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Research Article

Hemodynamic Effect of 2% Lidocaine with a 1:100,000 Adrenaline in Patients with Cardiovascular Diseases Undergoing Single Tooth Extraction

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ABSTRACT

Objective: To assess the effect of vasoconstrictor in dental local anaesthetic on hemodynamic parameters in patients with cardiovascular disease following tooth extraction.

Methods: This prospective study was conducted at Al-Manara college for medical sciences, Amarah, Iraq. The sample of the study included 50 patients with cardiovascular disease who were presented for extraction of a single mandibular molar under local anaesthesia. The local anaesthesia was achieved with inferior alveolar nerve block using single cartridge of 2% lidocaine with 1:100,000 adrenaline. Systolic and diastolic blood pressure, heart rate, and oxygen saturation were measured before injection, immediately after injection, and after 5 and 15 minutes of injection.

Results: Although the systolic blood pressure and heart rate were elevated, the diastolic blood pressure was decreased and no change was seen in the oxygen saturation.

Conclusion: The local anaesthetic injection of lidocaine with adrenaline, along with the surgical procedure of tooth extraction, produces significant increase in the systolic blood pressure and heart rate in the patients with cardiovascular diseases.

Keywords: Adrenaline; Anaesthetic; Cardiovascular disease; Lidocaine; Tooth extraction

INTRODUCTION

In minor oral surgical procedures, Local Anesthetics (LA) are frequently employed for safe and efficient intraoperative and perioperative pain management. The nerve impulse from the teeth and the surrounding soft tissues is irreversibly interrupted by LA. The most commonly used local anesthetics nowadays are the combination of lidocaine, the most popular amide, and adrenaline, the most popular vasoconstrictor. Without a vasoconstrictor, lidocaine does not provide a sufficient duration of anesthetic activity, which can result in intraoperative pain, systemic endogenous catecholamine release, and detrimental cardiovascular problems like an increase in blood pressure and heart rate and possibly even arrhythmia [1]. Adrenaline is the most commonly used vasoconstrictor that has both local and systemic effects at the injection site. Adrenaline stimulates 1 receptors in peripheral blood arteries, which causes vasoconstriction [2]. Stimulation of β_1 receptors by adrenaline increases the heart rate and raises the blood pressure [3]. When mixed with adrenaline, a vasoconstrictor, lidocaine, a vasodilator when given alone, creates a combination that tends to counteract the effects of the former. It is generally recognized that this combination can increase anesthesia's clinical depth while also reducing systemic lidocaine toxicity and minimizing blood loss during tooth extraction [4,5].

Adrenaline's potential adverse effects include dose-dependent cardio-vascular consequences. Cardiovascular Diseases (CVD) affect a wide range of patients, with essential hypertension, ischaemic heart disease, rheumatic heart disease, valvular heart disease, congenital heart disease, arrhythmias, heart failure, transient ischemic attacks, and cerebrovascular diseases among

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the most prevalent [6]. Lidocaine and adrenaline combination used for oral surgery may cause intraoperative hemodynamic changes during surgery [7]. These systemic side effects are primarily caused by poor technique, such as administering nerve block injections without adequate aspiration, injecting a high dose, interfering with other medications, or allowing the anesthetic ingredient to immediately take effect when injected into a highly vascular location [8,9]. The surgeon can operate more safely by keeping track of these patients' hemodynamic changes because it can help avoid emergencies [10].

The use of local anesthetics with adrenaline has drawn criticism since, even with correct technique, there is a conceivable chance of systemic absorption, which could have negative cardiovascular effects, especially in individuals with cardiovascular disorders [11]. It is also widely believed that the use of local anesthetics combined with adrenaline puts patients with heart illness, particularly those who have undiscovered cardio-vascular conditions, at risk for life-threatening medical problems [12].

This study evaluated the safety of adrenaline in local anaesthesia on cardiovascular events in patients with CVD.

MATERIALS AND METHODS

This prospective study was conducted at the faculty of dentistry at Al-Manara college of medical sciences, Amarah, Iraq, from September 29th 2022 to April 1st 2023. Fifty patients with cardiovascular disease, who needed single tooth extraction, were included in the study. All patients were anaesthetized with one cartridges of 1.8 ml Local Anaesthesia (LA), containing 2% lidocaine with 1:100,000 adrenaline. Four hemodynamic parameters were measured, including systolic blood pressure, diastolic blood pressure, heart rate and oxygen saturation. The parameters were measured immediately before local anaesthetic injection, immediately after injection, and after 5 and 15 minutes of injection. Inclusion criteria: Patients who were diagnosed with hypertension and other cardiovascular diseases. Patients were excluded if they need surgical removal of the tooth, or the tooth was fractured at the time of extraction.

The inferior alveolar nerve was administered using aspirating dental syringe. If the blood was encountered in the cartridge during aspiration, the needle was pulled out of the injection site and the cartridge was replaced with a new one.

All procedures were performed in morning sessions with relaxed atmosphere and without having been prescribed any preoperative anxiolytic medications. On the dental chair, a pulse oximeter (merlin medical® pulse oximeter) was applied to the left index finger to measure the oxygen saturation. The blood pressure and heart rate were measured by an electronic sphygmomanometer (OMRON® automatic blood pressure monitor).

Statistical analysis was performed using SPSS software (IBM corp. released 2017. IBM SPSS statistics for windows, version 25.0. Armonk, NY: IMB Corp). Comparisons between the groups was carried out using a dependent t test. The significance level was set at $P \leq 0.05$.

RESULTS

The sample size of the study was 50 patients, 29 (58%) females and 21 (42%) males with a mean age of 47 ± 18 years (range 38-77 years). Hypertensive patients was 41 (82%), 4 (8%) patients had angina pectoris and 5 (10%) patients suffered from arrhythmias.

The systolic blood pressure showed no significant changes immediately after injection; however, after five minutes of the injection there was a statistically significant increase in the systolic blood pressure from 130.4 mmHg to 134.6 mmHg (p=0.006). The systolic blood pressure return back to its nearly normal value 15 minutes after injection (Table 1). The diastolic blood pressure showed a statistically significant reduction immediately after injection, from 69.1 mmHg to 65.8 mmHg (p<0.001). At 5 and 15 minutes after injection the diastolic blood pressure is significantly different from the baseline measurement (Table 2).

Table 1: Comparison of systolic blood pressure at different time points after injection.

	Systolic blood pressure (mmHg)					
	Pair 1		Pair 2		Pair 3	
	Before	Immediately after	Before	After 5 mins.	Before	After 15 mins.
Maximum	154	155	154	160	154	159
Minimum	123	128	123	130	123	136
Mean	130.4	131.9	130.4	134.7	130.4	130.1
SD	15.7	14.9	15.7	15.2	15.7	14.8
T-value	1.4		2.9		0.3	
P-value	0.16		0.006		0.788	

Table 2: Comparison of diastolic blood pressure at different time points after injection.

	Diastolic blood pressure (mmHg)					
	Pair 1		Pair 2		Pair 3	
	Before	Immediately after	Before	After 5 minutes	Before	After 15 minutes
Maximum	90	88	90	102	90	88
Minimum	67	64	67	65	67	66
Mean	69.1	65.8	69.1	67.5	69.1	68.3
SD	13.3	12.8	13.3	15.4	13.3	12
T-value	6.4		1.1		1.4	
P-value	0		0.275		0.167	

The heart rate showed a statistically significant increase from the baseline, immediately after injection (91.4 *vs.* 94.9, p=0.007) and after 5 minutes of injection (91.4 *vs.* 95.1, p=0.004) (Table 3). After 15 minutes, the heart rate returned back to its pre-injection value. There was no a significant change in the oxygen saturation at the three time points after injection (Table 4).

Table 3: Comparison of heart rate at different time points after injection.

	Heart rate (beat/minute)					
	Pair 1		Pair 2		Pair 3	
	Before	Immediately after	Before	After 5 minutes	Before	After 15 minutes
Maximum	115	118	115	160	115	159
Minimum	65	72	65	130	65	136
Mean	91.4	94.9	91.4	95.1	91.4	91.3
SD	10.9	11.1	10.9	10.8	10.9	10.8
T-value	2.8		3.1		0.08	
P-value	0.007		0.004		0.935	

Table 4: Comparison of oxygen saturation at different time points after injection.

	Oxygen saturation (%)					
	Pair 1		Pair 2		Pair 3	
	Before	Immediately after	Before	After 5 minutes	Before	After 15 minutes

Maximum	100	100	100	100	100	100
Minimum	85	83	85	86	85	87
Mean	94.1	94.6	94.1	94.1	94.1	94.8
SD	4.8	3.4	4.8	3.3	4.7	2.9
T-value	1.1		0.07		1.2	
P-value	0.293		0.943		0.248	

DISCUSSION

This study examined the impact of a local anesthetic combining lidocaine (2%) and adrenaline (1:100,000) on the heart rate, oxygen saturation, systolic blood pressure, and diastolic blood pressure in patients with cardiovascular disorders undergoing single tooth extractions. The measurements of these variables were carried out before, immediately after, and at five and fifteen minutes after the injection of local anesthetic.

This study indicated that in individuals with cardiovascular illness, systolic blood pressure significantly increased 5 minutes after injection. In addition, the heart rate significantly increased immediately following injection and lasted for 5 minutes. Immediately following injection, the diastolic blood pressure statistically significantly decreased before returning to almost pre-injection levels.

The tension and apprehension during tooth extraction and the impact of exogenous adrenaline may be responsible for the hemodynamic alterations [13]. The stimulation of peripheral alpha-1 receptors, which predominantly raises blood pressure through induced vasoconstriction and contraction of vascular smooth muscles, may be responsible for an increase in systolic blood pressure. The stimulation of beta-2 receptors, which results in dilatation of blood arteries in skeletal muscles, may be the cause of the drop in diastolic blood pressure. The beta-1 receptors in the heart are responsible for mediating the rise in heart rate [14].

The sympathomimetic catecholamine adrenaline has pharmacologic effects on both alpha and beta-adrenergic receptors. In modest doses, it has a stronger affinity for beta receptors. Large doses, however, have a selective effect on alpha receptors. Adrenaline causes enhanced vascular smooth muscle contraction, pupillary dilator muscle contraction, and intestinal sphincter muscle contraction through its impact on alpha-1 receptors. Increased heart rate, myocardial contractility, and renin release *via* beta-1 receptors are additional major effects [15].

The American heart association recommended that the maximum dose of adrenaline in local anesthesia for a healthy individual is 0.2 mg however, if the patient has serious cardiovascular disease, this should be reduced to 0.04 mg. In comparison to the maximal dose in healthy people, which is 0.2 mg, a local anesthetic cartridge containing adrenaline at a concentration of 1:100,000 have 0.018 mg of adrenaline. This amount of adrenaline is present in 11 cartridges of 1.8 ml. The maximum recommended dose of adrenaline for local anesthetic injections given to individuals with cardiovascular disease is 0.04 mg, which only includes 2.2 cartridges containing 1.8 ml [16].

Abraham, et al., endings on cardiovascular problems expected after normal dental care and our study are consistent [17]. They discovered that intraoral injection of 2% lidocaine with 1:100,000 adrenaline resulted in a higher rise in blood pressure in hypertensive patients undergoing tooth extraction. The results of our investigation are likewise consistent with those of Niwa, et al., who assessed the safety of using local anesthesia including adrenaline in patients with cardiovascular disease. Impedance cardiography was used to monitor the hemodynamic response to an intraoral injection of 1.8 ml of 2% lidocaine and 1:80,000 adrenaline [18]. Ten minutes after the injection, they saw substantial cardiovascular changes and theorized that these changes were minor and within normal limits. Additionally, it was noted that the heart rate and systolic blood pressure elevated from the baseline by 5.1% and 4.1% respectively, while diastolic blood pressure decreased by approximately 10%.

Our study group's drop in diastolic blood pressure is comparable to that of Chaudhry, et al., who discovered that pre-hypertensives and stages I and II hypertensives saw drops in mean diastolic blood pressure five minutes after receiving local anesthesia injections [19]. Chaudhry, et al., also discovered that after two minutes of injection of two cartridges containing 2% Lidocaine with 1:100,000 adrenaline, the mean systolic blood pressure increased in pre-hypertensive, hypertensive stage I and II patients. Systolic blood pressure recovered to normal in all groups after the injections lasted for five minutes, and in hypertension stage II patients, it even decreased somewhat.

Santos, et al., examined the usage of local anesthetics used in the removal of lower third molars that included 4% articaine combined with 1:100,000 (10 mug/mL) or 1:200,000 (5 mug/mL) adrenaline [20]. In two sessions, fifty healthy patients underwent local anesthesia using either 1:100,000 or 1:200,000 adreanaline to remove their symmetrically positioned lower third molars. They did not discover a significant difference in the measurements of systolic and diastolic blood pressure with injection, in contrast to our findings.

2% lidocaine and epinephrine 1:100,000 (L100) or 4% articaine and epinephrine 1:200,000 (L200) were the local anesthetics used in the study by de Morais, et al., to analyze hemodynamic changes following the surgical removal of symmetrically

positioned lower third molars. Systolic, diastolic, and mean blood pressure measurements at any evaluation time showed no hypertensive peak. Additionally, neither oxygen saturation nor diastolic blood pressures were impacted by the anesthetic solution type. Kammerer, et al., conducted a study to compare and assess the clinical anaesthetic efficacy of five different 4% adrenergic articaine solutions in pulpal anesthesia following infiltration. They emphasized that these solutions' infiltration anesthesia had no impact on heart rate, blood pressure, or oxygen saturation.

To evaluate the pharmacokinetics and cardiovascular effects of 11.9 ml of 4% articaine Hydrochloride (HCl) plus 1:100,000 adrenaline with those of 11.9 ml of 4% articaine HCl plus 1:200,000 adrenaline, Hersh, et al., conducted a randomized, double-blind, two-way crossover clinical experiment. According to the study's findings, there were no appreciable changes between the two adrenaline concentrations.

In our investigation, there was no statistically significant difference in the oxygen saturation. However, in their respective trials, Santos, et al.; de Morais, et al., both noted an increase in oxygen saturation following the injection of adrenaline into local anesthesia.

In contrast to the results of our investigation, Meechan, et al. also looked at how heart transplant recipients responded to dental local anesthetic solutions with and without adrenaline. They came to the conclusion that 10 minutes after injection the heart transplant patients suffered a considerable tachycardia. The heart rate did not significantly change following the infusion of an adrenaline-free solution. Blood pressure measurements, both systolic and diastolic, were unaffected. As the tension and fear brought on by the surgical process ended, the measured parameters recovered to baseline readings 15 minutes after the tooth extraction. Our study's findings concur with those of other research that show no appreciable increases in oxygen saturation.

CONCLUSION

The local anaesthetic injection of lidocaine with adrenaline, along with the surgical procedure of tooth extraction, produces significant increase in the systolic blood pressure and heart rate in the patients with cardiovascular diseases. However, the diastolic blood pressure was significantly reduced and the oxygen saturation shows no significant changes.

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