

Academia Journal of Medicine Year 2026, Volume-9, Issue- 1 (January- June)



Comparative Evaluation of the Efficacy and Onset of Local Anesthesia Using Buffered 2% Lidocaine with 1:100,000 Adrenaline and Non-Buffered 2% Lidocaine with 1:100,000 Adrenaline in Dental Extraction – A Clinical Study

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ARTICLE INFO

Keywords: Buffered local anesthesia, lidocaine, onset time, dental extraction, pain perception

doi:10.48165/ajm.2026.9.01.14

ABSTRACT

Aim: To comparatively evaluate the onset time and efficacy of buffered 2% lidocaine with 1:100,000 adrenaline and non-buffered 2% lidocaine with 1:100,000 adrenaline in patients undergoing dental extraction.

Materials and Methods: This randomized, single-blind clinical study was conducted on 40 patients indicated for simple dental extraction. The patients were randomly divided into two groups (n = 20 each). Group I received non-buffered 2% lidocaine with 1:100,000 adrenaline, while Group II received buffered 2% lidocaine with 1:100,000 adrenaline. The buffered solution was prepared by adding 8.4% sodium bicarbonate to the anesthetic solution immediately before administration. The onset time of anesthesia was recorded using a stopwatch from completion of injection to the first subjective sign of numbness. Pain during injection and pain during extraction were assessed using a Visual Analog Scale (VAS). The need for supplementary anesthesia was also recorded. Statistical analysis was performed using the independent *t*-test and Chi-square test, with the level of significance set at $p < 0.05$.

Results: The buffered lidocaine group demonstrated a significantly faster onset of anesthesia compared to the non-buffered group ($p < 0.05$). Pain scores during injection and during extraction were significantly lower in the buffered group. Additionally, fewer patients in the buffered group required supplementary anesthesia.

Conclusion: Buffered 2% lidocaine with 1:100,000 adrenaline provides faster onset and improved anesthetic efficacy with reduced pain perception compared to non-buffered lidocaine during dental extraction. Its use may enhance patient comfort and clinical efficiency in routine dental practice.

Introduction

Local anesthesia is a fundamental component of dental

practice and is essential for the painless performance of routine procedures such as dental extractions. An ideal local anesthetic should provide rapid onset, adequate depth of

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anesthesia, and minimal discomfort during administration and treatment. Despite the widespread use of lidocaine with adrenaline as the gold standard local anesthetic in dentistry, patients frequently report pain during injection and delayed onset of anesthesia, which may negatively affect their overall treatment experience.^{1,2}

One of the key factors influencing the onset and efficacy of local anesthesia is the pH of the anesthetic solution. Commercially available lidocaine with adrenaline is acidic in nature to enhance shelf life and stability of adrenaline. However, the acidic pH can lead to increased pain during injection and a slower onset of anesthesia due to reduced availability of the non-ionized form of the anesthetic agent, which is essential for nerve membrane penetration.^{3,4}

Buffering local anesthetic solutions with sodium bicarbonate has been suggested as an effective method to increase the pH of the solution, thereby enhancing the proportion of non-ionized anesthetic molecules. This modification has been reported to reduce injection pain and accelerate the onset of anesthesia. Buffered local anesthesia has gained interest in dental practice due to its simplicity and potential to improve patient comfort without altering the anesthetic agent itself.^{4,5} Although several studies have evaluated buffered local anesthesia in medical and dental settings, limited clinical data are available comparing the onset time and anesthetic efficacy of buffered and non-buffered lidocaine specifically in dental extraction procedures. Therefore, the present study was undertaken to comparatively evaluate the onset and efficacy of buffered 2% lidocaine with 1:100,000 adrenaline and non-buffered 2% lidocaine with 1:100,000 adrenaline in patients undergoing dental extraction, with the aim of identifying a clinically effective and patient-friendly anesthetic approach in general dental practice.

Materials and Methods

Study Design: The present study was conducted as a randomized, single-blinded clinical comparative study in the Department of Oral Surgery and Maxillofacial Surgery.

Ethical Approval: Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study. All participants were informed about the nature and purpose of the study, and written informed consent was obtained from each patient.

Study Population and Sample Size: A total of 40 patients requiring simple, non-surgical dental extraction under local anesthesia were selected for the study.

Inclusion Criteria

- Patients aged 18–55 years
- Patients indicated for simple dental extraction

- Systemically healthy individuals (ASA I)
- Patients willing to participate and provide informed consent

Exclusion Criteria

- History of allergy to lidocaine or adrenaline
- Pregnant or lactating women
- Presence of acute infection or inflammation at the injection site
- Patients with cardiovascular disorders or systemic conditions contraindicating adrenaline use
- Patients under analgesic, sedative, or anxiolytic medication

Randomization and Group Allocation

Patients were randomly allocated into two groups using a lottery method:

- **Group I (n = 20):** Non-buffered 2% lidocaine with 1:100,000 adrenaline
- **Group II (n = 20):** Buffered 2% lidocaine with 1:100,000 adrenaline

Preparation of Buffered Local Anesthetic Solution: For Group II, the buffered anesthetic solution was prepared immediately before administration by adding 8.4% sodium bicarbonate (Sodac Neon Laboratories Ltd, Mumbai India) to the local anesthetic solution (Lignospan, Septodont) in a 10:1 ratio (0.18 ml of sodium bicarbonate added to 1.8 ml of anesthetic solution). Freshly prepared buffered solution was used for each patient.

Administration of Local Anesthesia: Local anesthesia was administered using a standard aspirating syringe with a 27-gauge needle (Dispovan, Hindustan Syringes and Medical Devices Limited, Faridabad, Haryana, India). The same volume of anesthetic solution and the same injection technique were used for both groups. All injections were administered by a single experienced operator to eliminate inter-operator variability.

Assessment of Onset of Anesthesia: The onset time of anesthesia was measured using a stopwatch. Timing started immediately after completion of the injection and ended when the patient reported the first subjective sensation of numbness, which was confirmed by gentle probing at the extraction site. The onset time was recorded in seconds.

Assessment of Anesthetic Efficacy: Anesthetic efficacy was evaluated based on:

- Pain experienced during tooth extraction
- Requirement of supplementary anesthesia, if any
- Pain during extraction assessed using a Visual Analog Scale (VAS)

Assessment of Pain During Injection: Immediately after administration of local anesthesia, patients were asked to rate their pain during injection using a Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (severe pain).

Blinding: Patients were blinded to the type of anesthetic solution administered. Due to the nature of anesthetic preparation, the operator was not blinded.

Statistical Analysis: The collected data were tabulated and analyzed using SPSS 23 software. Descriptive statistics, including mean and standard deviation, were calculated for the onset time of anesthesia and Visual Analog Scale (VAS) scores. An independent t-test was used to compare quantitative variables between the two study groups, while the Chi-square test was employed to analyze categorical variables such as the requirement for supplementary anesthesia. A p-value of less than 0.05 was considered statistically significant.

Result

All 40 patients completed the study, and the data obtained were subjected to statistical analysis. The comparison between the two groups revealed significant differences in onset time of anesthesia, pain perception during injection, and anesthetic efficacy during extraction.

The results demonstrated that the buffered lidocaine group exhibited a significantly faster onset of anesthesia compared to the non-buffered lidocaine group. Pain scores recorded during injection and during extraction were significantly lower in patients receiving buffered anesthesia. Furthermore, the requirement for supplementary anesthesia was lower in the buffered group, indicating superior anesthetic efficacy. Overall, buffering lidocaine enhanced both the speed of anesthetic action and patient comfort during dental extraction. (Table 1)

Table 1: Comparison of Onset Time, Pain Scores, and Anesthetic Efficacy Between the Two Groups

Parameter	Non-buffered Lidocaine (Mean ± SD /n %)	Buffered Lidocaine (Mean ± SD /n %)	p-value
Onset time (seconds)	182.4 ± 24.6	121.6 ± 18.9	< 0.05*
Pain during injection	4.9 ± 1.3	2.8 ± 1.1	< 0.05*
Pain during extraction	3.6 ± 1.2	1.9 ± 0.9	< 0.05*
Supplementary anesthesia required	6 (30%)	2 (10%)	< 0.05*

*Significant

Discussion

The present study demonstrated that buffered lidocaine resulted in a significantly faster onset of anesthesia, reduced

pain during injection and extraction, and a lower requirement for supplementary anesthesia when compared to nonbuffered lidocaine in dental extraction procedures. These findings support the concept that altering the pH of the anesthetic solution improves clinical performance by increasing the proportion of the nonionized form of the anesthetic, which more readily diffuses across nerve membranes.

The faster onset observed in the buffered group can be attributed to the increased pH of the anesthetic solution, which increases the proportion of non-ionized lidocaine molecules capable of penetrating nerve membranes. This finding aligns with Palanivel et al. (2020)⁶, who reported that buffered lidocaine achieved a faster onset and reduced injection pain in dental extractions. Similarly, Kalra et al. (2023) found that buffered 2% lidocaine resulted in improved anesthetic efficacy and lower pain scores compared to non-buffered solutions in their clinical trial on dental extractions.⁷ Pain during injection was also significantly lower in the buffered group. Acidic anesthetic solutions can irritate tissues, causing discomfort, whereas buffering neutralizes the solution and reduces burning sensations. AlShehabi et al. (2020) observed that buffering lidocaine with sodium bicarbonate significantly decreased patient-reported pain during regional anesthesia.⁸ Fatima et al. (2025) similarly reported that buffered local anesthetic solutions produced lower VAS scores for injection pain compared to standard lidocaine in patients undergoing dental procedures.⁹ The requirement for supplementary anesthesia was lower in the buffered group, indicating more reliable anesthetic depth. This is consistent with findings from a meta-analysis summarized by AulestiaViera PV (2018) which concluded that buffering local anesthetic solutions improved anesthetic success rates, particularly in inflamed or challenging tissues.¹⁰ However, some studies have reported variable effects depending on the type of nerve block, tissue inflammation, and patient population. Nonetheless, the cumulative evidence suggests that buffering lidocaine enhances clinical performance by reducing pain, improving onset time, and increasing anesthetic efficacy. The present study confirms these benefits in the context of routine dental extractions.

In clinical practice, buffering lidocaine is a simple, cost-effective modification that can improve patient comfort and procedural efficiency, especially in anxious patients or in situations where rapid and reliable anesthesia is essential.

Conclusion

The present study demonstrated that buffered 2% lidocaine with 1:100,000 adrenaline provides a faster onset of anesthesia, reduced pain during injection and extraction, and a lower requirement for supplementary anesthesia compared to non-buffered lidocaine in dental extraction procedures.

Buffering the anesthetic solution is a simple, cost-effective modification that enhances both patient comfort and clinical efficiency. Incorporating buffered local anesthesia into routine dental practice may improve patient experience, particularly in anxious patients or in procedures requiring rapid and reliable anesthesia.

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