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# Evaluation of changes in arterial blood pressure during treatment in hypertensive and non-hypertensive patients

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BOSTON UNIVERSITY

HENRY M. GOLDMAN SCHOOL OF DENTAL MEDICINE

THESIS

**EVALUATION OF CHANGES IN ARTERIAL BLOOD PRESSURE DURING TREATMENT IN  
HYPERTENSIVE AND NON-HYPERTENSIVE PATIENTS**

by

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Submitted in partial fulfillment of the requirements for the degree of

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**EVALUATION OF CHANGES IN ARTERIAL BLOOD PRESSURE DURING PERIODONTAL  
TREATMENT IN HYPERTENSIVE AND NON-HYPERTENSIVE PATIENTS**

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**ABSTRACT**

**Aim:** To evaluate the changes in arterial blood pressure during periodontal procedures under local anesthesia in hypertensive and non-hypertensive patients and to compare effects related to gender, age, and different types of blood pressure medications on systolic and diastolic blood pressure.

**Materials and Methods:** Fifty-nine patients enrolled and consented to participate in this study. Twenty-eight were diagnosed with hypertension and thirty one were non- hypertensive. Their blood (BP) was measured once during the consultation visit. During the scaling and root planning (SRP) visit BP was measured at three time points: before local anesthesia (LA) injection, immediately after LA and at the end of the procedure. During the surgical visit BP was determined at the same three time points as the SRP visit.

**Results:** There were no statistically significant differences in systolic and diastolic blood pressure between hypertensive and normotensive patients, males versus females, age groups and different types of blood pressure medications during SRP and surgical visits under local anesthesia.

**Conclusion:** Although age, gender, blood pressure medications and hypertensive status have no significant influence on the arterial blood pressure in both hypertensive and normotensive patients

during SRP and periodontal surgical visits, it is important to measure pre-operative BP to avoid or minimize the chances of life-threatening complications during dental treatment.

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## Evaluation of Changes in Arterial Blood Pressure During Periodontal

### Treatment in Hypertensive and Non-Hypertensive Patients”

#### **Introduction:**

Hypertension is the most common chronic condition that primary care physicians and other health care practitioners have to consider. In the United States, hypertension is found in 11 percent of the population age 30 to 39 , 44 percent of age 50 to 59 and 45 percent in age 60 to 69 .<sup>14</sup> The high prevalence of hypertension in the community is currently driven by 2 phenomena: the increased age of population and the growing prevalence of obesity, which is seen in developing as well as developed countries. In many communities, high dietary salt intake is also a major factor.<sup>25</sup>

Hypertension is diagnosed when a person’s systolic blood pressure is  $\geq 140$  mm Hg or their diastolic blood pressure is  $\geq 90$  mm Hg, or both on repeated examinations. The systolic BP is important and is the basis for diagnosis in most patients.<sup>25</sup> These numbers apply to adults who are older than 18. Patients with diabetes or chronic kidney disease should be treated for BP  $< 140/90$  mm Hg. However, the clinical benefits of the lower target values of 130/80 mm Hg have not been established for these patients.<sup>25</sup> Blood pressure depends on the contractility of the heart and of the resistance of the peripheral arteries. Epinephrine is widely used as an additive in local anesthetics (typically in concentrations of 1:100,000) to improve the depth and duration of the anesthesia, as well as to reduce bleeding in the operative field. Epinephrine counteracts the anesthetic's localized vasodilator effects in subcutaneous and submucosal vessels, thereby reducing the risk of anesthetic toxicity by decreasing the rate of systemic absorption from the site of injection.

Epinephrine increases cardiac output and induces a constriction of subcutaneous and digestive tract peripheral arteries and as a consequence will increase BP.

Blood pressure is not a constant variable; rather, it shows marked spontaneous oscillations over short-term (minutes to days) and long-term (month) periods. In recent years, a large number of clinical studies have clearly identified the contribution of blood pressure variability to the cardiovascular complications associated with hypertension.<sup>29</sup> Blood pressure variability correlates closely with target organ damage and the effect is independent of mean blood pressure values. This can be explained by increased stress on the myocardium and the blood vessels. The correlation between blood pressure variability and organ damage has a potentially important impact on treatment. Consequently, monitoring blood pressure behavior, particularly its variability during treatment, has become an important end point in clinical trials.<sup>8</sup>

The latest BP classification according to the Joint National Committee Report (JNC-7) on the prevention, detection, evaluation and treatment of high BP is as follows:<sup>13</sup>

- Prehypertension: patients with systolic BP between 120 mm Hg and 139 mm Hg or diastolic BP between 80 and 89 mm Hg.
- Stage 1 hypertension: patients with systolic BP between 140 to 159 mm Hg or diastolic BP between 90 to 99 mm Hg.
- Stage 2 hypertension: systolic BP  $\geq$ 160 mm Hg or diastolic BP  $\geq$  100 mm Hg.

Dentists need to measure their patient's BP before any dental procedure. Many patients are unaware of their high BP because hypertension may be asymptomatic. The dentist might be the first to diagnose hypertension. Many of the hypertensive patients are not compliant with their blood pressure medications. Detecting elevated blood pressure in a dental office often reminds already diagnosed patients of the importance of taking their medications.

Finally, should a medical emergency occur, having pretreatment “base –line” vital signs is important.

Periodontitis, a chronic low-grade inflammation of gingival or periodontal ligament tissue, has been linked to endothelial dysfunction, hypertension and increased mortality risk. Inflammatory biomarkers are increased in hypertensive patients with periodontitis. Furthermore, oxidative stress and endothelial dysfunction have been hypothesized to be involved in the pathogenesis of hypertension. It is well known that hypertension and periodontitis share common risk factors, namely, smoking, stress, increased age, and socioeconomic factors. These risk factors may confound the association between hypertension and periodontitis.<sup>30</sup>

Ninety to 95 % of hypertensive patients present with unknown etiology. It is called essential hypertension, and treatment usually involves anti-hypertensive medications. The remaining 5% to 10% have secondary hypertension, which has identifiable causes such as faulty heart valves, catecholamine secreting tumors, increased thyroid hormones, oral contraceptives and renal-vascular disease. Treatment of secondary hypertension usually involves treatment of the underlying cause.

Many drug classes are used for the treatment of stage 1 and stage 2 hypertension. Thiazide and Thiazide-like diuretics are the first drug given for most of the patients. They act by reducing vascular resistance and blood volume. Beta blockers are also frequently prescribed. They reduce the rate and force of heart contraction and also decrease the release of renin from the kidney. Angiotensin converting enzyme inhibitors (ACE) work by inhibiting the renin-angiotensin system by preventing conversion of angiotensin 1 to angiotensin 2 thus producing vasodilation to

lower the blood pressure. They also inhibit aldosterone release by the adrenal cortex which reduces reabsorption of sodium by the kidney and reduces blood volume. Calcium channel blockers reduce all the variables in blood pressure by minimizing calcium influx into smooth and cardiac muscles. They decrease total peripheral resistance and often slow the heart rate and reduce the force of contraction. Alpha blocking agents act as receptor antagonists of alpha-adrenergic receptors causing relaxation of the blood vessels. To be maximally effective, they should usually be combined with diuretics. Angiotensin 2 receptor blockers antagonize the renin-angiotensin system, They reduce blood pressure by blocking the action of angiotensin 2 on AT1 receptors and thus prevent the vasoconstrictor effects of the receptor.

It has been speculated that BP changes during periodontal procedures might be a problem when treating hypertensive patients.

The following questions pertain:

1. Are there any risks in treating hypertensive patients in our periodontal clinics?
2. Are there any significant differences in the effects among the different anti-hypertensive medications for treating patients in our clinics?
3. Does measuring blood pressure predict any possible cardiovascular incidents in our clinics?

The aim of this clinical study is to evaluate the changes in arterial blood pressure during periodontal procedures under local anesthesia in hypertensive and non-hypertensive patients.

## **Materials and Methods:**

Fifty nine subjects (28 with and 31 without a diagnosis of hypertension) scheduled to undergo a standard care periodontal procedure were selected to participate in this study. At the time of initial consultation visit we selected eligible subjects to participate in this study.

The inclusion criteria for eligibility are as follows:

- Male and female patients seen by postgraduate periodontology residents at Henry Goldman School of Dental Medicine, Boston University.
- Adult patients age 18 and older
- Patients with hypertension controlled with hypertensive drugs.
- Patients coming to periodontology clinics at Boston University for periodontal comprehensive evaluation.
- Patients without diagnosis of hypertension (control group).

And the exclusion criteria are as follows:

- Pregnant women.
- Cognitively impaired subjects.

Blood pressure (BP) was measured as follows:

- a. Baseline consultation visit: the BP will be measured once during this visit.
- b. Scaling and root planing visit (SRP): the BP measured at three time points:
  - Point 1) before local anesthesia (LA) injection.
  - Point 2) immediately after (LA).
  - Point 3) at the end of the procedure

The BP cuff will remain on the subjects' arm until the local anesthesia is given to obtain the first and second reading then it will be removed. It will be replaced at the end of the procedure to obtain the final reading.

- c. Surgical visit: The BP will be measured at the same three time points as the SRP visit.

A non invasive BP and digital pulse Oximeter (NONIN) 2120 is used to measure the patient's BP and heart rate. The FDA has approved this device for the usage described in this study. It is a portable device for use in measuring and displaying functional oxygen saturation of arterial hemoglobin, pulse rate, and BP of adult and pediatric patients in hospitals, medical facilities, and subacute environments. The model 2120 is intended for spot-checking and / or continuous monitoring of patients. Fluctuation of BP will be computed and analyzed.

Research subjects will be divided into two groups: hypertensive and non-hypertensive (control group). Data will be evaluated and analyzed for significant fluctuations in BP recorded during the periodontal procedures. This is an observational study on fluctuations in blood pressure during periodontal procedures in individuals with normal blood pressure and in individuals with a diagnosis of hypertension. There is no randomization and no placebo group. The study has been accepted and approved by the International Review Board (IRB) at Boston University Henry Goldman School of Dental Medicine, IRB number: H- 32717.

### **Statistical Analysis:**

The Shapiro –Wilk test was used to test whether a sample came from a normally distributed population. Student's-t test was used to test the hypothesis that two populations have equal means. Analysis of variance was used to compare the means between more than two samples. The Barlett-test was used to compare variance of more than two samples.

Local anesthesia was applied to the two groups SRP (V2) and periodontal surgery (V3) at three time points { before LA (1) , five minutes after LA (2) and at the end of the procedure (3) }.

The null hypothesis:

- There is no statistically significant difference in means systolic and diastolic blood pressures between hypertensive and non hypertensive individuals.
- There is no statistically significant difference in mean systolic and diastolic blood pressures between males versus females.
- There is no statistically significant difference in mean systolic and diastolic blood pressures between the different age groups.
- There is no statistically significant difference in mean systolic and diastolic blood pressures between the different types of blood pressure medications.

The alternative hypothesis:

- There is statistically significant difference in blood pressure between (hypertension, gender, age and blood pressure medication).

**Results:**

Fifty nine patients enrolled and consented to participate in the study. Twenty-eight were diagnosed with hypertension controlled with hypertensive medications and thirty one were non-hypertensive. Among the fifty nine patients, thirty one were males and twenty eight were females. Participants were divided into three age groups: (18- 30), (31-60), and (61-80). Three participants were in the 18-30 age group, 29 were in the 31-60 age group, 17 were in the 61-80 age group and 10 were of unknown age. Table 1 shows a list of different type of antihypertensive medications taken by the patients diagnosed with hypertension.

Table No. 1

<i><b>Blood Pressure Medications</b></i>	<i><b>Number of patients</b></i>
Calcium Channel blocker + B-blocker	1
ACE-Inhibitor	4
Angiotensin 2 receptor blocker	1
B-blocker	4
B-blocker + ACE-Inhibitor	1
Calcium Channel blockers	2
Diuretics	4
ACE-Inhibitor + Diuretics	1
B-blocker + Diuretics	1



Part 1: The study of high blood pressure and application of Lidocaine with vasoconstrictor and its impact on the difference of the blood pressure

### **1. Root planning and deep scaling group (V2)**

Using the Shapiro-Wilk test for normality and the Bartlett-test we are able to use t-test and analysis of variance (ANOVA).

- 1) The difference between V2 systolic 1 (systolic blood pressure before the application of local anesthesia) and V2 systolic 2 (systolic blood pressure after the application of local anesthesia ): There was no statistically significant difference between the means of HTN (t-test p-value = 0.399) and between Age, Gender and HTN (ANOVA Age p-value=0.968, Gender value=0.237, HTN p-value=0.966).
- 2) The difference between V2 diastolic 1 (diastolic blood pressure before the application of local anesthesia) and V2 diastolic 2 (diastolic blood pressure after the application of local anesthesia) : there was no statistically significant difference between the means of HTN (t-test p-value = 0.3467) and between Age, Gender and HTN (ANOVA Age p-value=0.981, Gender p-value= 0.466, HTN p-value=0.313)
- 3) The difference between V2 systolic 1 and V2 systolic 3 (systolic blood pressure at the end of the procedure): there was no statistically significant difference between the means of HTN (t-test p-value = 0.1149) and between Age, Gender and HTN (ANOVA Age p-value=0.222, Gender p-value= 0.180, HTN p-value=0.264)
- 4) The difference between V2 diastolic 1 and V2 diastolic 3 (diastolic blood pressure at the end of the procedure): there was no statistically significant difference between the means of HTN (t-test p-value = 0.5165) and between Age, Gender and HTN (ANOVA Age p-value=0.414,

Gender p-value=0.345, HTN p-value=0.856)

Result: we retain the null hypothesis; in our study we have proved no impact of the vasoconstrictor of local anesthesia on blood pressure.

## 2. Periodontal operation group (V3)

We used the Shapiro-Wilk test for normality, the Bartlett-test and analysis of variance (ANOVA) – the parametric statistical method.

1. Between V3 systolic 1 and V3 systolic 2: there was no statistically significant difference between the means of HTN (t-test p-value = 0.7563) and between Age, Gender and HTN (ANOVA Age p-value=0.777, Gender p-value=0.613, HTN p-value=0.876)
2. Between V3 diastolic 1 and V3 diastolic 2: there was no statistically significant difference between the means of HTN (t-test p-value = 0.391) and between Age, Gender and HTN (ANOVA Age p-value=0.143, Gender p-value=0.395, HTN p-value=0.982)
3. The difference between V3 systolic 1 and V3 systolic 3: there was no statistically significant difference between the means of HTN (t-test p-value = 0.2936) and between Age, Gender and HTN (ANOVA Age p-value=0.4281, Gender p-value= 0.2424, HTN p-value=0.0707)
4. The difference between V3 diastolic 1 and V3 diastolic 3: there was no statistically significant difference between the means of HTN (t-test p-value = 0.7544) and between Age, Gender and HTN (ANOVA Age p-value=0.2764, Gender p-value=0.1135, HTN p-value=0.6904)

**Result:** we retain the null hypothesis; there is no statistical significant difference between the means. The vasoconstrictor effect of local anesthesia showed no influence on the blood pressure in our data.

### The overall result of part 1

We do not prove any statistical significant impact of the vasoconstrictor local anesthesia on the blood pressure in the both of studies. The conventional null hypothesis rejection region for a significance level of 0.05 was used.

## Part 2: The impact of the vasoconstrictor local anesthesia by the patients' medication

### 1. Root scaling patients

There was no significant difference between the means of either systolic (p-value = 0.2062) or diastolic (p-value = 0.1265) blood pressure in the initial the sample (before V2 and V3).

There was no significant difference (p-value = 0.4807) for systolic or diastolic (p-value = 0.751) blood pressure before and after anesthesia application.

There was a statistically significant difference (p-value = 0.038) for systolic but not for diastolic (p-value = 0.9307).

### 2. Periodontal operation patients

There was no statistical difference in systolic (p-value = 0.3692) or diastolic (p-value = 0.4325) blood pressure before anesthesia (initial sample).

There was no significant difference for systolic (p-value = 0.8367) or for diastolic (p-value = 0.1733) before and after anesthesia.

There was no statistically significant difference for systolic (p-value = 0.5805) or for diastolic (p-value = 0.3214) blood pressure between before and after anesthesia.

Overall result: there was no statistically significant difference between means by medication. The

only exception is the difference between the systolic blood pressure before the application and after the whole root scaling.

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## **Discussion:**

Detection of the hypertensive patient is important from several aspects. Many complications of hypertension such as angina pectoris, myocardial infarction and arrhythmias can be avoided or minimized by early detection and treatment. From a dental standpoint, potential life-threatening complications can be prevented by avoiding dental treatment for patients at risk because of severe uncontrolled hypertension.<sup>24</sup>

Stress and anxiety play a very important role in elevating a patient's blood pressure during dental procedures. Thus, it is important to follow stress-reduction protocol on anxious patients. Giving the patients an idea about the dental procedures, informing them about what will be done and allowing them to ask questions will help in establishing strong relationship between the patient and the dentist, which can help in reducing patient's anxiety. Severely anxious patients can be prescribed a small dose of diazepam (5 mg) or short acting benzodiazepines, such as oxazepam (30 mg) the night before and 1 hour before treatment.<sup>24</sup> Nitrous oxide can also be used for more anxious patients.

The duration of the dental procedure also have an impact on the patient's blood pressure. The average duration of the SRP visit is one to two hours. The average duration of the periodontal surgical visits is forty-five minutes to three hours. The longer the duration of the procedure, the greater is the increase in patient's arterial blood pressure. Therefore long appointments should be minimized when treating patients with hypertension.

Operative pain can increase the patient's blood pressure. Providing the patient with pain-free dental services by giving local anesthesia will help in minimizing the rise in patient's arterial blood pressure. Epinephrine in local anesthetics should be used with caution especially in patients

who are hypertensive. According to the literature, most patients with controlled hypertension can safely be given up to two cartridges of 2% lidocaine with 1:100,000 epinephrine (0.036 mg epinephrine)<sup>24</sup>.

The present study sought to evaluate the changes in arterial blood pressure during periodontal procedures under local anesthesia in hypertensive and non-hypertensive patients. It also aimed to evaluate if there is any significant difference in systolic and diastolic blood pressures between gender, age groups and between different types of blood pressure medications. Fifty-nine patients enrolled and consented to participate in this study. Twenty-eight of them were diagnosed with hypertension (SBP > 140 and or DBP > 90mm Hg) who were controlled with hypertensive medications and thirty one of them were non- hypertensive. Local anesthesia of 2% Xylocaine with 1: 100,000 epinephrine was used during scaling and root planing as the initial phase for periodontal treatment and during the periodontal surgery phases. The use of vasoconstrictors in local anesthetics ensures a more prolonged effect of the anesthetic agent at the site of deposition. The sympathetic response after administration of local anesthesia is not only mediated by the vasoconstrictive effect of epinephrine but also it is mediated by the painful stimuli of the injection and the psychological stress. Its use in hypertensive patients remains controversial due to potential side effects.<sup>12</sup>

In our study, we found that there was no statistically significant difference in arterial blood pressure during SRP and periodontal surgery under local anesthesia between hypertensive and non hypertensive groups. This finding is in agreement with other studies. Miller et al ( ) concluded in his study that hypertensive patients experience minimal fluctuations in blood pressure that are no greater than those in normotensive patients and, therefore, may present no greater clinical risk during the dental stress associated with certain oral surgical procedures.<sup>5</sup> Another study by Faraco et al ( ) concluded that there were no changes in the analyzed cardio-circulatory parameters during dental implant surgery (systolic,

diastolic, and mean arterial blood pressures and heart rate) in normotensive subjects anesthetized with 2% lidocaine with epinephrine 1:80 000.<sup>15</sup> Also, Matsumura et al ( ) showed in their study that in the preliminary analysis of the changes in blood pressure and heart rate variability in hypertensive and normotensive patients, they did not detect differences in the blood pressure and heart rate variability responses between normotensive and hypertensive patients.<sup>2</sup>

In this study, age has no statistical influence on arterial blood pressure. However, some studies showed that the responses and the regulation of the autonomic nervous system between younger and older patients are different during dental surgery. The function and the regulation of the autonomic nervous system are impaired in elderly patients which might explain the increase in arterial blood pressure during the administration of local anesthesia.<sup>2</sup>

Recent psychological studies suggest that women display a stronger anticipatory response to stressful events in general. This seems to apply to the dental setting as well, since in women the heart rate before dental treatment is higher than in men'. This gender related difference in heart rate is a long-term effect. Even 24 hours before a scheduled check-up, the mean heart rate of women is higher.<sup>10</sup> No studies were found regarding the arterial blood pressure difference between males and females during dental procedures under local anesthesia. In our study we found out that gender has no statistical significant influence on arterial blood pressure during SRP and periodontal surgical procedures.

In this study, there was no statistical significant difference in systolic and diastolic blood pressure in hypertensive patients taking different types of blood pressure medications including calcium channel blockers, B-blockers, ACE-Inhibitors, Angiotensin 2 receptor blockers and diuretics. Although, it would seem physiologically reasonable that some antihypertensive medications, such as adrenergic inhibitors and vasodilators may alter the tendency of patient's blood pressure to vary during stress. This effect has not been described in the literature. In addition, patients being treated with diuretics alone,

would not be expected to demonstrate such an effect.<sup>5</sup>

The clinical significance of cardiovascular changes caused by dental treatment is a controversial topic and remains the subject of continuing study. For the most part, the mean cardiovascular changes induced by dental treatment are limited. Increases in blood pressure and heart rate can provoke arrhythmias, anginal attacks and myocardial infarctions in patients with a compromised cardiovascular risks and in normotensive patients as well. Pain and fear-anxiety play important roles in the cardiovascular changes during dental treatment. Thus it is important to follow stress reduction protocol on all dental patients and use adequate amount of local anesthesia and not exceeding 1:100,000 of epinephrine.<sup>10</sup>



## **Conclusion:**

In our study, we found out that:

- There was no statistically significant difference in systolic and diastolic blood pressure between hypertensive and normotensive patients during SRP and surgical visits under local anesthesia.
- There was no statistical significant difference in systolic and diastolic blood pressure between males and females during SRP and surgical visits under local anesthesia.
- There was no statistical significant difference in systolic and diastolic blood pressure between different age groups.
- There was no statistical significant difference in systolic and diastolic blood pressure between different types of blood pressure medications.

Although, age, gender, blood pressure medications and hypertensive status have no statistical significance influence on the arterial blood pressure in both hypertensive and normotensive patients during SRP and periodontal surgical visits, it is important to take the pre-operative blood pressure measurements in both hypertensive and normotensive patients to avoid or minimize the chances of getting life-threatening complications during dental treatment under local anesthesia.

Since there might be some hidden medical background of the patient that might lead to complications during periodontal treatment. Therefore, we must medically assess our patients in a proper way to minimize the possibility of any risks that might occur.

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## **Curriculum Vitae:**

### **Personal Details:**

<b>Full Name</b>	Taiba Taleb AlSarraaf
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### **Education:**

- Mishref High School – Kuwait (June,2004), GPA = 3.94 (on the 4 point system).
- Kuwait University, Faculty of Dentistry:
  - Bachelor degree of Medical Science (B.M.S), 2008.
  - Bachelor degree of Dental Medicine (B.D.M), 2011.
  - GPA = 3.23 (on the 4 point system)
  - Class Rank: Second place.
- KBR-1 degree 2011.
- NBDE part 1 (2012).

- Currently I am a third year perio resident at Boston University Finishing in July 2016.

### **Awards:**

- Rewarded by his Highness Ameer of Kuwait Al sheikh Sobah Al Ahmed in 2009 as an honor graduate student.
- Rewarded by the Prime Minister of Education and High Education as an honor student in 2009.
- Won the student competition in AEEDC Dubai conference (10-12 March 2009).
- Rewarded on 16<sup>th</sup> of April 2012 by his Highness Ameer of Kuwait as an honor graduate dentist.

### **Conferences**

- Attended the Kuwait Dental Association 13<sup>th</sup> Conference (13-15 January 2007)
- Participated in the 10<sup>th</sup> International Annual Conference of the Kuwait Association for Dental Research (4-5 December 2010).
- Attended the 15<sup>th</sup> Kuwait Dental Association Scientific Conference (2011).
- Attended the 16<sup>th</sup> Kuwait Dental Association International Scientific Conference and the Third for Workshop.
- Attended AEEDC Dubai conference (2009).
- Attended the AAP meeting in San Francisco 2014 and in Orlando 2015.

### **Extra Curricular Courses:**

- SPSS training at Kuwait University (2010).
- Standard First Aid and CPR course at Dasman Diabetic center (2011).
- Standard First Aid and CPR course at Boston University (2013).
- ACLS certified (2013).

**Student Society Membership:**

- Member of the Kuwait Dental Student Society (KDSS) in (2008, 2009).