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Cardiopulmonary Changes after Dental Procedures with Adrenaline Containing Local Dental Anesthesia

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Authors' contributions

This work was carried out in collaboration between all authors. Author ME designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors OA and HY recorded the hemodynamic changes, heart rate and blood pressure and literature searches. Author AB participated in the clinical part of the research and author AS performed the dental procedure to the patient. All authors read and approved the final manuscript.

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ABSTRACT

Background: The injection of adrenaline containing local dental anaesthesia may be associated with variable adverse effects on the cardio- respiratory system that are clinically undetectable.
Methods: The present study was conducted on 60 male patients who received adrenaline containing local dental anaesthesia, and 30 male patients who did not receive local dental anesthesia as a control group. Careful history taking, clinical examination, heart rate, SBP, DBP, MBP, respiratory rate, spirometry to measure FEV1, PEF, and oximetry to measure O2 saturation before and 15 minutes after dental procedures were obtained.
Results: Our results showed high statistical significant increase in HR, SBP, DBP, MBP, RR, and decrease in O2 saturation, FEV1, and PEF after dental procedures with adrenaline containing local

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dental anesthesia compared to baseline values in patients group, and a high statistical significant increase in RR only after dental procedures in control group.
Conclusion: Dental procedures with adrenaline containing local dental anesthesia have a stressful effect on the cardio respiratory systems as evidenced by the statistically significant increase in HR, SBP, DBP, MBP, RR, and statistically significant decrease in O2 saturation, FEV1, and PEF after dental procedures compared to baseline values.

Keywords: Cardiopulmonary changes; lung function; oxygen saturation; adrenaline containing local dental anaesthesia.

ABBREVIATIONS

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MBP: Mean Blood Pressure; FEV_1: Forced Expiratory Volume in the First Second; PEF: Peak Expiratory Flow; RR: Respiratory Rate; HR: Heart Rate.

1. INTRODUCTION

Dental practitioners use local anesthetics very frequently in their daily practice [1]. Local dental anesthesia is believed to control pain that result from dental procedures. Fear and psychological stress resulting from the painful injections, and oral tissue manipulation discomfort may be associated with varying degrees of hemodynamic changes that are clinically indetectable [2-6]. The secretion of endogenous catecholamines can be induced by pain and anxiety triggered by dental procedures. When the condition is associated with the injection of local anesthetics with vasoconstrictors, it may increase their unwanted effects on the cardio- respiratory system [7-9]. Local anesthetic agents containing sulfites may induce bronchospasm in asthmatic patients [7]. The respiratory rate, O_2 saturation and/ or CO_2 levels in the blood can be altered by stress and anxiety [10]. The aim of the present work is to assess the impact of dental procedures with and without adrenaline containing local dental anesthesia on cardiopulmonary variables.

2. METHODS

The present case controlled study was conducted on 60 male patients who received adrenaline containing local dental anesthesia and 30 male patients that felt comfortable with dental procedure without local dental anesthesia as a control group. Patients attended the male dental clinics of college of Dentistry in the period between October 2014 and January 2015 was included in this study.

All patients and control group were subjected to thorough history taking, and clinical examination, intraoral examination (screening), dental Panoramic X ray to detect the patient complaint and the dental procedure required for the patient. Heart rate (HR), systolic (SBP), diastolic (DBP), mean blood pressure (MBP) and respiratory rate (RR) before and 15 minutes after dental procedures were collected. Mean blood pressure was calculated by the following equation: MBP = [(2 x diastolic) +systolic] / 3. Spirometry to measure forced expiratory volume in the first second (FEV1), peak expiratory flow (PEF), and pulse oximetry to measure O_2 saturation before and 15 minutes after dental procedures. Baseline readings for spirometry, and O_2 saturation by pulse oximetry were taken after rest for five minutes in the dental chair. The readings were also taken 15 minutes after dental procedure. Patients had no fear of the dental procedure. Adrenaline containing local dental anesthetics was administered using 1.8 ml of (Scandicaine 2% special) injectable solution. Each 1.8 ml cartridge contains Mepivacaine hydrochloride 36 mg, adrenaline 0.018 mg, sodium chloride 11.70 mg, potassium metabisulfite 2.16 mg corresponding to 1,24 mg so_2, sodium edetate 0,45 mg, concentrated hydrochloric acid 0,024 microml, sodium hydroxide solution, water for injection.

The collected data were analyzed using statistical analysis system SAS [11]. Data was presented using freque54ncies, mean and standard deviation as appropriate. Mann Whitney and Fischer's exact tests were used to compare the characteristics between the studied cases (with local dental anesthesia) and controls (without local dental anesthesia). Paired t test was used to compare cardiopulmonary parameters before and after dental procedure in cases and controls. $P \leq 0.05$ was considered of statistical significance.

3. RESULTS

This study was conducted on 60 patients with ages ranged from 19 to 57 years and a mean of 34.4 ± 11.5 years who received local dental anesthesia, and 30 patients with ages ranged from 20 to 55 years and a mean of 32 ± 11.5 years who did not receive local dental anesthesia as a control group. Our findings showed 28 out of 60 Patients (46.66%) of local dental anesthesia group, and 12 out of 30 Patients (40%) of control group were smokers. Diabetes mellitus and hypertension were found in 10 Patients (16.66%), of local dental anesthesia group, whereas 3 Patients (10%) had D.M., and 4 patients (13.33%) had hypertension in the control group. Sixteen Patients were subjected to dental filling, 24 to tooth extraction, 18 to oral surgery, and two to dental scaling in local dental anesthesia group. While 18 Patients were subjected to dental filling, and 12 Patients to dental scaling in control group (Table 1).

Our results showed high statistical significant increase in HR, SBP, DBP, MBP, RR, and decrease in O_2 saturation, $FEV_{1,}$ and PEF after dental procedures with adrenaline containing local dental anesthesia compared to baseline values in patients group, and high statistical significant increase in RR, and statistical insignificant difference in HR, SBP, DBP, MBP, O_2 saturation, $FEV_{1,}$ and PEF after dental procedures compared to baseline values in control group (Table 2).

Our data showed highly statistical significant increase in mean values of HR, SBP, and decrease in mean values of O_2 saturation, $FEV_{1,}$ and PEF after dental procedures compared to baseline values in patients with adrenaline containing local dental anesthesia group compared to control group. But no statistical significant changes in mean values of DBP, MBP, and RR between both groups (Table 3).

Our results showed high statistical significant increase in HR, SBP, DBP, MBP, and decrease in O_2 saturation, $FEV_{1,}$ and PEF after all dental procedures with adrenaline containing local dental anesthesia compared to baseline values in patients group, and high statistical significant increase in RR after tooth extraction only with adrenaline containing local dental anesthesia compared to baseline values in patients group (Table 4).

4. DISCUSSION

Effective dental care is difficult to provide under most conditions, without local dental anesthetics and vasoconstrictors [7]. The haemodynamic effect of vasoconstrictors combined in local dental anaesthetics had been investigated for many years [12-14]. Side effects of local dental anesthesia may be attributed to the anesthetic agent and any vasoconstrictor contained in the injectable solution [15]. Monitoring of cardiovascular parameters has been continuously exploited by dentists during dental surgical procedures, and in research trials,

Table 1. Patient characteristics of the studied groups

	Patients with local dental anesthesia group No=60	**Control group No=30**
Age (years): M±SD	34.4 ± 11.5	32 ± 11.5
Maximum age (years):	57	55
Minimum age (years):	19	20
Gender:		
Males	60	30
Females	0	0
Smoking habit		
Smokers	28 (46.66%)	12 (40%)
Non smokers	32 (53.33%)	18 (60%)
Associated D.M.	10 (16.66%)	3 (10%)
Associated hypertension	10 (16.66%)	4 (13.33%)
Cardiac disease	0	0
Respiratory disease	0	0
Type of dental procedures:		
Filling	16 (26.66%)	18 (60%)
Tooth extraction	24 (40%)	0
Oral surgery	18 (30%)	0
Scaling	2 (3.33%)	12 (40%)

Table 2. Cardiopulmonary changes after dental procedures with and without adrenaline containing local dental anaesthesia

Cardiopulmonary variables	Patients with local dental anesthesia group No =60		Control group No=30	
	Before dental procedures M ± SD	After dental procedures M ± SD	Before dental procedures M ± SD	After dental procedures M ± SD
Heart rate (HR) (beat/min)	78.8 ± 11.9	88.7 ± 10.1 P <.0001*	73.6 ± 7.4	74.6 ± 11.5 P< 0.13
SBP mmHg	129.9 ± 15.6	148.9 ± 17.9 P <.0001*	135.7 ± 12.5	136.1 ± 11.5 P < 0.87
DBP mmHg	87.1 ± 8.6	97.1 ± 8.5 P <.0001*	85.9 ± 8.7	88.3 ± 7.9 P <.10
MBP mmHg	101.4 ± 10.0	114.4 ± 9.9 P <.0001*	102.5 ± 9.2	104.2 ± 8.0 P< .23
Respiratory rate (RR) breath/min	15.8 ± 1.9	16.3 ± 1.5 P <.01*	15.4 ± 1.1	16.4 ± 1.6 P <.0001*
O_2 Saturation %	97.7 ± 0.97	97.2 ± 0.99 P <.0001*	97.3 ± 0.8	97.3 ± 0.9 P< .98
FEV_1 L/sec	2.9 ± 0.62	2.3 ± 0.51 P <.0001*	2.8 ± 0.8	2.6 ± 0.6 P< .28
PEF L/sec	386 ± 60.9	358 ± 62.5 P <.0001*	344.5 ± 62.7	336 ± 65.5 P <.40

Table 3. Mean change of cardiopulmonary variables after dental procedures with and without adrenaline containing local dental anaesthesia

Mean change of cardiopulmonary variables Mean ±SD	Patients with local dental anesthesia group No =60	Control group. No=30	P value
Heart rate (HR) (beat/min)	9.8 ± 8.2	3.0 ± 1.1	<.0001*
SBP mmHg	19.0 ± 13.8	11.9 ± 0.3	0.01*
DBP mmHg	10.0 ± 6.7	6.1 ± 2.4	0.68
MBP mmHg	13.0 ± 7.1	5.9 ± 1.7	0.43
Respiratory rate (RR) breath/min	1.1 ± 0.5	1.2 ± 1.0	0.76
O_2 Saturation %	0.7± 0.5	1.1 ±0.0	0.02*
FEV_1 L/sec	0.6±0.2	0.5 ± 0.2	<.0001*
PEF L/sec	28.6 ±18.0	43.1± 8.1	<.0001*

aiming to record hemodynamic changes in healthy subjects and those with cardiovascular disease [16-21]. Local anesthetic agents containing sulfites may induce bronchospasm in asthmatic patients [7]. Results of the present study revealed high statistical significant increase in HR, SBP, DBP, and MBP after dental procedures with adrenaline containing local dental anesthesia patients group compared to baseline values. This is in accordance to Haghighat et al. [22] who observed a significant increase in SBP, and DBP which decreased after injection ended. The increment in heart rate after 15 minutes could be explained by the vasodilating effect of Mepivacaine. Also, Shaban et al. [23] demonstrated no significant difference detected in SBP, DBP, and MAP at the end of injection and 10 min later. HR was increased significantly after injection and remained significantly higher than baseline after 10 min. Similarly, three studies observed an elevation in the SBP, and DBP from baseline with the injection of local anesthetic containing epinephrine. No significant differences in MBP from baseline values were recorded after dental procedures using local anesthetic with or without epinephrine [24,25,26]. The maximum MBP recorded with the injection of local anesthetic in two out of five studies. These results were recorded immediately or two minutes after injection of local anesthetic. MBP was noticed to return to baseline by 5 minutes or immediately

after dental procedure, respectively [24,26]. Niwa et al. [26] reported a statistical significant increase in heart rate at the time of the local dental injection of lidocaine with epinephrine in their work when they recorded heart rate at 0, 2, 5, and 10 minutes after the injection and. On the other hand, Al–Saffar et al. [27] in their study showed statically insignificant hypotension and statistical significant increase in heart rate ($p < 0.05$) after tooth extraction with administration of infiltration local anesthesia. Davenport et al. [28], reported significantly increased plasma epinephrine following injection of local dental anesthetic and epinephrine, but no significant changes in heart rate and MBP. Up to our knowledge, available literatures concerning the changes in pulmonary function and O_2 saturation after dental procedures with adrenaline containing local dental anaesthesia are limited. Aeschliman et al. [10] demonstrated that the respiratory rate, O_2 saturation and/ or CO_2 blood values can be altered by stress and anxiety. Our results revealed high statistical significant increase in RR, and highly statistical significant decrease in O_2 saturation, $FEV_{1,}$ and PEF after dental procedures compared to baseline values in patients with local dental anesthesia group. This is in agreement with Emara et al. [29] who demonstrated that pulmonary function results revealed statistical significant decrease in PEF and O_2 saturation after dental procedures compared to pre-procedures results in patients with bronchial asthma, and statistical significant reduction in O_2 saturation after dental procedures compared to pre-procedures results in healthy group. Also, Mathew et al. [30] who performed the lung function for 57 asthmatic patients with ages ranging from 6- to 18-year-old as a baseline, immediately after and after 30 minutes of dental treatment. Their findings showed statistical and a clinical significant reduction of pulmonary functions in approximately 15 % of the subjects. Similarly, in a study conducted by Kaviani et al. [31] the mean value of Spo_2 detected by pulse oximetry before local anesthetic injection was 98.2% and remained unchanged during surgery. The mean values of the pulpal Spo_2 in the adjacent tooth, before and after local anesthesia were 87.73 and 79.27%, respectively with statistically significant decrease; immediately after surgery, it was 86.13% and one hour after surgery was 86.4%. Sulphites are widely used as preservative additives in the food, drinks and pharmaceutical products. Adverse clinical side effects had been reported on exposure to sulphites in sensitive individuals and ranging from dermatitis, urticaria, flushing, hypotension, abdominal pain and diarrhoea to life-threatening anaphylactic and asthmatic reactions [32]. Changes of FEV_1, PEF and oxygen saturation levels after dental procedures with adrenaline containing local dental anesthesia in our studied patients could be explained by sulfite preservative contents of local anesthetics which has a bronchoconstrictor effect. Also, according to the potential effect of adrenaline, bronchial smooth muscle will be relaxed, and vasoconstriction will also occur. Based on this basic mechanism, beta adrenergic agonist will alter ventilation/perfusion mismatch in whole lung, so it may change PaO2. Silvestre et al. [33] in their study found no significant changes were detected in heart rate, arterial pressure, and SpO_2 recorded at three separate time intervals during tooth extraction in controlled hypertensive patients. Our results showed high statistical significant increase in HR, SBP, DBP, MBP, and decrease in O_2 saturation, $FEV_{1,}$ and PEF after all dental procedures with adrenaline containing local dental anesthesia compared to baseline values in patients group, and high statistical significant increase in RR after tooth extraction only with adrenaline containing local dental anesthesia compared to baseline values in patients group. Changes in heart rate and oxygen saturation levels in the present study may be explained by the impact of pain and other factors such as age, sex, history of hypertension, previous dental procedures, adrenaline containing local dental anesthesia and psychological response [34]. We concluded that dental procedures whatever its type. Changes in heart rate and oxygen saturation levels in the present study may be explained by the impact of pain and other factors such as age, sex, history of hypertension, previous dental procedures, adrenaline containing local dental anesthesia and psychological response [34]. We concluded that dental procedures with adrenaline containing local dental anesthesia have a stressful effect on the cardio respiratory systems as evidenced by the statistically significant increase in HR, SBP, DBP, MBP, RR, and statistically significant decrease in O_2 saturation, $FEV_{1,}$ and PEF after dental procedures compared to baseline values. There are two limitations for this study, firstly, the relative limited number of the studied patients and absence of female patients as the study was conducted at the male dental clinics of faculty of Dentistry. Secondly, the relative small number of dental procedures and the single use of adrenaline containing local dental anesthetic agent.

Table 4. Cardiopulmonary changes after dental procedures with adrenaline containing local dental anaesthesia

Cardiopulmonary variables mean ±SD	Tooth extraction (n= 24)		Dental scaling (n= 2)		Oral surgery (n= 18)		Dental filling (n= 16)	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
HR (beat/min)	78.1 ± 13.3	87.3 ± 10.9 P< 0.02*	74±12.8	87±11.2 P<0.001*	80.6 ± 13.4	92.0 ± 9.2 P<0.001*	76.3 ± 9.3	87.1 ± 10.7 P<0.0002*
SBP mmHg	128.8 ± 11.1	144 ± 13.5 P<.0001*	127±11.5	135±12.9 P<.0001*	138 ± 17.4	160 ± 20.4 P<0.001*	122.6 ± 18.0	145.5 ± 14.7 P<0.01*
DBP mmHg	88.6 ± 9.5	98 ± 9.1 P<0.004*	82±8.9	95±9.3 P<.0001*	87.7 ± 8.9	98 ± 2.3 P<0.0003*	89.6 ± 7.7	99.8 ± 10.2 P<0.001*
MBP mmHg	102.1 ± 9.8	133.3 ± 9.5 P<0.0004*	97±9.7	108.3±9,3 P<.0001*	104.5 ± 10.7	118.6 ± 9.4 P<.0001*	97.3 ± 9.6	111.7 ± 11.2 P<0.001*
RR breath/min	15.7 ± 1.7	16.4 ± 1.6 P<0.01*	14.4±1.2	15±2.5 P<0.26	16.2 ± 1.4	16.6 ± 1.3 P<0.22	15.6 ± 2.7	16 ± 1.5 P<0.54
O_2 saturation %	97.5 ± 1.3	97 ± 1.2 P<0.01*	98±1.2	97±1.1 P<.0001*	98 ± 0.7	97.4 ±0.5 P<0.01*	97.8 ± 0.6	97.3 ± 1.1 P<0.13
FEV_1 L/sec	2.5 ± 0.7	2.3 ± 0.6 P<0.001*	2.6±.75	2.5±0.6 P<0.22	2.5 ± 0.5	2.2 ± 0.6 P<0.001*	3.6 ± 0.5	2.5 ± 0.4 P<0.01*
PEF L/sec	296.3 ± 74.3	266.3 ± 75.3 P<.0001*	270±74.4	230±94.1 P<.0001*	259.4 ± 48.8	229.5 ± 95.5 P<0.003*	305.6 ± 49.1	281.8 ± 54.6 P<0.02*

**Significant*

5. CONCLUSION

Dental procedures with adrenaline containing local dental anesthesia have a stressful effect on the cardio respiratory systems as evidenced by the statistically significant increase in HR, SBP, DBP, MBP, RR, and statistically significant decrease in O_2 saturation, $FEV_{1,}$ and PEF after dental procedures compared to baseline values.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this paper and accompanying images'.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by Taibah University College of Dentistry Research Ethics Committee (TUCD REC) organized and operated according to the Saudi national regulation of the national bioethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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