how the data were collected (e.g., questionnaire or clinical examination).

Although the results from the present study were based on a self-administered questionnaire rather than on a medical and dental examination nevertheless the questions and the responses relating to the experience of the type of pain could identify the possible origin of the pain. For example, when asked to describe the type of pain during the dive 16.2% ( $n=22$ ) described the pain in the following manner 1) severe persistent pain on ascent and descent (33% [ $n = 7$ ]); 2) dull throbbing pain on descent (33.3% [ $n = 7$ ]); 3) a sharp momentary pain on ascent (4.8% [ $n =$

4]) and 4) dull throbbing pain on ascent (4.8% [n = 1]); one diver was not sure (4.8%). These results appear to be reasonably consistent with the observations from Zonatta et al. [3] who reported that toothache pain occurred upon a change in pressure during diving.

The importance of divers being medically fit before diving is essential and generally divers will be assessed by the dive instructor prior to a dive. Normally divers would be requested to complete a medical questionnaire form (Padi.com) prior to the dive. However there appears to be limited emphasis on a diver being dentally fit prior to diving, a study undertaken by Ranna *et al.*[9] reported that 42% (n=41) of divers reported barodontalgia during the dive. These can be easily avoided if divers visited their dentist for treatment prior to diving, however the responses from the divers in the present study would indicate that 43% of the respondents did not have a dentist. Furthermore, even when they were made aware of a dental problem, they often failed to make an appointment before diving. Given the potential risks of experiencing barodontalgia during diving and its possible sequelae after the dive more emphasis should be made of divers being 'dentally fit' prior to a dive. The importance of maintaining good oral care by regular dental appointments prior to a dive cannot be underestimated.

## Conclusions

Periodontal pain was an uncommon complication during diving, toothache was more prevalent in divers <30 years of age (16.2%). The other dental problems experienced by divers were headache (49%), sinus pain (32.2%), jaw pain (22.1%) and toothache (16.2%). Our findings can be compared favourably with those of previous studies, such as Zanotta *et al.*[3], Ranna *et al.*[9] and Jagger *et al.* [11].

## References

- Holowatyj RE. Barodontalgia among flyers: a review of seven cases. *JCDA*. 1996; 62(7): 578-584.
- Laval-Meunier F, Bertran PE, Arrivé E, Paris JF, Monteil M, Nguyen S, Moussu C, Rouas A, Catros S. Frequency of barodontalgia among military or civilian pilots and aircrew members. *Aviat Space Environ Med*. 2013; 84 (10): 1055-1060.
- Zanotta C, Dagassan-Berndt D, Nussberger P, Waltimo T, Filippi A. Barodontalgias, dental and orofacial barotraumas: a survey in Swiss divers and caisson workers. *Swiss Dent J*. 2014; 124(5):510-519.
- Zadik, Y Dental Barotrauma *Int J Prosthodont* 2009; 22: 354-357.
- Zadik Y. Barodontalgia: what have we learned in the past decade? *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. April 2010, 109:e65-e69)
- Stoetzer, M, Kuehlhorn C, Ruecker M, Ziebolz D, Gellrich NC, Constantin von See C. , Pathophysiology of barodontalgia: a case report and review of the literature. *Case Rep Dent*. 2012; 2012: 453415.
- Zanotta L, C. & Dagassas-Berndt, D. (2014). Barodontalgias, dental and orofacial barotraumas. *Research and science*,124, 5.
- Zadik Y, Drucker S. Diving dentistry: a review of the dental implications of scuba diving. *Aust Dent J*. 2011;56(3):265-271.
- Ranna, V, Malmstrom, H., Yunker, M. et al. Prevalence of dental problems in recreational SCUBA divers: a pilot survey. *Br Dent J* 221, 577-581 (2016).
- Jagger RG, Jackson SJ, Jagger DC. In at the deep end--an insight into scuba diving and related dental problems for the GDP. *Br Dent J*. 1997;183(10):380-382.
- Jagger RG, Shah CA, Weerapperuma ID, Jagger DC. The prevalence of orofacial pain and tooth fracture (odontocrexia) associated with SCUBA diving. *Prim Dent Care*. 2009 Apr;16(2):75-8.
- Mohammed Y, Maria I, Abeer A, Abdulaziz H. The prevalence of oro-facial barotrauma among scuba divers. *Diving and Hyperbaric Medicine: the Journal of the South Pacific Underwater Medicine Society* 2015, 45 (3): 181-3.
- Hobson RS. Temporomandibular dysfunction syndrome associated with scuba diving mouthpieces. *Br J Sports Med*. 1991;25(1):49-51.