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**Original Article**

# Comparative Analysis of Local Anaesthesia with Two Different Concentrations of Adrenaline in Mandibular Third Molar Extraction: A Quasi-Experimental Study

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## ABSTRACT

Local anaesthesia is often used in dental procedures to eliminate pain during procedures. Lignocaine mixed with adrenaline is popular because it extends the time of anaesthesia and reduces the drug's absorption into the bloodstream, thus decreasing the risk of toxicity. **Objective:** To assess the efficacy and cardiovascular effects of a two-per-cent lidocaine solution containing two concentrations of adrenaline, 1:80000 and 1:100000, during the extraction of mandibular third molars. **Methods:** A quasi-experimental study was conducted on 50 patients selected for bilateral mandibular third molar surgery. The patients' sites were equally divided into two groups: Group 1-2% lignocaine with adrenaline concentration of 1:80,000, and Group 2 – 2% lignocaine with adrenaline concentration of 1:100,000. The study recorded the onset and duration of anesthesia, pulse rate, blood pressure, and pain intensity, which was assessed using the Visual Analog Scale (VAS). Data were compiled and analyzed using SPSS version 26. **Results:** Group 1 (1:80,000) had a longer duration of anesthesia (149.79 ± 18.05 min) than Group 2 (116.82 ± 12.74 min, p=0.001). Time of onset showed minor differences; VAS pain scores were slightly higher in Group 1 (3.5 ± 1.12) than in Group 2 (2.5 ± 1.12, p=0.100). Cardiovascular parameters showed no significant changes. Time of onset showed minor differences. **Conclusions:** Local anaesthesia with 1:80,000 adrenaline provided a longer duration of anaesthesia compared to 1:100,000 adrenaline, with comparable onset times and pain scores. Both concentrations provide effective anesthesia. 1:100,000 adrenaline is safer for patients with cardiovascular risk.

## INTRODUCTION

Local anaesthesia is widely used in modern dentistry to enhance patient comfort during procedures by temporarily inhibiting nerve impulses, thereby preventing pain in bones and soft tissues [1, 2]. Among the available local anaesthetic agents, lignocaine (lidocaine) is commonly preferred due to its rapid onset and moderate duration of action [3]. To prolong anaesthesia and reduce systemic absorption, local anaesthetics are frequently combined with vasoconstrictors such as adrenaline [4, 5]. Adrenaline, as a vasoconstrictor, slows the systemic absorption of local anaesthetics, thereby prolonging anaesthetic effect and reducing potential toxicity [6, 7]. It also helps control bleeding during oral and maxillofacial procedures [8-10]. However, systemic absorption of


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adrenaline can cause cardiovascular effects, including increased heart rate, elevated blood pressure, and arrhythmias, particularly in patients with pre-existing cardiac conditions [11, 12]. The present study was designed to compare the onset and duration of anaesthesia between 1:80,000 and 1:100,000 adrenaline concentrations [13]. Although low-dose epinephrine-containing local anaesthetics are generally well tolerated, systemic cardiovascular responses may occur depending on the dose, injection technique, and patient characteristics, particularly in individuals with cardiovascular disease [12]. Previous studies suggest that both concentrations provide adequate anaesthesia in healthy patients, with the lower 1:100,000 concentration offering a reduced cardiovascular risk profile [14].

Given the need to balance effective anaesthesia with patient safety, this study aims to compare the clinical efficacy and safety of 2% lignocaine combined with either 1:80,000 or 1:100,000 adrenaline in patients undergoing mandibular third molar extraction. Key variables assessed include onset and duration of anaesthesia, pain scores, and cardiovascular responses such as blood pressure and pulse rate. This study aimed to provide evidence-based guidance on the optimal choice of adrenaline concentration for safe dental practice, particularly in patients at risk of cardiovascular complications.

## METHODS

A quasi-experimental study was conducted at the Department of Oral and Maxillofacial Surgery, Dow University of Health Sciences, Karachi, employing a non-probability convenience sampling technique from 16 August 2023 to 16 February 2024. Data were collected after getting approval of the research ethics committee (IRB-3098/DUHS/Approval/2023/310, dated 15th August 2023), and informed written consent was obtained from the patients. Sample size was calculated using OpenEpi online software, based on the mean difference between the time of onset of Group 1 (local anesthesia with 1:80,000 adrenaline) and Group 2 (local anesthesia with 1:100,000 adrenaline). The mean onset time for Group 1 was 1.31 ± 0.75, while for Group 2 it was 1.62 ± 0.63 [11]. This equations was used for sample size calculation: $n = 2\sigma^2 (Z\alpha/2 + Z\beta)^2 / (\mu_1 - \mu_2)^2$. A sample size of 37 participants was required based on a two-sided significance level (α) of 0.05 and 80% power. To enhance the strength and reliability of the study, the sample size was increased to 50 participants. To enhance the strength and reliability of the study, the sample size was increased to 50 participants. Inclusion and exclusion criteria consisted on patients indicated for bilateral mandibular third molar extraction requiring the same local anesthesia technique and aged 18–35 years were included in the study. Patients who were allergic to local anesthesia, presented with local inflammation or tenderness at the injection site, or were on antidepressant or antipsychotic medications were excluded from the study. In this quasi experimental study, each patient received both local anaesthesia solutions (1:80,000 and 1:100,000 adrenaline) on different sides, with a time interval of 3 weeks between procedures to allow full recovery and prevent carryover effects. The two interventions were administered to different sides in separate surgical sessions; however, allocation of the adrenaline concentration to the operative side/session was not randomized. Therefore, the study was treated as a quasi-experimental split-mouth design rather than a randomized controlled trial. In this study multiple variables were assessed to compare the effects of 2% lignocaine with 1:80,000 and 1:100,000 adrenaline. Time of onset was recorded both subjectively, based on the patient's perception of numbness, and objectively, using soft-tissue probing. Duration of anaesthesia was measured from complete onset to the return of normal sensation. The amount of local anaesthetic administered for each extraction was recorded in milliliters. Pain during the procedure was evaluated using a 10-point Visual Analogue Scale (VAS). Cardiovascular parameters, including systolic and diastolic blood pressure and pulse rate, were measured before injection, immediately after, and at the end of the procedure using standard monitors. Concentration of adrenaline in dental local anesthesia used was 1:100,000, as it provides adequate vasoconstriction, improves the duration of anesthesia, and reduces systemic absorption of the anesthetic solution while maintaining cardiovascular safety. In the present study, 1:80,000 adrenaline concentration was also evaluated because it is frequently used in oral surgical procedures where enhanced hemostasis and prolonged anesthetic effect may be desirable. Therefore, this study compared 2% lidocaine with 1:80,000 and 1:100,000 adrenaline to assess their relative efficacy and cardiovascular effects during mandibular third molar extraction. The detailed medical history and clinical evaluation were performed prior to inclusion in the study to avoid potential adverse effects. Other additional factors such as patient age, gender, impaction difficulty, absence of local infection, and recent analgesic intake. Surgical procedures were standardized and performed by the same operator to minimize variability. However, the principal investigator responsible for outcome assessment was not blinded to the intervention, which may have introduced measurement bias. The study was reported according to the relevant reporting considerations for quasi-experimental studies. A study flow diagram was used to describe participant inclusion, intervention allocation, follow-up, and analysis (Figure 1).


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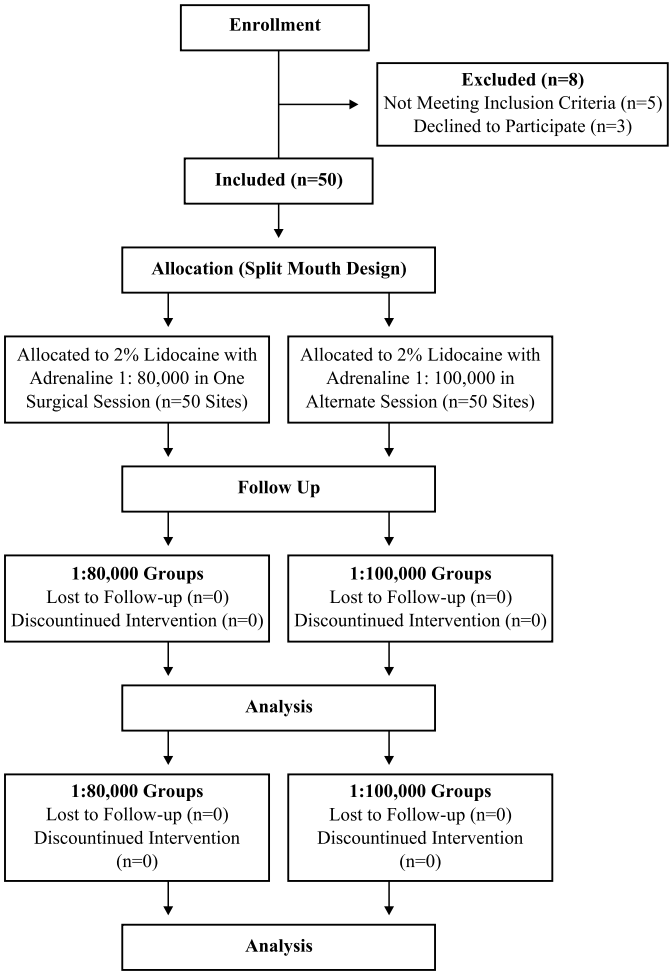



**Figure 1:** Flow Chart of Study

The participants were briefed about the nature and purpose of the study, including pulse rate assessment. They were assured that their information would be used for research purposes only. A complete history was obtained from each patient. The sites were divided into Group 1: 2% lignocaine with adrenaline concentration of 1:80,000, and Group 2: 2% lignocaine with adrenaline concentration of 1:100,000. After marking the injection sites, the principal investigator left the room, and the consultant administered the local anesthesia at the experimental and control sites. Following the pre-treatment with local anesthesia, the principal investigator re-entered the room, and the patient was assessed for pulse rate, blood pressure, and duration of anesthesia, which was confirmed by the supervisor. To minimize influence during local anaesthetic administration, the principal investigator was absent while the consultant administered the assigned local anaesthetic solution. The principal investigator subsequently returned to assess the predefined clinical outcomes; however, the investigator was not blinded to the intervention during outcome assessment. Prior to performing statistical analyses, the normality of all continuous variables (time of onset, duration, LA amount, VAS pain score, systolic and diastolic BP, pulse rate) was assessed using the Shapiro-Wilk test. The results indicated that the data were normally distributed ($p > 0.05$ for all variables), justifying the use of parametric tests such as the independent and paired t-tests. If any variables were found to be non-normally distributed, the corresponding non-parametric tests (e.g., Wilcoxon signed-rank test, Mann-Whitney U test) would have been used, and this has been reported accordingly. Prior to performing statistical analyses, the normality of all continuous variables (time of onset, duration, LA amount, VAS pain score, systolic and diastolic BP, pulse rate) was assessed using the Shapiro-Wilk test. Within-group comparisons (pre- and post-anesthesia values for systolic blood pressure, diastolic blood pressure, and pulse rate) were performed using paired t-tests. To control for the risk of Type I error due to multiple comparisons (three tests performed), a Bonferroni correction was applied. Consequently, a p-value of $< 0.017$ (0.05/3) was considered statistically significant for these specific pre-post comparisons.

Patients' data were compiled and analyzed using SPSS Version 26.0. Frequency and percentage were calculated for categorical variables. For quantitative variables such as age, pulse rate, and onset of anesthesia, mean ± standard deviation (SD) was calculated. The independent sample t-test was applied, and a p-value ≤ 0.05 was considered statistically significant.

## RESULTS

A total of 50 patients participated in this split-mouth study. In Group 1 the mean age of the patients was 26.4 ±4.2 years, while in Group 2 it was 25.9 ± 3.8 years. The gender distribution shows 56% males and 44% females in Group 1 and 54% males and 46% females in Group 2. The demographic characteristics of the study participants are presented (Table 1).

**Table 1:** Demographic Characteristics of Patients in Both Groups

| Variables | Group 2 (1:100,000), Mean ± SD / n (%) | Group 1 (1:80,000), Mean ± SD / n (%) |
|---|---|---|
| Age | 26.4 ± 4.2 | 25.9 ± 3.8 |
| Male | 28 (56%) | 27 (54%) |
| Female | 22 (44%) | 23 (46%) |

The study shows the comparison of anesthetic parameters between Group 1 (1:80,000 epinephrine) and Group 2 (1:100,000 epinephrine). Independent sample t-test was applied to compare the mean values between the two groups. The subjective onset time showed a trend toward being longer in Group 1 but did not reach statistical significance ($p=0.045$) at the pre-defined significance level of $p \leq 0.050$. The objective onset time was similar between the groups (3.13 ± 0.97 min in Group 1 vs 3.31 ± 0.92 min in


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Group 2) with no statistically significant difference (p=0.053). The duration of anesthesia was significantly longer in Group 1 (149.79 ± 18.05 min) than in Group 2 (116.82 ± 12.74 min) (p=0.001). The amount of local anesthetic used was the same in both groups (2.31 ± 1.2), although a statistically significant difference was reported (p=0.002). The 1:80,000 adrenaline concentration provided a significantly longer duration of anaesthesia but was associated with significantly higher VAS pain scores (3.5 ± 1.12) compared to the 1:100,000 concentration (2.5 ± 1.12, p=0.100). Therefore, while 1:80,000 may be preferred for prolonged procedures, 1:100,000 appears to offer better pain control during the extraction (Table 2).

**Table 2:** Comparing the Time of Onset, Duration, Amount of Local Anaesthetic Used (LA), and VAS Pain Score for the Patients

| Variables | Group 1 (1:80000), Mean ± SD | Group 2 (1:100000), Mean ± SD | p-value |
|---|---|---|---|
| Time of Onset (Subjective) | 1.74 ± 0.75 | 1.62 ± 0.63 | 0.045 |
| Time of Onset (Objective) | 3.13 ± 0.97 | 3.31 ± 0.92 | 0.053 |
| Duration | 149.79 ± 18.05 | 116.82 ± 12.74 | 0.001 |
| LA Amount | 2.31 ± 1.2 | 2.31 ± 1.2 | 0.100 |
| VAS Pain Score | 3.5 ± 1.12 | 2.5 ± 1.12 | 0.002 |

Changes in cardiovascular parameters (systolic blood pressure, diastolic blood pressure, and pulse rate) were assessed before and after local anaesthesia administration. Paired t-tests showed no statistically significant changes within either group ($p > 0.05$ for all parameters). Furthermore, independent samples t-test comparing the magnitude of change (post-minus-pre values) between the 1:80,000 and 1:100,000 groups revealed no significant differences ($p > 0.05$ for all), indicating that both adrenaline concentrations had similar effects on short-term cardiovascular parameters (Table 3).

**Table 3:** Pre- and Post-Anesthesia Cardiovascular Parameters

| Variables | Pre-Anesthesia, Mean ± SD | Post-Anesthesia, Mean ± SD | p-value |
|---|---|---|---|
| Systolic BP (mmHg) | 125.6 ± 10.4 | 127.2 ± 11.0 | 0.072 |
| Diastolic BP (mmHg) | 78.3 ± 6.5 | 79.0 ± 6.8 | 0.145 |
| Pulse Rate (beats/min) | 82.5 ± 10.2 | 84.0 ± 10.5 | 0.065 |

## DISCUSSION

Local anaesthesia (LA) with vasoconstrictors is widely used in dentistry to prolong anaesthetic effect and control bleeding. This study compared two concentrations of adrenaline (1:80,000 and 1:100,000) in lignocaine for the extraction of mandibular third molars [15]. Kumar *et al.* reported that the clinical effectiveness of local anaesthetic solutions remains largely unaffected by the concentration of epinephrine, supporting our observation of comparable onset times [14].The duration of anaesthesia was longer with the 1:80,000 adrenaline concentration in the present study. Previous clinical studies evaluating different adrenaline concentrations have also demonstrated that variation in vasoconstrictor concentration may influence the duration of local anaesthetic effect [16-18]. This suggests that, although both concentrations are clinically effective, a slightly higher adrenaline concentration may provide prolonged analgesia for longer procedures. Regarding pain perception, the VAS scores indicated slightly higher pain in the 1:80,000 group (mean 3.5) compared to the 1:100,000 group (mean 2.5), although this difference is clinically moderate. These results are comparable to other studies evaluating patient-reported pain during mandibular extractions, which reported minor differences between epinephrine concentrations [19-21]. The present results indicate that the mean time of onset did not differ significantly between the two groups, consistent with previous reports by Malamed *et al.* who found that variations in epinephrine concentration do not significantly alter the onset of anaesthesia [20]. Physiological responses, including blood pressure and pulse rate, showed minor fluctuations before and after anaesthesia, consistent with previously documented patient reactions to lignocaine with epinephrine [16, 18]. No significant adverse cardiovascular effects were observed, indicating that both concentrations are safe for routine dental use. The findings demonstrated a longer duration of anesthesia with 1:80,000 adrenaline, while the 1:100,000 concentration showed comparatively lower pain scores and may present fewer cardiovascular concerns. Similar observations were reported by Veeramuthu *et al.* and Venkateshwar *et al.* who also found that higher concentrations of adrenaline tend to prolong anesthetic duration but may influence cardiovascular parameters [13, 17]. Overall, the present findings suggest that both 1:80,000 and 1:100,000 adrenaline concentrations are effective for routine dental procedures, providing adequate anaesthesia and hemodynamic stability. Future research exploring more precise variations in adrenaline concentrations may help optimize patient comfort and procedural efficacy further.

The quasi-experimental split-mouth design did not involve random allocation of the interventions, which may have introduced selection or allocation bias. Blinding was not performed during outcome assessment, which may have introduced detection bias, particularly for subjective outcomes such as pain and anaesthetic onset. The relatively small sample size may limit the generalizability of the findings to a wider population. The study was conducted at a single center using non-probability convenience sampling, which may limit the representativeness and external validity of the findings to other clinical settings and populations In addition, only


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short-term outcomes were assessed, as long-term effects and delayed reactions were not evaluated. Although all procedures were performed by the same operator, the unblinded outcome assessment may have introduced detection bias, particularly for subjective outcomes. Furthermore, individual systemic factors such as patient anxiety, metabolic rate, and minor medical conditions were not fully controlled, which may have influenced the response to local anaesthesia. Both 1:80,000 and 1:100,000 adrenaline with 2% lignocaine are effective for mandibular third molar extraction. The 1:80,000 concentration provides a longer duration of anaesthesia, while 1:100,000 shows comparable efficacy with better cardiovascular safety. Therefore, 1:100,000 adrenaline is recommended for medically compromised patients, whereas 1:80,000 may be preferred when prolonged anaesthesia is required. Further multicenter studies with larger samples, randomized allocation, blinded outcome assessment, and inclusion of patients with relevant cardiovascular conditions are recommended to confirm the comparative efficacy and cardiovascular safety of these adrenaline concentrations.

## CONCLUSIONS

Both 1:80,000 and 1:100,000 adrenaline concentrations with 2% lidocaine demonstrated clinical effectiveness during mandibular third molar extraction. The 1:80,000 concentration provided a significantly longer duration of anaesthesia, whereas the 1:100,000 concentration was associated with lower VAS pain scores. No significant short-term changes in systolic blood pressure, diastolic blood pressure, or pulse rate were observed following administration of either concentration. However, as the study included healthy participants and assessed only short-term cardiovascular responses, these findings should not be interpreted as evidence of greater cardiovascular safety in patients with cardiovascular disease.

## Authors' Contribution

Conceptualization: MMK
Methodology: MMK, AAJ
Formal analysis: MMK
Writing and Drafting: MMK, MI
Review and Editing: MMK, MI, AAJ, HN, SAK, SH, DESR

All authors approved the final manuscript and take responsibility for the integrity of the work

## Conflict of Interest

All the authors declare no conflict of interest.

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