

Evaluation of Hemodynamic Changes Caused During Dental Extractions- A Clinical Study

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Abstract

Introduction: Local anesthesia is routinely used for dental extractions and other dental procedures. Local anesthetic agents and dental surgery can contribute in hemodynamic changes like altered blood pressure, oxygen saturation and pulse rate.

Objectives: To estimate the variation of blood pressure, pulse rate and oxygen saturation during local anesthesia administration and after dental extraction.

Materials and Methods: 196 patients from age group 18-74 years of age, who were indicated for dental extractions were selected for the study. Blood pressure, pulse rate and

oxygen saturation were recorded before, after LA administration after dental extraction.

Result: Significant variation in alteration of pulse rate is seen during LA administration and after extractions and less variation is seen in blood oxygen saturation levels. Significant increase in systolic blood pressure was found in patients after local anesthesia injection and also after extraction.

Conclusion: Systolic blood pressure is increased due to increased sympathetic activity which is due to local anesthesia injection and dental extractions. Pulse rate and

oxygen saturation vary in anxiety. Any major fluctuation in these variables which is noted early, may alert us to prevent any medical emergency during routine dental procedures.

Keywords: Blood pressure; Pulse rate; Oxygen saturation; Local anesthesia; Dental extractions

Introduction

Local anesthesia is routinely used for dental extractions. Most commonly used local anesthetic agent is lidocaine, which is available in 1%, 2%, 5% concentrations. Local anesthetic contains vasopressor which causes hemodynamic changes like altered blood pressure and pulse rate. Although these changes are without complications in many patients, one has to use them carefully in patients with underlying cardiovascular diseases.¹

Arterial Blood Pressure may be defined as the lateral pressure exerted by the contained column of blood on the wall of arteries. Sustained elevation of the systemic arterial pressure is referred as Hypertension.² World Health Organization reported hypertension as one of the important causes of premature morbidity and mortality.

Pulse oximetry is a major technological advance made in monitoring the health and safety of patients during critical care and anesthesia.³ A pulsating vascular bed is placed between a two-wavelength light source and a detector which measures, through light absorption, the variation between “red” oxy hemoglobin and “blue” reduced hemoglobin. The pulse oximeter is generally applied to a finger or toe. A beat-to-beat percent of oxygen saturation and heart rate appears on a digital readout. The instrument is totally noninvasive and an excellent association has been demonstrated between pulse oximetry and arterial blood gas determinations.⁴ Oxygen saturation is measured as SpO₂ in pulse oximeter. SpO₂ between 90% and 94% is referred as mild hypoxemic episode, SpO₂ between 85%

and 89% as moderate hypoxemic episode and severe hypoxemia when its lesser than 85%.⁵

The possibility of dental extraction as a risk factor for altered blood pressure, SpO₂ and pulse rate remains unknown. It is a question whether dental extraction could cause a significant change in blood pressure which in combination with psychologic and physical stress, painful stimuli, and the action of catecholamines present in local anesthetic solutions, that could cause harm or even death to the patient if not managed properly.^{6,7}

The purpose of the present study was to compare the incidence and extent of changes in blood pressure, pulse rate and oxygen saturation alteration after administration of local anesthesia and after extraction using local anesthesia with adrenaline.

Methodology

The study included 196 patients who underwent dental extraction at Department of Oral and Maxillofacial Surgery, Dayananda Sagar College of Dental Sciences and Hospital. The patients were selected based on the following criteria-

Inclusion Criteria

- Patients indicated for tooth extraction under local anesthesia.
- Patients between 18-70 years of age.

Exclusion Criteria

- Patients with a known medical history of any systemic disease like hypertension, diabetes, and bleeding disorders
- Patients with history of cardiac surgery; including pace maker insertion
- Smokers, alcoholics, and drug abusers
- Pregnant patients
- Patients with an acute infection with or without fever

The details of the study were explained to the patients and written informed consent was obtained. On the day of

dental surgery, each patient was asked to complete a questionnaire concerning medical history and medication use.

The parameters of the study involved measurement of-

- Change in Peripheral Oxygen Saturation (SpO₂) during Dental Extraction from the baseline SpO₂ [Time Frame: Baseline, 5-min post-anesthesia injection and 5-min post-extraction]. The SpO₂ was recorded using a non-invasive GIBSON infrared digital pulse oximeter placed on the patient's index finger.
- Change in Heart Rate (HR) during Dental Extraction from the baseline HR [Time Frame: Baseline, 5-min post-anesthesia injection and 5-min post-extraction]. The heart rate was recorded using a non-invasive GIBSON infrared digital pulse oximeter placed on the patient's left index finger.
- Change in Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) during Dental Extraction from the baseline [Time Frame: Baseline, 5-min post-anesthesia injection and 5-min post-extraction]. The blood pressure was measured utilizing the analog sphygmomanometer and stethoscope and recorded in mmHg.
- The patients were kept in a supine position for 10 min after which blood pressure, oxygen saturation and pulse rate were measured and were defined as the Baseline values.
- Local anesthesia was administered after a control period of at least 10 min. Lidocaine, 2% with epinephrine (1:80,000), was used as an anesthetic for all of the patients. 5 minutes following local anesthesia injection blood pressure, oxygen saturation and pulse rate were again recorded in the similar manner. Surgery was begun 10 min after injection of the local anesthetic. After surgery, the patients were

kept in a supine position during the recovery period. 5 minutes following completion of dental extraction blood pressure, oxygen saturation and pulse rate were recorded in the similar manner.

- All procedures (local anesthesia administration and tooth extraction) were performed by the same operator and the parameters were also recorded by the same personnel for all patients.
- The blood pressure and pulse rate were taken at least twice to obtain a mean value. Confounding errors for the study was the number of teeth to be extracted and difficulty of extraction.

Results

All values were expressed as the mean \pm SD. To analyze the effects of local anesthesia and tooth extraction on blood pressure, percentage oxygen saturation and heart rate variability, a 'paired t test' was used to determine means which were significantly different from the baseline values. p value of 0.05 was considered statistically significant.

The study included 196 patients with mean age of 42.7 ± 3.0 years. Among them, there were 73 men and 123 women.

Baseline pulse rate (mean \pm S.D) of patients before the procedure was 82.9 ± 11 beats/min which has risen to 88.1 ± 12 beats/min after administration of local anesthesia and reduced to 86.2 ± 13 beats/min, 5 minutes after the dental extraction. (Graph 1)

Mean Percentage Oxygen saturation in patients before procedure was $96.5 \pm 2\%$, which slightly increased to $96.8 \pm 1\%$ after injecting local anesthesia and then reduced back to $96.2 \pm 2\%$ after completion of the procedure. (Graph 2)

The average baseline systolic blood pressure for all of the patients were 127 ± 12 mm Hg. Administration of local anesthetics and tooth extraction caused increases in both

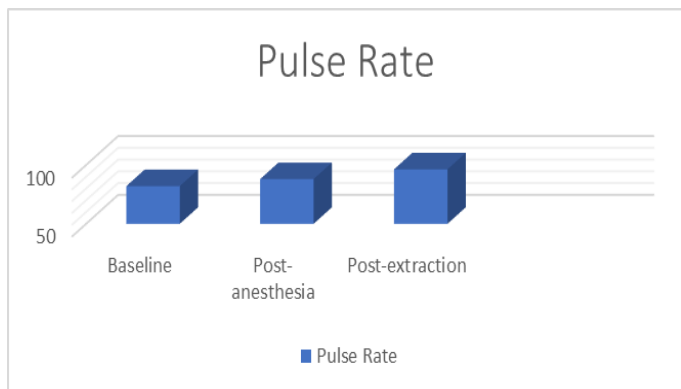
systolic blood pressure and pulse rate, and the peak systolic blood pressure occurred after tooth extraction (134 ± 19 mm Hg). After injecting local anesthesia, the mean systolic blood pressure was 130 ± 18 mm Hg. (Graph 3)

However, diastolic blood pressure did not change significantly during the entire treatment period (baseline= 79 ± 7 mm Hg, post-anesthetic= 81 ± 13 mm Hg and post-extraction= 82 ± 9 mm Hg). Middle-aged and older patients had higher blood pressures and lower pulse rates compared with young patients.

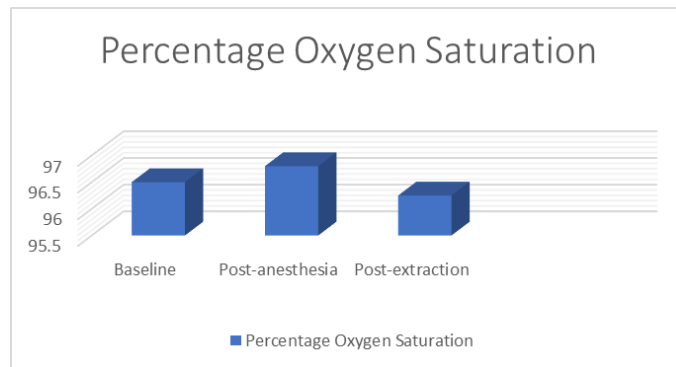
There was slight reduction of mean SPO_2 by 0.3% after the injection of local anesthesia and there was overall decrease of 0.25% after extraction which is certainly not significant. Administration of local anesthesia caused mean rise in Pulse rate of 5/min but decreased by 2/min after completion of extraction. ($p < 0.001$) The changes in the values of systolic blood pressure, percentage oxygen saturation and pulse rate are summarized in Graph 4.

Evaluation of pre-anesthesia, post anesthesia and post-extraction pulse rate shows no significant change in pulse rate in 5.2 per cent of the patients studied and 88 per cent of the patient had an increase in pulse rate post-extraction. Whereas significant increase in blood pressure was seen in 63.3% patients after administration of local anesthesia and in 72.1% patients after dental extraction. ($p < 0.001$)

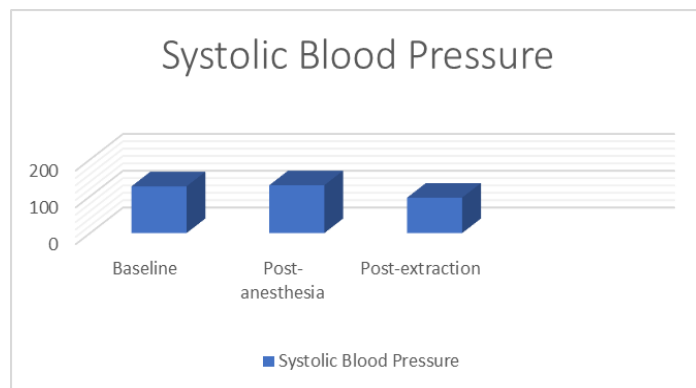
Graphs



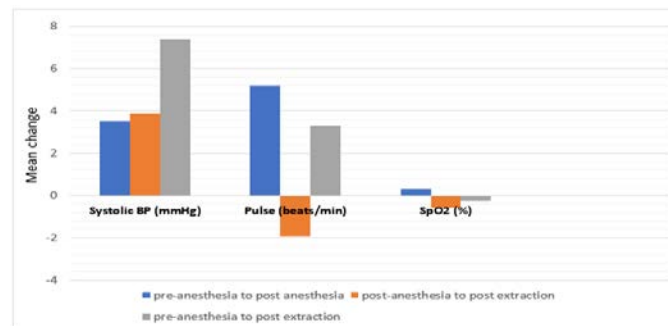
Graph 1: Pulse rate of patients at baseline, after administration of local anesthesia (post-anesthesia) and 5 min after the extraction (post-extraction)



Graph 2: Percentage Oxygen saturation of patients at baseline, after administration of local anesthesia (post-anesthesia) and 5 min after the extraction (post-extraction)



Graph 3: Systolic blood pressure of patients at baseline, after administration of local anesthesia (post-anesthesia) and 5 min after the extraction (post-extraction)



Graph 4: Mean change in values of systolic blood pressure, percentage oxygen saturation and pulse rate patients at baseline, after administration of local anesthesia (post-anesthesia) and 5 min after the extraction (post-extraction)

Discussion

Many patients who visit dental clinics have systemic diseases such as hypertension, ischemic heart disease, and other atherosclerotic diseases. In one study, 64% of the elderly patients who visited the dental clinic were found to have one or more systemic diseases, and among them hypertension was the most frequent systemic disease, occurring in 30% of the patients.⁸ Furthermore, cardiovascular accidents caused by hypertension during dental surgery have also been reported.⁹ It is therefore important to determine the responses of blood pressure and sympathetic outflow during dental surgery.

Koehler-Knoll et al.¹⁰ have demonstrated that catecholamines present in local anesthetics causes increase in blood pressure. However, studies conducted by Davenport et al.¹¹ and Salonen et al.¹² did not show such an increase

The sympathetic nervous system activity tends to increase during dental surgery, as a result of painful stimuli, psychological stress or the epinephrine contained in the local anesthetic. This increased sympathetic activity would therefore increase the blood pressure and pulse rate and can also affect oxygen saturation.¹³

In the present study, both systolic blood pressure and pulse rate increased significantly during the dental surgery, resulting in an increase in the rate-pressure product. The middle-aged and older patients had a greater increase in blood pressure after dental extraction, which can be due to enhanced sympathetic activity or may be due to the atherosclerotic changes and augmented vascular reactivity in older patients.

Plasma epinephrine concentrations remain high 30 min after its administration with local anesthesia. Therefore, the combined effects of factors including painful stimuli and psychological stress and the direct effect of

epinephrine contained in the local anesthetics might elicit a greater sympathetic response.

Bible et al.¹⁴ conducted a meta-analysis which concluded that local anesthetics like lidocaine with epinephrine tend to increase the systolic blood pressure and also heart rate. These findings are consistent with our results. Salonen and colleagues showed that the use of Lidocaine in combination with epinephrine caused a significant increase in heart rate of the patients which are comparable and consistent with our findings.¹²

The present study showed that injection of lidocaine caused reduction of pulse rate. This may be attributed to vasodilative effect of Lidocaine. There was no major change in oxygen saturation alteration during LA administration.

Many previous studies showed SpO₂ values remained constant throughout dental surgery, regardless of the anesthetic combination involved.¹³ Both the mean maximum value at extraction (98.7%) and the mean minimum value at the end of suturing (95.8%) were within the normal range which was again similar to the results obtained in our study.

Pulse rate and oxygen saturation vary in anxious patients. Any major fluctuation in these variables which is noted early, may alert us to prevent any medical emergency during routine dental procedures.

Conclusion

Based on the results obtained from the study it can be concluded that dental surgery using local anesthesia caused significant increases in systolic blood pressure and pulse rate, and the increase in systolic blood pressure was greater in middle-aged and older patients. Changes in oxygen saturation was not clinically significant and usually varies in anxious patients. In healthy patient's local anesthesia administration below the maximum lethal dose does not cause any major systemic changes provided

a proper Local anesthesia procedure is done. Any major fluctuation in these variables which is noted early, may alert us to prevent any medical emergency during routine dental procedures.

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