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## RESEARCH ARTICLE

### PERCEPTION OF KNOWLEDGE AND ATTITUDE OF DENTAL COMPLICATIONS OF SCUBA DIVING IN KSA: A DENTAL PRACTITIONER AND DIVERS FEEDBACK

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#### ABSTRACT

**Background:** Scuba diving is associated with certain dental complications, with which a majority of the scuba divers and dental practitioners are not familiar. Knowledge of these two groups has been found to be on the lower side as far as the barotraumas are concerned. **Objectives:** The aim of this paper is to evaluate the knowledge of dental practitioners and scuba divers regarding management and prevention of dental complications during, before, and after scuba diving activities in the kingdom of Saudi Arabia. **Methods:** This is a dual survey-based study. Respective surveys were prepared and sent to scuba divers and dental practitioners in different regions of Saudi Arabia. Dental professionals were divided into further groups based upon their work experience and designations. Questions related to their demographics and knowledge of dental complications related to scuba diving were included in the survey. **Results:** A total of n=268 dental practitioners and an equal number (n=268) of scuba divers responded to the survey. The total number of study participants was N=536. We found some statistically significant results, where consultants exhibited better knowledge (59%) as compared with general practitioners having more experience (31%) regarding the relationship between scuba diving and dental complications (p value=0.011). As far as dental complications were concerned, the results revealed mixed responses from different educational levels in both dental practitioners as well as scuba diving group. Although the comparisons were statistically significant in the two groups (pvalue= 0.000), varying levels of knowledge were found among all educational levels. **Conclusions:** Dental professionals having more experience and training exhibited improved knowledge and attitude towards the relationship between scuba diving and dental complications. Scuba divers must be presented with special instructions related to several types of dental complications whenever seeking dental treatment.

## INTRODUCTION

Scuba diving is a popular sport that has become one of the most attractive and enjoyable sports in the kingdom of Saudi Arabia. Due to several factors, divers face dental complications during, and after diving. Dental complications may appear due to not taking the special dental considerations before diving. It's important for dental practitioners to be aware of dental complications arising from Scuba diving. Also, the divers should be aware of preventive measures to avoid any further dental complications. A study that provides information and evaluates the knowledge of the dental practitioners and divers can provide valuable feedback on managing and preventing dental complications arising from scuba diving. An investigation done by Toyonaka dental clinic and Osaka University (Hirose et al., 2016) reviewed the Diver's Mouth Syndrome (DMS). The study examined how the design of the

diving mouthpiece can contribute to causing DMS. It was strongly suggested that customizing the mouth piece may reduce the risk of Scuba Diving Mouth Syndrome. Lobbezoo et al. (2014) determined the risk factors associated with Temporomandibular Disorders (TMD) among scuba divers. It was observed that around 44% of the study participants had experienced TMD, which was due to certain risk factors including clenching, warm water, biting on the mouthpiece and quality of the mouthpiece. Therefore, related questions were included in this survey to investigate the possible prevalence of this problem among Saudi scuba divers. Another Study was done in Hebrew university- Hadassah and university of Pennsylvania (Zadik et al., 2011) indicated special terminology regarding dental implications of Scuba diving. The study reviewed some of the more common dental diving complications. Two causes can be blamed for the relevant conditions. First, a big percentage of those conditions were

caused by pressure changes arising from diving. The second reason was related to the mouthpiece used by the divers. Zadik *et al.* (2011) emphasized the significance of multiple head and neck complications that may be caused by indirect barodontalgia. Dental baro-trauma is believed to be associated with possible tooth as well as restoration fracture. This phenomenon takes place when the diver makes his way up from high pressure, which according to some studies leads to pressure changes in micro air bubbles under the cement and causes the dislodgement and fracture of the restoration. Scuba diving has also been associated with pressure induced pain in endodontically treated teeth of divers. Teeth without calcium hydroxide dressing applied before composite restorations tended to have pressure induced pain, whereas the opposite resulted in no pain among scuba divers (See *et al.*, 2011). The aim of the study was to evaluate the knowledge of dental practitioners and scuba divers regarding management and prevention of dental complications during, before, and after scuba diving activities in the kingdom of Saudi Arabia. The research hypothesis of this paper is that scuba diving activities may induce dental complications as a result of high pressure and stress exposure. Since divers are not aware of dental precautionary measures, it is believed that this unawareness may lead to severe dental problems.

**MATERIALS AND METHODS**

This is a dual survey-based study. Respective surveys were prepared and sent to scuba divers and dental practitioners in different regions of Saudi Arabia. Questions in both surveys were matched and inquiries were made followed by the responses being presented in tabulated form. A total of 268 scuba divers and 268 dental professionals participated in this study. Dental professionals were divided into further groups based upon their work experience and designations. The survey for both groups included questions related to demographics, usage of a special survey, knowledge about relation between scuba diving and dental complications, specific instructions targeting the divers, prevalence of different types of dental complications, safety to dive having prosthesis, effects of mouthpiece and malocclusion, types of dental malocclusions, and so on.

**RESULTS**

The survey also inquired about the type of malocclusion affecting the divers' oral health on the basis of their educational levels. It can be noted from Figure 3 that the high school group showed better knowledge in this regard, as open bite (8%) was selected in the highest number by this group. Their comparison to other groups was found to be statistically significant (p-value: 0.000). Since the data was categorical in nature, a Chi-square test was used to compare the responses between subgroups. Some statistically significant results were found, where consultants exhibited better knowledge (59%) as compared with general practitioners due to having more experience (31%) regarding the relationship between scuba diving and dental complications (p value=0.011); (Figure 4). Similar results were established among scuba divers where participants with higher education (66%) showed better knowledge regarding the same question. However, this comparison with lower educational group (55%) was not statistically significant (p value=0.784); (Table 2). In Figure 5, comparisons among different work experience levels and

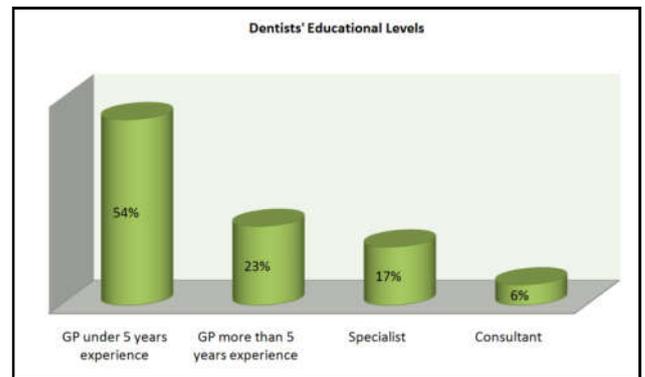


Figure 1: Dental practitioners' distribution on the basis of education and experience

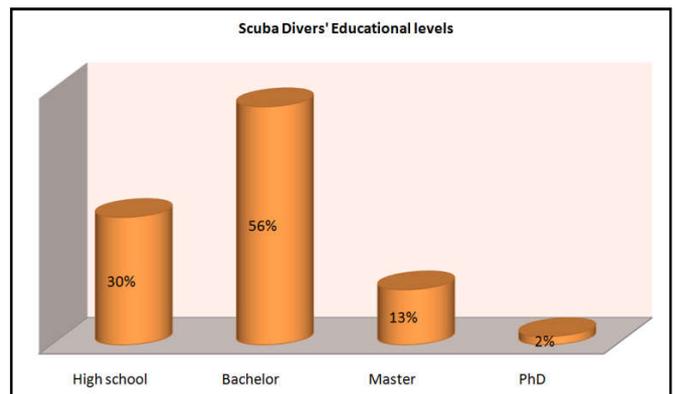


Figure 2: Scuba divers' educational levels

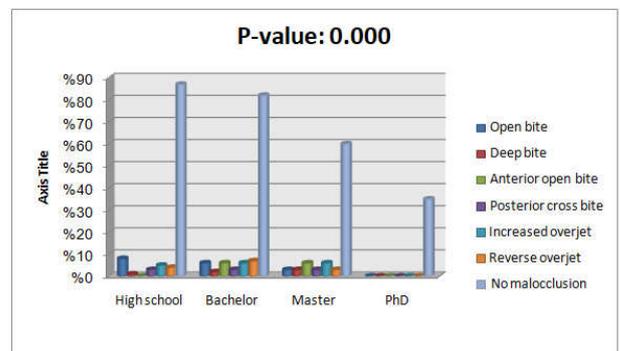


Figure 3. Scuba divers' responses to type of malocclusion causing dental complications

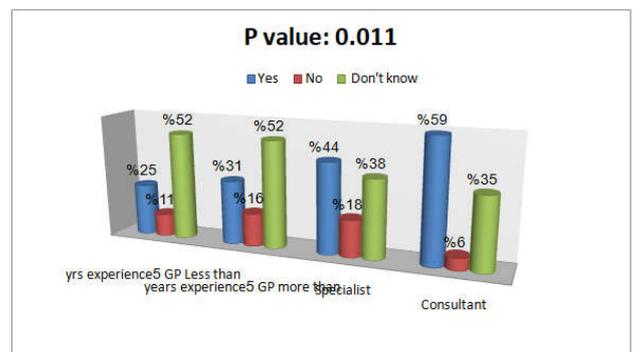


Figure 4. Dental practitioners' responses to the relationship between scuba diving and dental complications.

designations of dental practitioners are demonstrated. Middle ear pain (71%) and toothache (65%) were reported to be strongly associated with scuba diving as per the knowledge of consultant dental practitioners.

**Table 1: Dental practitioners' responses and comparisons on the basis of education/work experience**

Item	GP Less than 5 years experience	GP More than 5 years experience	Specialist	Consultant	P-value
Ever treated Scuba Diver?	Yes: 21% No: 79%	Yes: 26% No: 74%	Yes: 18% No: 82%	Yes: 29% No: 71%	0.116
Use special survey for divers?	Yes: 11% No: 89%	Yes: 18% No: 82%	Yes: 18% No: 82%	Yes: 12% No: 88%	0.426
Is there relation b/w scuba diving and dental complications?	Yes: 25% No: 11% Don't know: 52%	Yes: 31% No: 16% Don't know: 52%	Yes: 44% No: 18% Don't know: 38%	Yes: 59% No: 6% Don't know: 35%	0.011
Are there certain precautions following dental treatment?	Yes: 21% No: 24% Don't know: 55%	Yes: 33% No: 20% Don't know: 48%	Yes: 38% No: 16% Don't know: 47%	Yes: 35% No: 18% Don't know: 47%	0.326
Is there specific instruction given to divers after treatment?	Yes: 49% No: 51%	Yes: 43% No: 57%	Yes: 58% No: 42%	Yes: 47% No: 53%	0.492
Dental complications due to diving?	Dislodged Restoration: 25% Toothache: 42% Tooth fracture: 24% Falling of prosthesis: 31% Middle ear pain: 76% Nausea: 39% Hearing disturbance: 50%	Dislodged Restoration: 31% Toothache: 48% Tooth fracture: 41% Falling of prosthesis: 34% Middle ear pain: 67% Nausea: 36% Hearing disturbance: 44%	Dislodged Restoration: 33% Toothache: 60% Tooth fracture: 29% Falling of prosthesis: 31% Middle ear pain: 60% Nausea: 38% Hearing disturbance: 44%	Dislodged Restoration: 18% Toothache: 65% Tooth fracture: 35% Falling of prosthesis: 24% Middle ear pain: 71% Nausea: 35% Hearing disturbance: 29%	0.000
Which temporary restoration used b/w RCT visits	GIC: 35% TF (Cavit): 53% Resin: 6% No difference: 7%	GIC: 39% TF (Cavit): 36% Resin: 10% No difference: 15%	GIC: 51% TF (Cavit): 33% Resin: 9% No difference: 7%	GIC: 53% TF (Cavit): % Resin: 6% No difference: 18%	0.081
Recommended rest after extraction?	7 days: 32% 10 days: 35% One month: 19% No difference: 14%	7 days: 30% 10 days: 30% One month: 19% No difference: 14%	7 days: 24% 10 days: 27% One month: 31% No difference: 18%	7 days: 29% 10 days: 18% One month: 35% No difference: 18%	0.160
Safe to dive with Fixed Prosthesis but contraindicated with Removable Prosthesis	Yes: 61% No: 39%	Yes: 77% No: 23%	Yes: 64% No: 36%	Yes: 71% No: 29%	0.176
Depth of caries and dental complication during diving are related?	Yes: 44% No: 56%	Yes: 54% No: 46%	Yes: 49% No: 51%	Yes: 65% No: 35%	0.274
Mouth piece can cause respiratory trans-infection	Yes: 51% No: 49%	Yes: 70% No: 30%	Yes: 62% No: 38%	Yes: 53% No: 47%	0.059
Do you ask diver patient about TMJ problem?	Yes: 35% No: 65%	Yes: 49% No: 51%	Yes: 51% No: 49%	Yes: 47% No: 53%	0.121
Specific malocclusion can cause dental complications in divers?	Yes: 32% No: 12% Don't know: 56%	Yes: 46% No: 16% Don't know: 38%	Yes: 42% No: 13% Don't know: 44%	Yes: 24% No: 18% Don't know: 59%	0.243
Which malocclusion can cause MORE dental complications?	Open bite: 42% Deep bite: 22% Anterior open-bite: 23% Posterior Cross-bite: 18% Increased over-jet: 33% Reverse over-jet: 19% No difference: 25%	Open bite: 39% Deep bite: 31% Anterior open-bite: 31% Posterior Cross-bite: 21% Increased over-jet: 34% Reverse over-jet: 16% No difference: 20%	Open bite: 47% Deep bite: 24% Anterior open-bite: 24% Posterior Cross-bite: 7% Increased over-jet: 42% Reverse over-jet: 13% No difference: 22%	Open bite: 24% Deep bite: 12% Anterior open-bite: 18% Posterior Cross-bite: 6% Increased over-jet: 35% Reverse over-jet: 18% No difference: 29%	0.000
Orthodontic appliances can cause risk to diver's teeth?	Yes: 23% No: 20% Don't know: 57%	Yes: 39% No: 16% Don't know: 44%	Yes: 36% No: 20% Don't know: 44%	Yes: 24% No: 18% Don't know: 59%	0.317

This result was higher as compared to other groups with the comparison being statistically significant (p-value: 0.000). Furthermore, the dental practitioners' groups were also surveyed about the types of malocclusions, which may cause dental complications during a dive. Specialists group revealed that the most common malocclusion included open bite (47%) and increased over jet (42%). These percentages were significantly higher (p-value: 0.000) as compared to the responses reported by other groups.

The responses of scuba divers' groups when asked about the possibility of dental complications associated with scuba diving. The lowest educational group showed a better knowledge about the above-mentioned issues and opted for tooth ache (18%) and tooth fracture (5%). This was statistically significant as compared to other groups (p-value: 0.000). Two surveys with similar questions were constructed. One survey was directed towards dental practitioners, while the other was directed towards scuba divers. Comparisons of the results were made on the basis of scuba divers' education levels and dental professionals' experience and current work position. This study compared the responses from dental practitioners and scuba divers as far as the relationship between scuba diving and dental complications is concerned. Both study groups had to fill

up their surveys assessing their knowledge regarding the issues mentioned above. The total number of study participants was N=536, with n=268 dental practitioners, and an equal number (n=268) of scuba divers. Both groups were divided into subgroups based on gender, living region, educational level and age group. However, it was decided to compare the findings based on the educational level.

## DISCUSSION

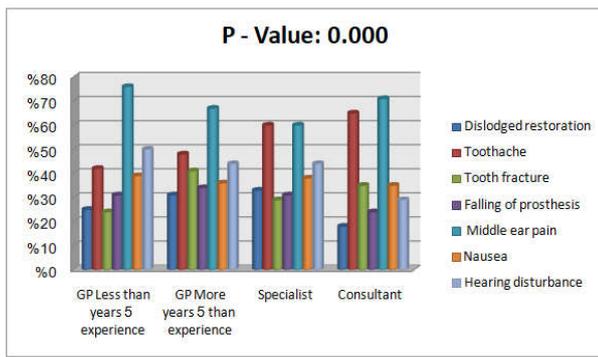
Scuba diving activities may induce dental complications as a result of high pressure and stress exposure. Since divers are not aware of dental precautionary measures, it is believed that this unawareness may lead to severe dental problems. The motive of this investigation was to assess the knowledge of divers as well as dental practitioners regarding the above-mentioned issue. It was noted that the knowledge of relationship between scuba diving and dental complications was observed to be higher among consultants (59%) and specialists (44%) as compared with the general practitioners (25% and 31%). Similarly, highly educated scuba divers also exhibited better knowledge (66%) about this question as compared with the lesser educated divers (55%).

Table 2: Scuba divers' responses and comparison on the basis of educational level

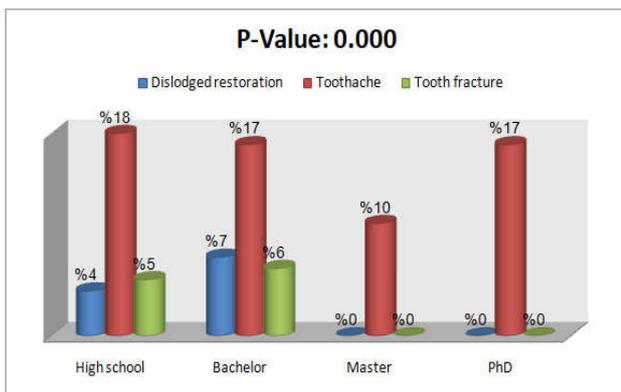
Item	High School	Bachelor	Master	PhD	P-value
Undergone dental treatment after diving?	Yes: 43% No: 57%	Yes: 42% No: 58%	Yes: 45% No: 55%	Yes: 67% No: 33%	0.684
Type of Mouthpiece used?	Commercial (Rent): 45% Commercial (Purchase): 53% Customized type: 2% Full face mask: 2%	Commercial (Rent): 34% Commercial (Purchase): 62% Customized type: 1% Full face mask: 2%	Commercial (Rent): 24% Commercial (Purchase): 61% Customized type: 10% Full face mask: 6%	Commercial (Rent): 33% Commercial (Purchase): 67% Customized type: 0% Full face mask: 0%	0.148
Were you given special survey for divers by dentist?	Yes: 25% No: 75%	Yes: 20% No: 80%	Yes: 12% No: 88%	Yes: 17% No: 83%	0.487
Is there relation b/w scuba diving and dental complications?	Yes: 55% No: 13% Don't know: 32%	Yes: 61% No: 13% Don't know: 28%	Yes: 45% No: 21% Don't know: 33%	Yes: 66% No: 17% Don't know: 17%	0.784
Did your dentist give special instructions following dental treatment?	Yes: 6% No: 78% Don't remember: 15%	Yes: 7% No: 77% Don't remember: 16%	Yes: 6% No: 84% Don't remember: 10%	Yes: 0% No: 83% Don't remember: 17%	0.956
Dentist informed of risks in diving after extraction?	Yes: 10% No: 90%	Yes: 13% No: 87%	Yes: 6% No: 94%	Yes: 17% No: 83%	0.716
Dental complications due to diving?	Dislodged Restoration: 4% Toothache: 18% Tooth fracture: 5% Falling of prosthesis: 0% Middle ear pain, nausea: 26%	Dislodged Restoration: 7% Toothache: 17% Tooth fracture: 6% Falling of prosthesis: 3% Middle ear pain, nausea: 20%	Dislodged Restoration: 0% Toothache: 10% Tooth fracture: 0% Falling of prosthesis: 0% Middle ear pain, nausea: 12%	Dislodged Restoration: 0% Toothache: 17% Tooth fracture: 0% Falling of prosthesis: 0% Middle ear pain, nausea: 0%	0.000
Recommended rest after extraction?	7 days: 7% 10 days: 3% One month: 1% Didn't extract tooth: 66% Dentist didn't inform: 24%	7 days: 6% 10 days: 2% One month: 6% Didn't extract tooth: 63% Dentist didn't inform: 22%	7 days: 0% 10 days: 2% One month: 2% Didn't extract tooth: 67% Dentist didn't inform: 27%	7 days: 17% 10 days: 0% One month: 0% Didn't extract tooth: 17% Dentist didn't inform: 66%	0.298
Safe to dive with Fixed Prosthesis but contraindicated with Removable Prosthesis	Yes: 13% No: 87%	Yes: 14% No: 86%	Yes: 21% No: 79%	Yes: 50% No: 50%	0.076
Depth of caries and dental complication during diving are related?	Yes: 35% No: 65%	Yes: 34% No: 66%	Yes: 36% No: 64%	Yes: 33% No: 67%	0.992
Mouth piece can cause respiratory trans-infection	Yes: 9% No: 91%	Yes: 10% No: 90%	Yes: 12% No: 88%	Yes: 0% No: 100%	0.824
Dentist asked you about problems in your jaws?	Yes: 8% No: 92%	Yes: 14% No: 86%	Yes: 27% No: 83%	Yes: 17% No: 83%	0.064
Specific malocclusion can cause dental complications in divers?	Yes: 32% No: 12% Don't know: 56%	Yes: 46% No: 16% Don't know: 38%	Yes: 42% No: 13% Don't know: 44%	Yes: 24% No: 18% Don't know: 59%	0.243
Which malocclusion can cause MORE dental complications?	Open bite: 8% Deep bite: 1% Anterior open-bite: 0% Posterior Cross-bite: 3% Increased over-jet: 5% Reverse over-jet: 4% No malocclusion: 87%	Open bite: 6% Deep bite: 2% Anterior open-bite: 6% Posterior Cross-bite: 3% Increased over-jet: 6% Reverse over-jet: 7% No malocclusion: 82%	Open bite: 3% Deep bite: 3% Anterior open-bite: 3% Posterior Cross-bite: 3% Increased over-jet: 6% Reverse over-jet: 3% No malocclusion: 60%	Open bite: 0% Deep bite: 0% Anterior open-bite: 0% Posterior Cross-bite: 0% Increased over-jet: 0% Reverse over-jet: 0% No malocclusion: 35%	0.000
Did your malocclusion affect your diving?	Yes: 3% No: 22% Don't have issues: 75%	Yes: 8% No: 24% Don't have issues: 68%	Yes: 3% No: 18% Don't have issues: 79%	Yes: 0% No: 0% Don't have issues: 100%	0.394
Orthodontic appliances can cause difficulty in using mouthpiece?	Yes: 0% No: 9% No ortho treatment: 91%	Yes: 4% No: 15% No ortho treatment: 81%	Yes: 0% No: 12% No ortho treatment: 88%	Yes: 0% No: 33% No ortho treatment: 67%	0.174

However, the comparison among dental practitioners was found to be statistically significant (p-value 0.011) and scuba diver was not significant (p-value 0.784). Specialist dental practitioners revealed that they gave special instructions to the scuba divers before they went for diving following any treatment. Their response was higher (58%) than other educational levels. However, the comparison was not statistically significant (p-value 0.492). Highly insignificant findings were reported as far as the scuba divers were concerned about this issue (p-value 0.487). We compared these findings with a study conducted by Jagger *et al.* (2009), who investigated the knowledge and experience of Australian scuba divers. They revealed that the divers did not receive any information from their dentists as far as prevention from dental complications was concerned. As mentioned in the literature review, scuba diving is associated with possible TMDs among divers (Hirose *et al.*, 2016). We inquired about this from the dental professionals and found that the experienced general practitioners (49%) and specialists (51%) tend to ask their scuba diver patients about any distress caused to their TMJs.

This comparison to other groups was statistically insignificant (0.121). On the other hand, around 17% of scuba divers reported that their dental practitioners had asked about any TMJ problems during their dental visits. As far as dental complications related to scuba diving were concerned, tooth ache (54% average) and pain in ears (69%) were found to be more common problems reported by both scuba divers and dental professionals. The comparisons among both study groups were found to be statistically significant (p-value 0.000). Lobbezoo *et al.* (2014) mentioned the relationship between mouthpiece usage and problems with TMJ. We aimed to find a relevance of various types of malocclusions with the problems in TMJ. Dental practitioners with more experience and qualification believed this may be related to the prevalence of open bite (24%-47%) and increased over jet (33%-42%), which results in uncomfortable use of mouth piece for the scuba divers. These findings were statistically significant (p-value 0.000). However, there was no statistically significant relationship reported between orthodontic appliances and the risk caused to the teeth of scuba divers (p-value 0.317).



**Figure 5. Dental practitioners responses to the dental complications associated with scuba diving**



**Figure 6. Scuba divers' response to possible dental complication associated with scuba diving**

Balestra *et al.* (2004) demonstrated the association of TMJ problems with scuba diving. They explained the phenomenon of stress causing the above-mentioned problem through biomechanics, where retrodiscal portion of the joint was found to be under stress. There is a scientific evidence of pulpal pain and its association with deep sea scuba diving as the divers are exposed to higher pressures. This was demonstrated by See *et al.* (2011) by determining the variations in pressure within the pulp chambers of extracted teeth being experimented under hyperbaric conditions. Under water high pressure, dives were being simulated and the teeth were subjected to measurements in order to calculate the pressure being exerted on them. One of our aims was to ask the dental professionals about the knowledge regarding pulpal pain due to deep caries. It was noted that 65% of consultants believed deep caries may cause pain to deep sea scuba divers as compared to general practitioners (44% and 54%). This comparison was not statistically significant (p-value 0.274). We found this information useful as pressure is directly associated with intra root canal pain. There are certain modifications and interventions that can be made in order to protect and maintain the scuba divers' prosthesis and restorations. This can be achieved by designing a custom edentulous mouthpiece. Furthermore, the dental practitioners must educate the divers regarding the post dental treatment precautions. It is advised that the divers must avoid diving within 24 hours of a dental treatment including prosthetic and restorative procedures. More precautions should be followed when the divers undergo surgical treatment, in which case they must avoid diving in deep waters for at least a week, and confirm healing from dentists before diving (Hobson, 1991). Temporomandibular problems should be addressed before divers go for a dive. This

is imperative in order to protect and prevent any further discomfort to the jaw. Use of mouthpiece is considered to be associated with this problem especially when the diver has some kind of malocclusion as well. Furthermore, it has been a regular practice of scuba divers that they exchange their mouthpieces during the course of their dives and this may be the cause of transmission of infectious diseases such as herpes. Educating divers regarding this issue is also an imperative part of dental practitioners' responsibility (Gunepin *et al.*, 2015). Finally, the dental practitioners may also make another intervention in their treatment modality when performing a root canal treatment for the diver. Canal orifices should be sealed with composite in order to prevent any breakage or dislodgment of the filling.

## Conclusions and Recommendations

- The research revealed that the level of knowledge regarding the relationship between scuba diving and dental complications is not sufficient.
- It is important to educate dental practitioners to not take only dental and medical histories, but also personal detailed histories about patients' hobbies and their regular activities.
- Awareness must be increased among dentists and divers to prevent any further dental complications especially dental practitioner with low experience.
- Scuba divers must be presented with special instructions related to several types of dental complications whenever seeking dental treatment.

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