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A Comparative Evaluation of Efficacy of Local Infiltration of Sodium Bicarbonate Buffered Local Anesthesia with Epinephrine Vs Non-Buffered La with Epinephrine: A Clinical Study

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Abstract:-

- ***Background:***

The aim of the study was to compare the efficacy of local infiltration of sodium bicarbonate buffered local anaesthesia with epinephrine vs non- buffered local anaesthesia with epinephrine.

- ***Method:***

Patients having periapical infection in the maxillary anterior and premolar region were selected for the study. A total of 50 patients were included in the study. In group A, 8.4% sodium bicarbonate buffered 2% Lignocaine with 1:80,000 adrenaline was used for local infiltration for extraction. In group B, 2% Lignocaine with 1:80,000 adrenaline (non-buffered) was used for local infiltration for extraction. The onset of anesthesia, was compared between group A and group B. Data was tabulated and statistical analysis was carried out using paired t-test.

- ***Result:***

The inter-group difference in onset of anesthesia,was assessed using paired t-test and highly significant difference was found between group A and group B ($p \leq 0.05$).

- ***Conclusion:***

Significant improvement seen in onset of anesthesia and duration of anesthesia.

Keywords:- *Buffered, Non-Buffered, Sodium Bicarbonate, Local Anesthesia, Pain, Duration.*

I. INTRODUCTION

In today's modern world, fear of pain and anxiety often deters individuals from seeking dental care. Local anesthetics play a crucial role in alleviating this fear by providing effective anesthesia during dental procedures.[1] These agents, such as lignocaine, work by blocking nerve conduction, thereby eliminating pain sensation. Lignocaine is frequently combined with epinephrine to enhance its effects, with the addition of epinephrine prolonging the anesthetic's duration in a dose-dependent manner. However, the acidic pH of commercial lignocaine preparations can lead to adverse effects, such as burning upon injection and delayed or inconsistent numbness, particularly in infected tissues.[2]

The inclusion of epinephrine in local anesthetic solutions helps in restricting blood flow, thus preventing the anesthetic from diffusing away from the injection site and prolonging its effectiveness. This buffering process elevates the pH of the solution, making it less acidic and more comfortable for patients. Additionally, buffering local anesthetics has been found to improve the quality of anesthesia and reduce onset time. To alleviate the burning or stinging sensation associated with anesthetic solution, sodium bicarbonate can be used with lidocaine. Various studies have investigated the addition of sodium bicarbonate to lidocaine and have suggested that it can reduce pain during injection and facilitate a quick onset of action. [3]

Overall, the use of buffered local anesthetics can enhance patient comfort, reduce injection pain, and improve the effectiveness of anesthesia in dental procedures. Understanding the impact of pH on local anesthesia and implementing buffering techniques can significantly enhance the patient experience during dental treatments. This study aims to explore sodium bicarbonate's role as a supplementary component to local anesthetics, 4 elevating their pH levels and potentially enhancing their effectiveness in treating localized dental infections.

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II. MATERIALS AND METHODOLOGY

The study was conducted after approval from the Institutional Ethical Committee and written informed consent was obtained from each patient. 50 subjects aged 18 to 70 years, presenting with periapical infection and evidence of periapical abscess, were selected and divided into two groups: Group A (Study group using Buffered LA) and Group B (Control group using non-buffered LA).

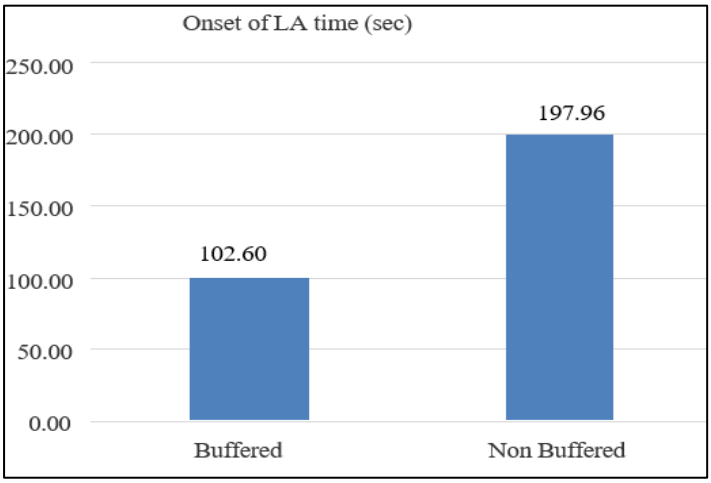
Inclusion criteria: Maxillary anterior and premolar teeth indicated for extraction under local anesthesia in ASA- I category subjects, presence of periapical infection in these teeth, history of acute pain, adult patients with complete formation of root apex, and consent to participate in the study.

Exclusion criteria: Displacement of tooth due to pathology, systemic diseases (ASA II and above), patients taking medications affecting anesthetic assessment, treated cases of mandibular and maxillary fractures/fractured tooth, mobility, severe bone loss, furcation involvement, refusal to give consent, and patients requiring extra dose of local anesthesia after the initial dose.

The extractions were performed wherein administration of 2% lignocaine with 1:80,000 adrenaline freshly buffered with 8.4% sodium bicarbonate in a 10:1 ratio was used for 25 patients (Group A- study group), while non-buffered 2% lignocaine with 1:80,000 adrenaline was administered in 25 patients (Group B- control group). Both, the surgeon and the patient were blinded to the nature of the solutions to avoid bias. Participants were randomly assigned to either Group A or Group B using computerised random allocation technique.

III. RESULT

In this study, the onset of anesthesia was measured **(Graph 1)** from needle retrieval after injecting either buffered or non-buffered solution to the time subjective and objective symptoms were tested with the pinprick method. The onset of action for buffered local anesthesia (LA) was 102.60 seconds (SD = 39.526) significantly faster than non-buffered LA. Non-buffered LA had a mean onset time of 197.96 seconds, indicating a mean difference of 95.360 seconds (t = 9.991, p = 0.000). The difference was statistically significant and demonstrates that buffered LA had a quicker onset of action compared to non-buffered LA.



Graph 1: Onset of LA Time (sec)

IV. DISCUSSION

The use of sodium bicarbonate as a buffering agent in local anesthesia has gained attention for its potential benefits. The pH of normal tissue is around 7.4, but in infected tissue, it can drop to 5.0-6.0. Buffering the local anesthetic solution with sodium bicarbonate helps raise the pH, allowing more of the drug to be in its active form, which enhances its ability to permeate nerve membranes and induce anesthesia.

Studies have shown that buffering local anesthetics with sodium bicarbonate can, expedite the onset of anesthesia, and prolong its duration. Alkalinization has been widely accepted in various medical specialties but has been slower to gain traction in dentistry. However, recent studies, including our own, have demonstrated its efficacy and potential clinical benefits. [5]

Buffering local anesthesia with adrenaline using sodium bicarbonate also has an additional advantage. Apart from minimising injection pain and expediting the commencement of pain relief, the method of buffering generates CO_2 in the solution. This CO_2 becomes part of the injection if it is administered in 30 to 45 seconds post buffering. Bokesch et al.[6] showed the significance of CO_2 by showing a more effective conduction block with lidocaine when free carbon dioxide was present in the solution. Wong et al.[8] illustrated that CO_2 doubled the potency of lidocaine, while Condouris and Sakalis [7] found that CO_2 in solution increased the action of procaine by 10-fold. These findings suggest that the synthesis of CO_2 in the solution could influence the outcomes seen in studies on buffering of local anesthetic and improve the results achievable through buffering 5 in clinical practice.

Fitton et al [9] in their study observed that the addition of 2.0 ml of sodium bicarbonate to 9 ml of 2 % lignocaine resulted in precipitation. However, when 9 ml of lignocaine was added to 0.5-1 ml of sodium bicarbonate, no precipitation occurred. In our study, we used a solution consisting of 1.8 ml of 2 percent lidocaine with 1:80,000 adrenaline and 8.4% sodium bicarbonate in a 10:1 ratio. This buffered solution had a total volume of 2 ml and contained 0.18 mmol/L of sodium bicarbonate.[1]10

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A meta-analysis conducted by Davies examined 22 prospective, randomized, controlled human trials that evaluated the use of pH buffering to reduce pain during anesthetic injections. This analysis included two dental studies. The findings indicated that buffering significantly improved the comfort of injections, which can be particularly beneficial in vulnerable regions like the face and cranium, or when injection discomfort poses challenges in giving treatment, such as with young patients. [11,12]

In their study, Primosch et al.[13] conducted research on the use of buffered lignocaine for infiltration in maxilla and concluded that there was no notable distinction in terms of pain or the time it took for anesthesia to take effect. Notably, our study findings contradict their results, as we observed a highly significant disparity in both 1 pain perception and the onset (time) of anesthesia.

The future of local anesthesia buffering systems looks promising, with advancements like the Anutra buffering system and the Onpharma buffering system offering more efficient and precise ways to buffer local anesthetics. The notable advantage of Antura buffering system is its ability to buffer a larger volume of the local anaesthetic solution, making it particularly useful in cases requiring multiple dental anaesthesia, such as in multiple dental restorations. [14]

The two solutions, namely the 8.4% sodium bicarbonate from the Onpharma onset system- the first chair-side LA cartridge buffering system developed in the United States and approved by the United States Food and Drug Administration (FDA) and the local anesthetic cartridge, are mixed using the onset mixing pen, which is a highly precise mixing device, connected via the cartridge connector. These systems provide dentists with tools to improve patient comfort and enhance the effectiveness of local anesthesia. [15]

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