# To evaluate the anesthetic efficacy of sodium bicarbonate buffered 2% lidocaine with 1:100,000 epinephrine in Inferior Alveolar Nerve Blocks: A prospective, randomized, double-blind study

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**ABSTRACT:**

**Aims:** The aim of the study was to evaluate the anesthetic efficacy of sodium bicarbonate buffered 2% lidocaine with 1:1000000 epinephrine in Inferior Alveolar Nerve Blocks (IAN).
**Design**: A prospective, randomized controlled, double-blind study in a crossover design.
**Material and Method**: Thirty blinded subjects randomly received 2 IAN blocks using 3 ml of 2% lidocaine with 1:100,000 epinephrine and 2% lidocaine with 1: 100,000 epinephrine/ 0.17 mEq/ml sodium bicarbonate at 2 separate appointments spaced at least 1 week apart, in a crossover design. Each patient served as his/her own control. Total of 60 blocks were administered i.e. 2 nerve blocks in each patient, on contralateral side. For testing, subjective and objective symptoms were assessed. Each anesthetic solution was assigned a blind 1 and blind 2 numbers and the data were recorded with these numbers. Statistical analysis used: Equality of proportion test is applied.
**Result**: Buffering of local anesthetic solution makes the experience of injection more comfortable to the patient with 70% marked no pain on solution deposition. Onset time of analgesia shows that 2% lidocaine with 1:100000 epinephrine with sodium bicarbonate has faster onset i.e. 74% of nerve blocks showed less than 1 minute of time while 2% lidocaine with 1:100000 epinephrine showed 67% of nerve blocks were effective after 2 minutes.
**Conclusion**: The findings suggest that buffering of anesthetic solution significantly decreases the pain of injection, provide faster onset when compared to unbuffered anesthetic solution for IAN block.

**Keywords:** Buffering, Inferior alveolar nerve block, Lidocaine, Sodium bicarbonate.

## INTRODUCTION

Fear and anxiety are the foremost common reasons that individuals avoid dental appointments. They typically result from anesthesia injections used for various dental procedures. Therefore, management of pain and anxiety throughout local anesthetic injections has clinical importance in everyday practice.

Pain because of anesthesia is caused not solely by mechanical trauma to the region of the injection however additionally by the swift extension of the tissues into which anesthetic solution is being injected. In fact, tissue tension will cause additional pain and discomfort than the needle puncture.

Dentists and other clinicians have used various methods to prevent pain while administering local anesthesia such as using topical anesthetics, slow infiltration, transcutaneous electrical nerve stimulation (TENS), computer-assisted local anesthesia (such as Wand), and vibration. Local anesthetics are the safest and most effective drugs for the prevention and management of pain. The first widely used dental anesthetic was cocaine, then procaine and lidocaine. All of these local anesthetic solutions have been formulated with vasoconstrictors, most often with epinephrine, but in some cases with levonordefrin, this makes the local anesthetic solution acidic and results in pain while administering local anesthesia, so to reduce the injection pain and make the onset of analgesia faster alkalinization of anesthetic solution can be carried out. Science of buffering local anesthetics results in more rapid, more efficient, and more predictable, as well as being more comfortable for the patient.

The inferior alveolar nerve (IAN) block is the most frequently used injection technique for achieving local anesthesia for mandibular restorative and surgical procedures. The inferior alveolar nerve block produces both subjective and objective symptoms, however, the approximate failure rate of these procedures ranges from 5 to 15%[1] or 15 to 20% according to Kaufman[2] (1984), nerve blocked starts to occur after within 2-3 minutes after deposition of anesthetic solution and with buffering of solution the time of nerve blocked becomes short and faster onset of anesthesia is obtained.

## MATERIALS AND METHODS

Thirty adult subjects participated in this study taken from the outpatient department of K.D. Dental College and Hospital, Mathura. Subjects were in good health and were not taking any medications that would alter their perception of pain. Exclusion criteria were as follows: Acute Infections, Medically compromised, Patients who were pregnant or lactating, Smokers, allergies to local anesthetics or sulfites, taking any medications that may affect anesthetic assessment, and inability to give informed consent. The study was approved by ethical committee, and written informed consent was obtained from each subject.

Thirty blinded subjects randomly received 2 IAN blocks using 3 ml of 2% lidocaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine/ 0.17 mEq/ml sodium bicarbonate at 2 separate appointments spaced at least 1 week apart, in a crossover design. Each patient served as his or her own control. Total of 60 blocks were administered i.e. 2 nerve blocks in each patient, 30 blocks on right side and 30 blocks on left side. For testing the experiment subjective and objective symptoms were assessed. Before beginning with the experiment each anesthetic solution was assigned a blind 1 and blind 2 numbers (Figure 1) and the data were recorded with these numbers.


Figure 1: Each anesthetic solution was assigned a blind 1 and blind 2

Under sterile conditions, first solution of 2% lidocaine solution with 1:100000 epinephrine, 3.6 ml was drawn in 5 ml of syringe from local anesthetic vial. Second solution of 2% lidocaine solution with 1:100000 epinephrine/0.17 mEq/ml sodium bicarbonate was prepared by adding 0.6 ml of sodium bicarbonate from a 25 ml 7.5 W/V vial into 3 ml of lidocaine solution in a 5 ml of syringe, the syringe was inverted 5-6 times to mix the solution, this produced a final concentration of 0.17 mEq/ml (Figure 2). There should not be any precipitation within the solution, if present discard the solution. Each syringe was covered with a tape with number on it. Both the solutions are prepared within 1 hour of the appointment and after that they were discarded.

Before nerve blocks were administered, each subject was instructed on how to rate the pain of needle insertion, needle placement, and solution deposition.

Figure 2: numbers 2% lignocaine hydrochloride with 1:100000 epinephrine vial, 7.5% W/V 25mEq/25ml Sodium Bicarbonate vial, 5 ml disposable syringes

The visual analogue pain scale ranges from 0-3. Zero indicated no pain, 1 indicated mild pain- that was recognizable but not discomforting, 2 indicted moderate pain- that was discomforting but bearable, and 3 indicated severe pain- that caused considerable discomfort and was difficult to bear.

## RESULT

**Table 1: Pain Ratings for Each Injection Phase for the 2 Anesthetic Formulations Ɨ**

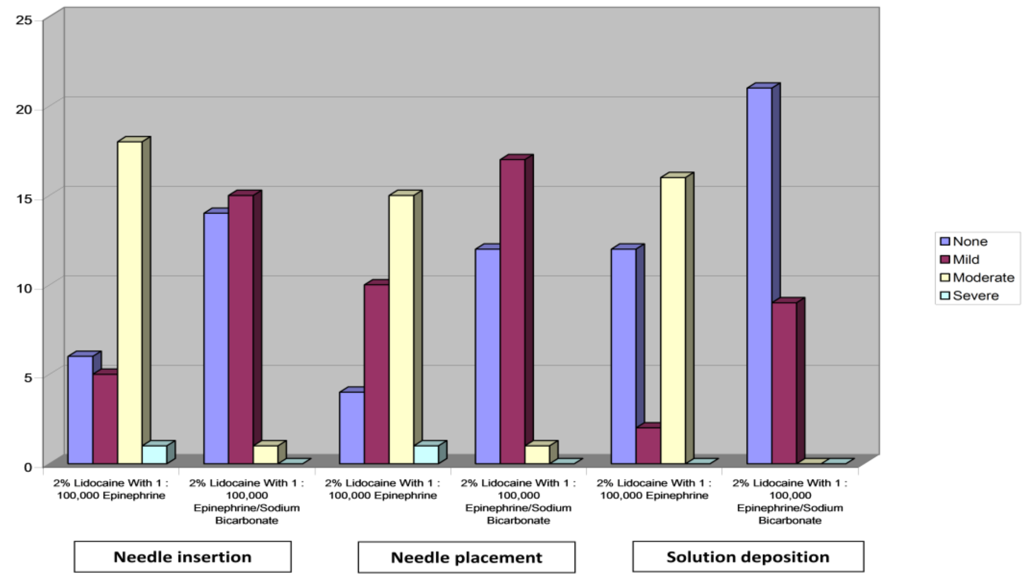
| Injection phase | No pain | Mild | Moderate | Severe |
|---|---|---|---|---|
| Needle insertion | | | | |
| 2% Lidocaine With 1:100,000 Epinephrine | 20%(6/30) | 16.67%(5/30) | 60%(18/30) | 3.33%(1/30) |
| 2% Lidocaine With 1:100,000 Epinephrine/$NaHCO_3$ | 46.67%(14/30 ) | 50%(15/30) | 3.33%(1/30) | 0%(0/30) |
| Needle placement | | | | |
| 2% Lidocaine With 1:100,000 Epinephrine | 13.33%(4/30) | 33.33%(10/30) | 50%(15/30) | 3.33%(1/30) |
| 2% Lidocaine With 1:100,000 Epinephrine/$NaHCO_3$ | 40%(12/30) | 56.67%(17/30) | 3.33%(1/30) | 0%(0/30) |
| Solution deposition | | | | |
| 2% Lidocaine With 1:100,000 Epinephrine | 40%(12/30) | 6.67%(2/30) | 53.33%(16/30) | 0%(0/30) |
| 2% Lidocaine With 1:100,000 Epinephrine/$NaHCO_3$ | 70%(21/30) | 30%(9/30) | 0%(0/30) | 0%(0/30) |

.*Significant difference (P<0.05) was noted between two techniques. Ɨn = 30

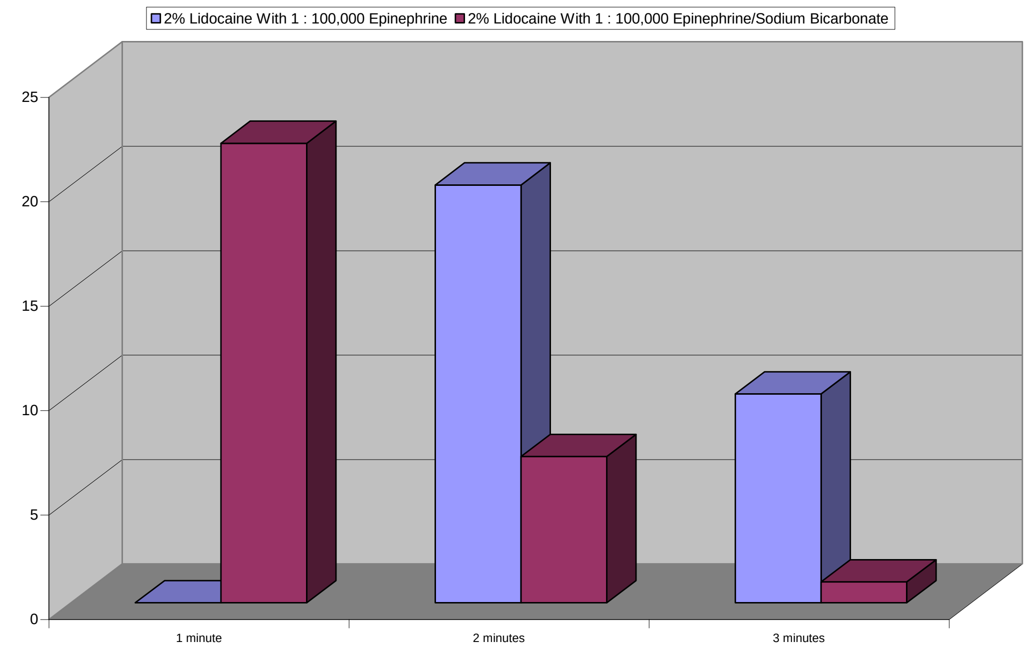
**Table 2: Comparison of Soft tissue Anesthesia Onset Times for the 2 Anesthetic Formulations (in minutes)**

| | **2% Lidocaine With 1:100,000 Epinephrine** | **2% Lidocaine With 1:100,000 Epinephrine// NaHCO3** |
|---|---|---|
| **Time** | **No. of blocks** | **No. of blocks** |
| 1 minutes | 0/30 | 22/30* |
| 2 minutes | 20/30 | 07/30* |
| 3 minutes | 10/30 | 01/30* |

*Significant difference (P<0.05) was noted between two techniques. Ɨn= 30




Graph 1: *Significant difference (P<0.05) was noted between two techniques. Ɨn = 30




Graph 2: *Significant difference (P<0.05) was noted between two techniques. Ɨn= 30

lt is difficult to compare our results with these previous studies. Thirty adult subjects participated, total of 60 inferior alveolar nerve blocks were administered and all produced effective nerve blockade. Pain ratings for each injection phase are presented in the table 1, which shows that buffering of local anesthetic solution causes less pain on injection, needle placement and deposition of solution compared to non-buffered solution. Statistically significant difference was found between the two anesthetic solutions, presented in the graph 1. Buffering of local anesthetic solution makes the experience of injection more comfortable to the patient. Onset time of analgesia of both the anesthetic solution are presented in the table 2, which shows that 2% lidocaine with 1:100000 epinephrine with sodium bicarbonate has faster onset i.e. 74% of nerve blocks showed less than 1 minute of time required for onset of anesthesia while 2% lidocaine with 1:100000 epinephrine showed 67% of nerve blocks were effective after 2 minutes. Buffering of local anesthesia significantly decrease the time of onset of anesthesia.

## DISCUSSION

The pH of local anesthetic solutions without vasoconstrictors is approximately 6.5.The addition of epinephrine (or levonordefrin) and the antioxidant sodium bisulfate lowers the pH into the range of 3.5 (lemon juice has a pH of 3.4). In the cartridge, the local anesthetic solution exists in 2 ionic forms: the tertiary form (B) and the quaternary form(BH+).The lower the pH of the solution, the greater the percentage of BH+ in the solution. This is of clinical significance in that it is the tertiary form of the drug (B) rather than the BH+ form that is lipid soluble and able to diffuse across the lipid-rich nerve membrane entering into the nerve, where it then picks up a H+, which converts it into the quaternary form of the drug (BH+), which then enters into sodium channels and blocks nerve conduction.[3]

When a small percentage of B is available, the speed of onset of anesthesia would be considerably slowed were it not for the body's buffering capability. Once injected into the tissues, the natural process of buffering occurs. The normal pH of tissues is 7.4. A drug with a lower pH (e.g. 3.5) that is injected into tissues will be buffered by the body, and the pH of the injected solution will be slowly increased toward 7.4. As this process continues, the percentage of B ions in the solution steadily increases.

We have increased the pH of the local anesthetic solution to 7.4 prior to injection; this increased the speed of onset of the anesthesia, as well as the comfort to the patient during the injection. (Local anesthetics at a pH of 3.5 produce a ''burning 'sensation as they are injected, and higher-pH solutions are rated by patients as more comfortable). A third advantage to buffering the local anesthetic solution is the 6,000-fold increase in the number of B molecules available to enter into the nerve, which would theoretically provide a more profound anesthetic effect.

Sodium bicarbonate is a commonly used buffer in medicine. It has been used in managing acidosis associated with medical conditions, such as prolonged cardiac arrest.[4] additionally; sodium bicarbonate is used by surgeons administering local anesthetic into the skin to assuage the pain commonly associated with the injection.[5]

Onset of soft tissue anesthesia for buffered lidocaine formulation for 76% of nerve blocks was less than 1 minute while in non buffered formulation for 66% of nerve blocks was more than 2 minute (table 2). Statistically significant difference was noted in onset times of both the anesthetic formulations. DiFazio et.al[7], Zahl et.al [8], Benson et.al[9], and Sinnott et.al [10] found that anesthetic formulations with higher pH values had a faster onset. However Galindo et al [11] and Christoph et al.[12]did not find pH-adjusted agents to have faster onset.

Pain of needle insertion in buffered anesthetic formulation resulted in a 47% incidence of no pain, 50% of mild pain and no incidence of moderate to severe pain while in case of non-buffered anesthetic formulation resulted in a 60% incidence of moderate pain, 16% of mild and 20% of no pain. Needle placement resulted in a 40% incidence of no pain, 57% incidence of mild pain, with no incidence of moderate to severe pain in buffered anesthetic formulation compared to non buffered formulation which resulted in a 50% incidence of moderate pain, 33% incidence of mild pain, 14% incidence of no pain. Solution deposition resulted in a 70% incidence of no pain, 30% incidence of mild pain, and no incidence of moderate to severe pain in buffered anesthetic formulation while in case of non-buffered formulation deposition resulted in a 54% incidence of moderate pain, 40% no pain, 7% incidence of mild pain. Younis and Bhutiani [13] and Ruegg et.al[14] reported less pain with buffered lidocaine compared with unbuffered lidocaine in medical-surgical procedures. In dental model using maxillary infiltrations, Bowels et.al[15] found less pain with buffered lidocaine but Primosch and Robinson[16] found no pain reduction. Because we have used Inferior alveolar nerve block, it is difficult to compare our results with these previous studies.

## CONCLUSION

The physiology, anatomy, and the kinetics of the time course of local anesthetics suggest that the body's processes of converting the cationic RNH+ form of local anesthetic to the active RN form are responsible for significant delay, uncertainty and inconsistency in anesthesia. Taking a patient's physiology out of the latency equation by buffering the local anesthetic solution at chair side immediately prior to injection is an attractive alternative to waiting for the body to accomplish the same buffering process. Ex vivo bicarbonate buffering has been studied and written about for more than 100 years, it is a process recommended by the authors of the leading anesthesiology textbooks, and it is a process that has been evaluated in a recently published Systematic Review by the Cochrane Collaboration,[17]which concluded that the sodium bicarbonate buffering of lidocaine is safe and effective for reducing injection pain.

We conclude that buffering a 2% lidocaine with 1:100000 epinephrine with sodium bicarbonate, significantly decreases the pain of injection, provide faster onset when compared to unbuffered 2% lidocaine with 1:100000 epinephrine for IAN block.

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