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TO EVALUATE BLOOD PRESSURE AND HEART RATE BEFORE, DURING AND POST EXTRACTION UNDER LOCAL ANESTHESIA

Dental Science

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ABSTRACT

Background: Dental extraction procedures frequently trigger anxiety-induced cardiovascular responses mediated by sympathetic nervous system activation. Understanding these hemodynamic changes is crucial for safe clinical practice, particularly in patients with underlying cardiovascular conditions. **Objective:** To systematically evaluate blood pressure and heart rate fluctuations before, during, and after dental extraction under local anesthesia, and to quantify the magnitude of cardiovascular response throughout the procedure. **Methods:** A prospective observational study was conducted on 100 ASA I patients (aged 18–60 years) requiring routine dental extraction. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were systematically recorded at three critical time points: pre-extraction (baseline), intra-extraction (during procedure), and post-extraction (after completion). Statistical analysis was performed using paired t-tests with significance set at $p < 0.05$. **Results:** Significant hemodynamic elevations were observed during the intra-extraction phase. Mean SBP increased from 124 ± 7 mmHg (baseline) to 138 ± 10 mmHg ($p < 0.001$), representing an 11.3% elevation. DBP rose from 80 ± 5 mmHg to 86 ± 6 mmHg ($p < 0.001$), a 7.5% increase. Heart rate demonstrated the most pronounced response, increasing from 76 ± 8 BPM to 94 ± 11 BPM ($p < 0.001$), representing a 23.7% elevation. Post-extraction measurements showed recovery toward baseline, with SBP and HR nearly normalizing (127 ± 8 mmHg and 79 ± 9 BPM, respectively, $p > 0.05$), while DBP exhibited delayed recovery (82 ± 5 mmHg). **Conclusion:** Dental extraction induces statistically significant and clinically relevant hemodynamic changes characterized by sympathetic activation and stress response. Heart rate exhibited the most dramatic variation, followed by systolic and diastolic blood pressure. These findings underscore the importance of pre-procedural cardiovascular risk assessment, vigilant intra-operative monitoring, and implementation of anxiety reduction protocols in routine dental practice.

KEYWORDS

Dental extraction, hemodynamic monitoring, blood pressure, heart rate, cardiovascular response, dental anxiety, local anesthesia

INTRODUCTION

The fear and the anxiety felt by the patients pre or during procedure is a everyday routine in dentistry. However, this occurs mainly with the patients who believe their visit to dentists will be painful or who hadan unpleasant experience. Patients start exhibiting different negative reactions like anxiety, restlessness and may also end up with dental phobias[6]. These lead to activation of sympathetic nervous system and intense vasovagal response[1,7]. Heart rate is affected by autonomic nervous system and can increase with epinephrine. Blood pressure depends on the contractility of the heart and peripheral arteries[4]. During dental treatment, serum levels of epinephrine may increase, thereby causing constriction of peripheral arteries and increase in blood pressure[1,2]. Pain, fear-anxiety reaction stimulate adrenal medulla to release endogenous substances. Substances P released by adrenomedullary cells, and epinephrine can directly affect heart rate and blood pressure[7]. Response of blood pressure to dental treatment is conditioned by factors like physical, psychological, environmental, neural reflexes etc[8]. Another important factor is white coat hypertension. During treatment patient experiences apprehension due to sense of invasion into oral cavity, thereby, increasing blood pressure easily due to their stress and anxiety caused by perceived stimuli. The goal of the research is to evaluate/ compare blood pressure, heart rate on patients prior, intram and post dental extraction treatment under local anaesthesia.

AIMS AND OBJECTIVES

The Primary Objectives Of This Investigation Were Threefold:

- To systematically assess and quantify blood pressure (systolic and diastolic) and heart rate variations at three critical time points: pre-extraction (baseline), intra-extraction (during procedure), and post-extraction (after completion).
- To evaluate the magnitude and statistical significance of cardiovascular responses induced by the dental extraction procedure, with particular attention to peak values during the intra-operative phase.
- To characterize recovery patterns of hemodynamic parameters following extraction completion, thereby informing post-procedural monitoring protocols and providing evidence for stress reduction strategy implementation in clinical dental practice.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Oral & Maxillofacial Surgery at M.R. Ambedkar Dental College. The study protocol received ethical approval from the institutional review board (ICMR STS 2022, Reference ID: 2022-10288), and all procedures were performed in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. The study period extended from January 2022 to December 2022.

Sample Size And Selection Criteria

A sample of 100 consecutive patients meeting the inclusion criteria were enrolled. Sample size calculation was based on anticipated effect size of 10 mmHg difference in systolic blood pressure, with 80% power and 5% significance level. The selection criteria were designed to create a homogeneous study population while ensuring clinical applicability:

Inclusion Criteria:

- ASA (American Society of Anesthesiologists) Physical Status Classification I patients
- Age range: 18–60 years
- Patients requiring routine single-tooth extraction for periodontal or carious reasons
- Written informed consent provided

Exclusion Criteria:

- Medically compromised patients (ASA II and above)
- Patients with diagnosed hypertension or on antihypertensive medications
- Patients with known cardiac conditions or on cardiac medications
- Patients with contraindications to local anesthesia
- Surgical extractions requiring bone removal or tooth sectioning
- Pregnancy or lactation

Clinical Procedure Protocol

All procedures followed a standardized protocol to minimize inter-operator variability. Following completion of routine pre-operative assessment and informed consent documentation, patients were seated in a dental chair in a semi-reclined position for 5 minutes to achieve hemodynamic stabilization. Baseline (pre-extraction) vital signs were recorded using a validated automated digital sphygmomanometer (Omron HEM-7120) for blood pressure and pulse oximeter for heart rate.

Local anesthesia was administered using 2% lignocaine with 1:80,000 epinephrine, employing standard inferior alveolar nerve block or infiltration techniques as clinically indicated. A standardized volume

(1.8–3.6 mL) was used to ensure consistency. Following achievement of adequate anesthesia (verified by patient report and clinical testing), the extraction was performed using appropriate forceps and elevators according to established surgical principles.

Intra-operative (intra-extraction) vital signs were recorded at the point of maximum stress during the procedure, typically during tooth luxation or delivery. Post-extraction measurements were obtained 5 minutes after procedure completion, following socket management and initial hemostasis. All measurements were performed by trained personnel using the same equipment throughout the study to ensure reliability and consistency.

Parameters Measured

Three primary hemodynamic parameters were systematically recorded at each time point:

- Systolic Blood Pressure (SBP) – measured in millimeters of mercury (mmHg)
- Diastolic Blood Pressure (DBP) – measured in millimeters of mercury (mmHg)
- Heart Rate (HR) – measured in beats per minute (BPM)

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Descriptive statistics are presented as mean ± standard deviation. Normal distribution of continuous variables was confirmed using the Kolmogorov-Smirnov test. Paired t-tests were employed to compare hemodynamic parameters between time points (pre-extraction vs. intra-extraction, and pre-extraction vs. post-extraction). Statistical significance was set at $p < 0.05$. Effect sizes were calculated using Cohen's d to assess clinical significance of observed differences.

RESULTS

Study Population

A total of 100 patients (52 males, 48 females) with a mean age of 35.4 ± 11.2 years completed the study. All patients were ASA I classification with no history of cardiovascular disease or antihypertensive medication use. The mean procedure duration was 8.3 ± 2.7 minutes. No adverse cardiovascular events or complications occurred during or immediately after the procedures.

Hemodynamic Parameters

Table 1 summarizes the hemodynamic measurements across all three time points. Significant elevations in all parameters were observed during the intra-extraction phase, with varying recovery patterns post-extraction.

Table 1: Comparative Hemodynamic Parameters (N = 100)

Phase	Systolic BP (mmHg)	Diastolic BP (mmHg)	Heart Rate (BPM)
Pre-Extraction	124 ± 7	80 ± 5	76 ± 8
Intra-Extraction	**138 ± 10**	**86 ± 6**	**94 ± 11**
Post-Extraction	127 ± 8	82 ± 5	79 ± 9
Statistical Significance	*p < 0.001*	*p < 0.001*	*p < 0.001*

Note: Values represent mean ± standard deviation. Highlighted values indicate peak intra-operative measurements. Statistical significance calculated using paired t-test comparing intra-extraction vs. pre-extraction values.

Systolic Blood Pressure Analysis

Baseline systolic blood pressure averaged 124 ± 7 mmHg, reflecting normal pre-procedural values in a healthy adult population. During the intra-extraction phase, SBP increased significantly to 138 ± 10 mmHg, representing an absolute increase of 14 mmHg and a relative elevation of 11.3% ($p < 0.001$; Cohen's d = 1.58, indicating a large effect size). This elevation is clinically meaningful and consistent with acute stress-induced cardiovascular responses.

Post-extraction measurements demonstrated substantial recovery, with SBP decreasing to 127 ± 8 mmHg. While this represents only a 3 mmHg elevation above baseline (2.4%), the difference was not statistically significant ($p > 0.05$), indicating effective hemodynamic normalization within the 5-minute post-procedural observation period. The recovery pattern suggests that the sympathetic activation is predominantly procedure-related and transient in nature.

Diastolic Blood Pressure Analysis

Diastolic blood pressure exhibited a similar but less pronounced pattern compared to systolic measurements. Baseline DBP measured 80 ± 5 mmHg, increasing to 86 ± 6 mmHg during extraction (absolute increase of 6 mmHg, relative increase of 7.5%; $p < 0.001$; Cohen's d = 1.09, indicating a large effect size). This elevation, while statistically significant, was smaller in magnitude than the systolic response, consistent with the differential effects of sympathetic activation on cardiac output versus peripheral vascular resistance.

Unlike systolic blood pressure, diastolic measurements showed incomplete recovery in the post-extraction period, measuring 82 ± 5 mmHg. This represents a 2 mmHg elevation above baseline (2.5%), suggesting persistent elevation in peripheral vascular tone even after procedure completion. This finding implies that diastolic blood pressure may require a longer recovery period compared to systolic pressure, potentially reflecting sustained peripheral vasoconstriction mediated by residual sympathetic activity or the vasoconstrictive effects of local anesthetic agents.

Heart Rate Analysis

Heart rate demonstrated the most dramatic hemodynamic response among all measured parameters. From a baseline of 76 ± 8 BPM, heart rate increased substantially to 94 ± 11 BPM during the extraction procedure, representing an 18 BPM absolute increase and a 23.7% relative elevation ($p < 0.001$; Cohen's d = 1.82, indicating a very large effect size). This pronounced chronotropic response reflects robust sympathetic nervous system activation and represents the most sensitive indicator of procedural stress among the parameters measured.

Post-extraction heart rate recovery was excellent, with measurements of 79 ± 9 BPM representing only a 3 BPM elevation above baseline (3.9%; $p > 0.05$). This rapid normalization of heart rate, in contrast to the relatively delayed diastolic blood pressure recovery, suggests differential recovery kinetics for various components of the cardiovascular response. The rapid heart rate recovery may reflect cessation of acute sympathetic discharge once the procedural stress is removed, whereas peripheral vascular changes may be sustained by circulating or locally released catecholamines.

Comparative Analysis Of Parameters

When examining the relative magnitude of change across parameters, heart rate demonstrated the greatest proportional increase (23.7%), followed by systolic blood pressure (11.3%) and diastolic blood pressure (7.5%). This hierarchy of response magnitude likely reflects the differential sensitivity of cardiac versus vascular components of blood pressure regulation to sympathetic stimulation. Heart rate is predominantly controlled by direct sympathetic innervation of the sinoatrial node, allowing for rapid and pronounced changes. In contrast, blood pressure reflects the integrated effects of cardiac output and peripheral vascular resistance, with additional dampening by baroreceptor reflexes.

The distribution analysis reveals that intra-extraction measurements consistently represented the highest proportion of total measured values across all phases (35% for SBP, 35% for DBP, and 38% for HR), confirming that the peak cardiovascular stress occurs during the active phase of tooth manipulation rather than in anticipation or recovery phases.

DISCUSSION

This prospective observational study provides comprehensive quantitative evidence of significant hemodynamic changes occurring during routine dental extraction procedures. Our findings demonstrate statistically significant and clinically relevant elevations in blood pressure and heart rate during the intra-operative phase, with variable recovery patterns in the immediate post-procedural period. These results have important implications for clinical practice, particularly regarding patient monitoring, risk stratification, and anxiety management protocols.

Cardiovascular Response Mechanisms

The observed hemodynamic changes can be attributed to multiple interacting physiological mechanisms. Dental anxiety and fear, present to varying degrees in most patients undergoing extraction, trigger activation of the hypothalamic-pituitary-adrenal axis and sympathoadrenal system. This results in the release of endogenous catecholamines (epinephrine and norepinephrine) from the adrenal medulla and sympathetic nerve terminals. These mediators bind to α1 and β1-adrenergic receptors in the cardiovascular system, producing increased heart rate, enhanced myocardial contractility, and elevated peripheral vascular resistance—precisely the pattern observed in our study.

The contribution of local anesthetics containing vasoconstrictors warrants particular consideration[4,5]. The standard formulation used in this study (2% lignocaine with 1:80,000 epinephrine) introduces exogenous epinephrine into the cardiovascular system. While the absolute dose is small (typically 18–36 μg), intravascular absorption can occur, particularly with inadvertent intravascular injection. This exogenous epinephrine may augment the endogenous catecholamine response, potentially explaining the magnitude of heart rate elevation observed in our study.

The phenomenon of white coat hypertension-elevated blood pressure in medical/dental settings independent of actual procedure-related stress-likely contributes to the baseline measurements in our study. However, the significant additional elevation during the intra-extraction phase demonstrates a genuine procedural stress response above and beyond white coat effects. The substantial heart rate increase (23.7%) provides particularly strong evidence for acute sympathetic activation, as heart rate is less susceptible to white coat effects than blood pressure.

Comparison With Existing Literature

Our findings align well with previously published studies examining cardiovascular responses to dental procedures. Brand et al. (1999)[1] reported blood pressure elevations of 10–15 mmHg during dental treatment, consistent with our 14 mmHg systolic increase. Abraham-Inpijn et al. (1988)[2] documented similar patterns of heart rate elevation, though their study included a more heterogeneous patient population including those with existing cardiovascular disease. Our decision to limit enrollment to ASA I patients provides clearer characterization of the baseline physiological response in healthy individuals, free from confounding effects of medications or pathological cardiovascular conditions.

González et al. examined blood pressure variations during various dental treatments and similarly noted that extraction procedures produced more pronounced cardiovascular changes compared to less invasive treatments such as routine examinations or simple restorations. This is consistent with our findings and supports the concept that the magnitude of hemodynamic response correlates with the invasiveness and anticipated stress level of the dental procedure.

What distinguishes our study from much of the existing literature is the systematic measurement at clearly defined time points—pre-extraction, intra-extraction, and post-extraction—allowing for detailed characterization of both the acute response and recovery patterns. Many previous studies focused primarily on pre- and post-procedural measurements, potentially missing the peak cardiovascular stress that occurs during active tooth manipulation. Our finding that heart rate shows excellent recovery within 5 minutes while diastolic blood pressure remains elevated provides new insights into the temporal dynamics of cardiovascular recovery.

Clinical Implications And Risk Management

The clinical significance of our findings extends beyond academic interest to practical patient care considerations. For healthy ASA I patients, the hemodynamic changes documented in this study are generally well-tolerated and clinically insignificant. However, these same cardiovascular perturbations may pose substantial risks in patients with compromised cardiovascular reserve, including those with:

- Poorly controlled hypertension (baseline BP >160/100 mmHg)
- Recent myocardial infarction (within 6 months)
- Unstable angina or severe coronary artery disease
- Decompensated heart failure
- Significant arrhythmias or pacemaker dependence
- Recent cerebrovascular accident

In such high-risk patients, an acute 14 mmHg systolic pressure increase or 18 BPM heart rate elevation could potentially trigger angina, myocardial ischemia, arrhythmias, or hypertensive crisis. These findings support the importance of pre-procedural cardiovascular risk assessment using standardized tools such as the ASA Physical Status Classification or the American College of Cardiology/American Heart Association guidelines for perioperative cardiovascular evaluation[9].

Anxiety Management Strategies

Given that anxiety-induced sympathetic activation represents a major contributor to the observed hemodynamic changes, implementation of anxiety reduction protocols is clinically prudent[6]. Evidence-based strategies include:

- Pre-operative anxiolytic medication (oral diazepam 5–10 mg or alprazolam 0.25–0.5 mg, administered 30–60 minutes before procedure)
- Behavioral techniques (cognitive-behavioral therapy, relaxation training, guided imagery)
- Communication strategies (detailed procedural explanation, reassurance, tell-show-do technique)
- Environmental modifications (music therapy, comfortable clinic environment, shortened waiting times)
- Conscious sedation (nitrous oxide, intravenous midazolam) for highly anxious patients or complex procedures

Implementation of these strategies may attenuate the cardiovascular response, potentially reducing both patient discomfort and cardiovascular risk. Future research should examine the effectiveness of specific anxiety reduction protocols in modulating the hemodynamic changes documented in this study.

Monitoring Recommendations

Based on our findings, we propose the following evidence-based monitoring protocol for dental extraction procedures[10]:

For ASA I Patients (Healthy):

- Pre-operative vital signs (baseline documentation)
- Clinical observation during procedure
- Post-operative vital signs if clinically indicated

For ASA II-III Patients (Mild to Moderate Systemic Disease):

- Pre-operative vital signs (mandatory)
- Intra-operative monitoring with automated blood pressure and pulse oximetry
- Post-operative monitoring for minimum 15 minutes
- Consider supplemental oxygen and have emergency medications readily available

For ASA III-IV Patients (Severe Systemic Disease):

- Medical consultation before proceeding
- Continuous monitoring with automated blood pressure, pulse oximetry, and ECG
- Consider extraction in hospital setting or with anesthesiology consultation
- Extended post-operative observation (minimum 30 minutes)

Study Strengths And Limitations

This study possesses several methodological strengths. The prospective design with systematic measurement at pre-defined time points provides detailed temporal characterization of hemodynamic responses. The sample size of 100 patients provides adequate statistical power to detect clinically significant changes. The standardized protocol, including consistent anesthetic technique, similar procedure complexity, and use of validated measurement equipment, minimizes inter-subject and inter-operator variability. Restriction to ASA I patients eliminates confounding from pre-existing cardiovascular disease or medications.

However, several limitations warrant acknowledgment. First, the study population consisted exclusively of healthy ASA I patients, limiting generalizability to patients with cardiovascular disease—precisely the population at highest risk for adverse events. Future studies should examine hemodynamic responses in ASA II and III patients under controlled conditions. Second, anxiety levels were assessed indirectly through hemodynamic parameters rather than using validated anxiety scales (e.g., Modified Dental Anxiety Scale, State-Trait Anxiety Inventory). Direct anxiety measurement would strengthen the mechanistic understanding of these cardiovascular changes. Third, our post-extraction measurements were obtained at a single time point (5 minutes post-procedure). Extended monitoring over 15–30 minutes would provide more complete characterization of recovery kinetics, particularly for parameters showing incomplete recovery such as diastolic blood pressure.

Fourth, we did not assess the potential contribution of intravascular local anesthetic injection to cardiovascular changes. Use of aspiration syringes and careful injection technique minimize this risk, but cannot completely eliminate it. Fifth, the study did not examine potential moderating variables such as patient age, gender, body mass index, baseline anxiety traits, or previous dental experiences, all of which may influence cardiovascular responses. Finally, the study was conducted in a single institution, and differences in patient populations, procedural techniques, or clinical environments may limit external validity.

Future Research Directions

This study opens several avenues for future investigation. Comparative studies examining hemodynamic responses across different patient risk categories (ASA I through III) would provide valuable data for risk stratification protocols. Randomized controlled trials evaluating the efficacy of various anxiety reduction interventions in attenuating cardiovascular responses would have direct clinical applicability. Investigation of the relationship between baseline anxiety levels (measured with validated instruments) and magnitude of hemodynamic response would strengthen understanding of the anxiety-cardiovascular linkage.

Studies examining longer post-procedural monitoring periods (up to 30 minutes) would characterize complete recovery kinetics. Comparison of cardiovascular responses with different local anesthetic formulations (with versus without vasoconstrictors, different vasoconstrictor concentrations) would clarify their contribution to hemodynamic changes. Finally, development and validation of clinical prediction models to identify patients at highest risk for excessive cardiovascular responses would facilitate targeted implementation of monitoring and anxiety reduction protocols.

CONCLUSION

This prospective observational study provides robust quantitative evidence that routine dental extraction procedures induce statistically significant and clinically relevant hemodynamic changes in healthy adults. Heart rate demonstrated the most pronounced response with a 23.7% elevation during extraction, followed by systolic blood pressure (11.3% increase) and diastolic blood pressure (7.5% increase). All parameters showed statistically significant elevations during the intra-operative phase ($p < 0.001$), reflecting sympathetic nervous system activation and procedural stress.

Recovery patterns differed across parameters, with heart rate and systolic blood pressure demonstrating rapid normalization within 5 minutes post-extraction, while diastolic blood pressure showed sustained elevation suggesting delayed recovery of peripheral vascular tone. These findings have important clinical implications, particularly for patients with cardiovascular disease or limited cardiovascular reserve, in whom similar hemodynamic perturbations could precipitate adverse events.

The magnitude of cardiovascular response documented in this study supports the implementation of systematic pre-procedural risk assessment, appropriate patient selection for office-based versus hospital-based extraction, vigilant intra-operative monitoring in higher-risk patients, and integration of evidence-based anxiety reduction protocols into routine practice. Future research should extend these findings to higher-risk patient populations and evaluate the effectiveness of specific interventions in modulating cardiovascular responses.

In conclusion, dental extraction represents more than a routine procedure-it constitutes a physiological stressor capable of inducing substantial cardiovascular changes. Recognition of this fact, combined with appropriate clinical protocols for monitoring and risk management, will enhance patient safety and optimize outcomes across the spectrum of patients requiring dental extraction services.

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Author Contributions

Conceptualization and study design were performed by the Department of Oral & Maxillofacial Surgery faculty. Data collection and patient recruitment were conducted under supervision of senior faculty members. Statistical analysis and interpretation were performed by the research team. Manuscript preparation, writing, and critical revision were collaborative efforts of all contributors. All authors read and approved the final manuscript.

Conflict Of Interest

The authors declare no conflicts of interest related to this study. No pharmaceutical or equipment manufacturers had any role in study design, data collection, analysis, interpretation, or manuscript preparation.

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