Original Article
DOI: https://doi.org/10.70749/ijbr.v3i5.2916

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Effect of Sodium Bicarbonate Buccal Infiltration on the Success of Inferior Alveolar Nerve Block (IANB) in Mandibular First Molars with Symptomatic Irreversible Pulpitis

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ARTICLE INFO

Keywords: Inferior alveolar nerve block, sodium bicarbonate buccal infiltration, mandibular first molars, anesthetic performance, inflamed tissues.

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Declaration
Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 19-02-2025 Revised: 12-05-2025
Accepted: 16-05-2025 Published: 30-05-2025

ABSTRACT

Background: The endodontic access of mandibular molars with symptomatic irreversible pulpitis requires achieving profound anesthesia which failure of inferior alveolar nerve block (IANB) frequently dictates the need to administer additional injections. Sodium bicarbonate Buffering/alkalinizing regimens (e.g. sodium bicarbonate) could be useful to enhance anesthetic performance in inflamed tissues. **Objective:** To determine the effect of sodium bicarbonate buccal infiltration on the success of IANB in mandibular first molars with symptomatic irreversible pulpitis. **Methods:** This comparative analytical (quasi-experimental) research was done in the Department of Operative Dentistry and Endodontics, Fatima Jinnah Dental College and Hospital, Karachi from October 2023 to April 2024. A consecutive sampling was carried out to recruit 72 patients with symptomatic irreversible pulpitis in first molars of the mandible who were divided into two groups (n=36). All the patients were provided with standard IANB. Group A also obtained sodium bicarbonate buccal infiltration whereas Group B obtained control buccal infiltration. The level of pain was measured by a 10-point VAS at access and pulp extirpation. Success of IANB was the completion of access/initial instrumentation with VAS 3 or less without the need of supplemental anesthesia. **Results:** IANB success was significantly higher in Group A than Group B (69.4% vs 38.9%, p=0.009). Group A reported lower pain during access (2.4±1.6 vs 3.6±1.8, p=0.004) and pulp extirpation (2.9±1.7 vs 4.1±1.9, p=0.006), faster onset of lip numbness (3.8±1.2 vs 4.6±1.4 minutes, p=0.011), and reduced need for supplemental anesthesia (30.6% vs 61.1%, p=0.009). Adverse events were infrequent and comparable. **Conclusion:** Sodium bicarbonate buccal infiltration significantly improves IANB success and reduces intra-operative pain and supplemental anesthesia requirement in mandibular first molars with symptomatic irreversible pulpitis.

INTRODUCTION

Local anesthesia is essential to painless endodontic therapy, but achieving deep pulpal anesthesia of mandibular anterior teeth with symptomatic irreversible pulpitis has proven a consistent clinical problem. The most common method of anesthesia of the mandibular molars is the inferior alveolar nerve block (IANB), which is often insufficient in the case of hot teeth, resulting in pain during access cavity development and pulp extirpation and necessitating the use of multiple additional injections. This not only augments chairside time and patient anxieties, but also has an adverse impact on patient satisfaction and the trustworthiness of the operators [1-3].

A number of mechanisms have been suggested in case of decreased anesthetic effect in irreversible pulpitis. Inflamed tissues also show reduced PH, increased vascularity and augmented expression of inflammatory mediators, which sensitize nociceptors. A lower proportion of the local anesthetic is in the lipid-soluble base form required to penetrate the nerve membrane in an acidic environment and this could delay the onset and decrease the depth of anesthesia. Therefore, clinicians often have to use buccal infiltrations, intraligamentary injections, intraosseous methods, or intrapulpal anesthesia to cover up the treatment [4-6].

Sodium bicarbonate has been utilized as an alkalinizing solution to buffer local anesthetic solutions to enhance its diffusion and onset. Theoretically, raising the local pH level can raise the ratio of the anesthetic in the active base form and provoke nerve blockade in inflammatory states. Buccal administration of sodium bicarbonate, as an adjunct to IANB is therefore a viable strategy which may possibly lead to a successful outcome of anesthetic treatment in mandibular first molars with irreversible pulpitis with a minimum of repeated injections [7-10].

To evaluate the effect of sodium bicarbonate buccal infiltration on the success of inferior alveolar nerve block in mandibular first molars with symptomatic irreversible pulpitis and to compare intra-operative pain and supplemental anesthesia requirements between the study groups.

METHODOLOGY

This comparative analytical (quasi-experimental) study was carried out in the Department of Operative Dentistry and Endodontics, Fatima Jinnah Dental College and Hospital, Karachi, with study duration 6 months from October 2023 to April 2024, after approval of the topic from the Research Evaluation Unit, College of Physicians and Surgeons Pakistan (CPSP) (Ref No: CPSP/REU/DSG-2022-184-4083).

The 72 patients exhibiting symptomatic irreversible pulpitis of a mandibular first molar (36 or 46) were recruited throughout the study period by non-probability consecutive sampling. Both male and female patients who exhibited clinical characteristics of irreversible pulpitis (spontaneous/prolonged pain, excessive response to thermal testing) and needed endodontic access were accepted. Patients who had a known allergy to local anesthetic agents, acute apical abscess/swelling, or needed emergency drainage of periapical pathology, limited mouth opening, and those with systemic contraindication of dental local anesthesia or who could not comprehend the pain rating system were eliminated.

After obtaining informed consent, participants were allocated into two equal groups (n = 36 each) using a non-random (alternate allocation/convenience) method as per clinical flow. All cases received a standardized inferior alveolar nerve block (IANB) using 2% lidocaine with 1:100,000 epinephrine (1.8 mL) administered via the conventional technique. Onset of anesthesia was assessed by the presence of subjective lip numbness. In Group A, the patients also underwent sodium bicarbonate buccal infiltration in the mucobuccal fold next to the mandibular first molar (prepared and administered as per departmental protocol) in addition to the control buccal infiltration (standard solution/placebo as done in the department) of the same technique. A fixed waiting period was followed by initiation of endodontic access.

The intensity of pain was measured with the 10-point Visual Analog Scale (VAS; 0 = no pain, 10 = worst pain imaginable) at several critical points during the procedure, such as preparation of an access cavity, and during pulp extirpation/initial instrumentation. The primary outcome was IANB success, defined as completion of access and initial canal procedures with no or mild pain (VAS ≤ 3) without requiring supplemental anesthesia. The onset time, intra-operative VAS pain scores, and the necessity of supplemental anesthesia (e.g., intraligamentary, intrapulpal, or additional infiltration), and the presence of any immediate adverse effects (e.g. burning sensation, swelling/hematoma, or trismus) were included as the secondary outcomes.

Data were entered and analyzed using SPSS (version as available). Quantitative variables (age, onset time, VAS scores) were expressed as mean ± SD and compared between groups using the independent samples t-test (or Mann–Whitney U test if data were non-normally distributed). Categorical variables (IANB success, requirement of supplemental anesthesia, adverse events) were presented as frequency and percentage and compared using the Chi-square test or Fisher's exact test when appropriate. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 72 patients were enrolled and divided equally into sodium bicarbonate (n=36) and control (n=36) groups. The mean age, gender distribution, tooth side (right/left), and involved tooth (36/46) were comparable between groups. Pre-operative pain severity was also similar, indicating both groups were well-matched at baseline.

Table 1

Baseline Demographic and Clinical Characteristics (n = 72)

Variable	Group A ($NaHCO_3$) n=36	Group B (Control) n=36	p-value
Age (years), Mean ± SD	27.9 ± 6.8	28.6 ± 7.1	0.664
Male, n (%)	20 (55.6)	19 (52.8)	0.812
Tooth side (Right), n (%)	18 (50.0)	17 (47.2)	0.816
Tooth number (36), n (%)	19 (52.8)	18 (50.0)	0.816
Pre-operative pain (VAS 0–10), Mean ± SD	7.8 ± 1.0	7.6 ± 1.1	0.422

The sodium bicarbonate group had a greater overall success rate of inferior alveolar nerve block than the control group. Patients that got sodium bicarbonate had much lower scores in pain during access cavity preparation and pulp extirpation and a quicker onset of lip numbness. The requirement of additional anesthesia was also greatly decreased in the sodium bicarbonate group, which justifies enhanced clinical performance.

Table 2

Primary and Secondary Anesthesia Outcomes

Outcome	Group A ($NaHCO_3$) n=36	Group B (Control) n=36	p-value
IANB success, n (%)	**25 (69.4)**	**14 (38.9)**	**0.009**
Onset of lip numbness (min), Mean ± SD	3.8 ± 1.2	4.6 ± 1.4	0.011
Pain during access (VAS 0–10), Mean ± SD	2.4 ± 1.6	3.6 ± 1.8	0.004
Pain during pulp extirpation (VAS 0–10), Mean ± SD	2.9 ± 1.7	4.1 ± 1.9	0.006
Supplemental anesthesia required, n (%)	11 (30.6)	22 (61.1)	0.009

Intraligamentary injection is the most frequently used procedure among patients who needed a supplemental anesthesia in both groups. The frequency of inadequate primary anesthesia was more often in the control group than in the sodium bicarbonate group by nearly twice the rate. Generally, the spread of the supplemental methods was widely homogenous, but the prevalence was significantly less with sodium bicarbonate.

Table 3

Type of supplemental anesthesia used (only among failures)

Supplemental technique	Group A (n=11)	Group B (n=22)
Intraligamentary injection, n (%)	6 (54.5)	10 (45.5)
Buccal reinfiltration, n (%)	3 (27.3)	7 (31.8)
Intrapulpal injection, n (%)	2 (18.2)	5 (22.7)

In both groups, adverse events were very rare as well as mild. The percentage of the patients who experienced a transient burning at the point of injection was a small percentage in the sodium bicarbonate group and this did not translate into clinically significant complications. Swelling/hematoma and trismus did not show any meaningful differences between the groups.

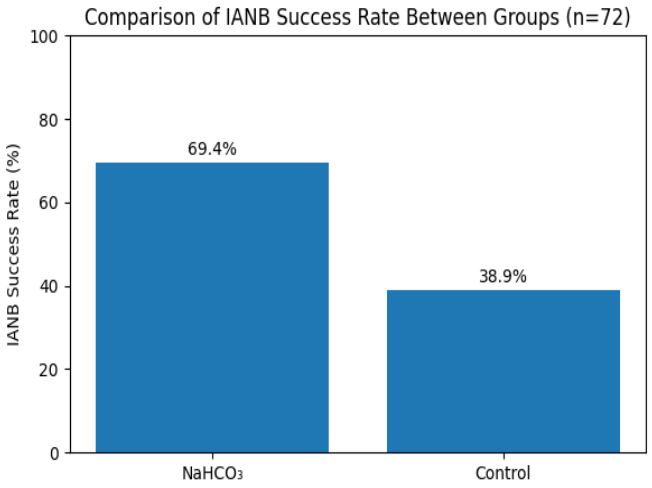
Table 4

Adverse events / injection-related complaints

Adverse event	Group A (n=36)	Group B (n=36)	p-value
Transient burning at injection site, n (%)	4 (11.1)	2 (5.6)	0.674
Mild swelling/hematoma, n (%)	1 (2.8)	1 (2.8)	1.000
Trismus (mild), n (%)	0 (0.0)	1 (2.8)	0.314

Figure 1

Comparison of inferior alveolar nerve block (IANB) success rate between the sodium bicarbonate ($NaHCO_3$) and control groups (n = 72; 36 per group). The $NaHCO_3$ group demonstrated a higher success rate (69.4%) compared with the control group (38.9%).



DISCUSSION

The current research assessed the effectiveness of sodium bicarbonate buccal infiltration as an adjunct to an already established inferior alveolar nerve block (IANB) in patients with symptomatic irreversible pulpitis of first molars in the mandible. The primary conclusion was that the adjunctive sodium bicarbonate technique had a high IANB success rate in comparison to the control condition and lower intra-operative pain scores in access and pulp extirpation and less requirement of supplemental anesthesia. These are clinically significant since mandibular molars with irreversible pulpitis have been known to pose persistent IANB failure and require giving more than one injection when providing emergency endodontics [11-13].

One possible reason behind better success is connected with the inflamed pulpal microenvironment where the tissue acidosis and inflammatory mediator may decrease the fraction of lipid-soluble base form accessible to permeate nerve membranes and accelerate nociceptor sensitization. The local pH can be altered towards alkalinity by placing sodium bicarbonate in the buccal tissues near the tooth, which may cause an increase in the percentage of anesthetic in the active form of the base and resulting in the diffusion of the anesthetic and nerve blockage. The sodium bicarbonate group was also found to experience lip numbness faster in the present dataset, which supports the idea of better anesthetic pharmacodynamics and could be applied in clinical practice in the form of smoother workflow [14-16].

Along with the increased success rates, the sodium bicarbonate group showed substantial reduced pain scores in procedural stages that usually provoke breakthrough pain in the irreversible pulpitis- especially the access cavity preparation and pulp extirpation. This decrease in procedural pain is practically significant as it may enhance cooperation with patients, decrease the levels of stress in the chairside setting, and mitigate interruptions caused by repeated anesthesia. Notably, the control group had almost twice as frequent supplemental injections when compared to the sodium bicarbonate one, which can be interpreted as the potential of the adjunctive methodology to minimize the total anesthetic exposure and needle penetrations, which can affect patient satisfaction and overall experience of the treatment [17-19].

In terms of safety, adverse events were not frequent, and both groups had mild events. A low percentage of patients complained about the transient burning sensation at the site of injection which is a natural effect of pH variations and tissue reaction; nevertheless, none of the clinically significant complications like the swelling persisting, blood clot, or trismus that could be attributed to the struggle was provided. Such results imply that the sodium bicarbonate buccal infiltration technique can be used as an aid method and does not increase any significant risk in the situation of careful application within the standard clinical guidelines [20].

There are certain limitations to this research. First, the study is quasi-experimental and non-randomly allocated, which does not allow the exclusion of selection bias. Second, the results were in part determined through the subjective pain assessment (VAS) subject to personal pain thresholds and anxiety. Third, this research was performed in one center and only involved mandibular first molars, and this probably restricts the ability to generalize the results to other teeth. The implementation of future multicentric randomized and controllable studies with controls on the level of buffering concentration and the determination of patient-reported outcomes (satisfaction and anxiety), would be more supportive and assist in determining the most effective protocol.

CONCLUSION

Sodium bicarbonate buccal infiltration, when used as an adjunct to conventional inferior alveolar nerve block, improves anesthetic success in mandibular first molars with symptomatic irreversible pulpitis. It is associated with lower intra-operative pain and a reduced need for supplemental anesthesia, without clinically significant adverse effects. This adjunctive technique may be considered a practical option to enhance anesthesia during endodontic management of “hot” mandibular molars in routine clinical practice.

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