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COMPARISON OF BUFFERED WITH STANDARD LOCAL ANESTHESIA IN ODONTOGENIC INFECTIONS; A RANDOMIZED CONTROLLED TRIAL

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Abstract

Objective: To compare the efficacy of buffered local anesthetic with standard local anesthetic for insight into pain reduction and speed of onset of anesthesia in the presence of odontogenic infections for maxillary or mandibular infiltration.

Study Design: Double-blinded, Randomized clinical trial (Clinical trial number: IRCT20230622058557N2).

Place and Duration of Study: Department of Armed Forces Institute of Dentistry, Rawalpindi, from March 2020 to September 2023.

Patients and Methods: A total of 100 (Group I-50, Group II-50) patients were included in the study who presented with odontogenic infection. All 100 patients received 2% lignocaine hydrochloride with adrenaline 1:100,000 and of these 100 patients,50 received a 1:10 dilution of the anesthetic cartridge with 0.18 ml solution of 8.4% sodium bicarbonate. The pain was accessed on a Visual analog scale before and after injection. The onset speed was measured by the time taken for the tissues injected to become numb after retrieval of the needle.

Results: According to the Visual Analog Scale score, the mean (SD) level of pain perceived after injection in Group I was 2.80 (0.83), and in Group II was 4.067 (1.65) which is statistically

significant result (p=0.001). The mean (SD) time of onset of anesthesia in minutes was 1.32 (0.41) for the buffered group compared to 2.82 (0.45) for the non-buffered group respectively (p= <0.001).

Conclusion: The use of buffered anesthesia significantly reduced the pain and time for the onset of anesthesia compared to standard lignocaine cartridges, particularly in infected areas, thus increasing the effectiveness of local anesthetic injections.

Keywords: alkalinization; adjusting pH; Buffering; local anesthetic; Pain, sodium bicarbonate visual analog scale (VAS).

INTRODUCTION

Local Anesthetics (LAs) are chemicals that attach to sodium channels in the nerve membrane and block conduction leading to pain relief. Local anesthetics are more effective for rapidly firing sensory fibers. These are blocked when a dentist anesthetizes the trigeminal nerve branches for any dental procedure. [1] Local anesthetic is the most dynamic tool in the clinician's hand. Continuous research is needed to stay updated [2].

The potential benefits of these drugs make them the main component of various in-office procedures. There are, however, multiple issues with using these drugs as well. The fear of injection, the adverse effects of needle penetration like pain, bruising, or edema, and the adverse effects of the drug, such as systemic toxicity or allergic and idiosyncratic reactions, are the prominent shortcomings of local anesthetics.[3]

Multiple studies confirm the acidic preparation of lignocaine with adrenaline to enhance the stability of the solution.[4,5] The acidic environment of infected tissues further decreases the pH of the surrounding tissues and interferes with the release of the free base that has to reach the nerve membrane, effectively decreasing the efficacy of local anesthetics to work in an inflamed environment.[6] To counter this acidity, we use sodium bicarbonate as a buffer.[7]

In addition to infection, elements that affect the pain on injection are the acidic pH of commercial preparations of lignocaine cartridges, piercing of skin by the needle, the injection rate, and the resulting expansion of tissues creating pressure. The addition of sodium bicarbonate not only raises the pH level of the cartridge, thus lessening the stinging sensation but also liberates up more of the free base to reach the sodium channels.[8]

Considering that the essence of numerous dental procedures is local anesthesia, it is imperative to bridge the knowledge gap and reinforce clinicians in providing optimal care to the patient.

Henceforth, this study aimed to study the efficacy of buffered local anesthesia in the presence of infections for pain perception compared to standard 2% lignocaine with 1: 100,000 adrenaline in maxillary or mandibular infiltration techniques.

PATIENT AND METHODS

A randomized, double-blinded, parallel assignment study was conducted at the Armed Forces Institute of Dentistry, CMH, Rawalpindi Pakistan from March 2020 to September 2023. The Institutional Review Board approved the current study criteria and protocol with reference ID (Ref: 905/ Trg-ABP1K2) obtained. We studied 100 patients from age 18 to 70, presenting to the Oral Surgery Department with odontogenic infections such as acute periapical periodontitis or periapical abscesses with or without extension into surrounding fascial spaces. Patients with a history of drug abuse or sensitivity to local anesthetic cartridge components were excluded from the study.

The sample size calculated using the WHO calculator from pilot study results (SD:3.03± 1.62) was increased to 100. Non-probability consecutive sampling technique was adopted. The patients were included and excluded according to the mentioned criteria. Before participating in the study, informed consent was obtained. A computer-generated random sequence was used to divide the patients into two groups (Group I= Buffered, Group II= Non-buffered) so that each group had 50 participants. Patients were randomly allocated to have either buffered 2% local anesthesia with

1:100,000 adrenaline and 8.4% sodium bicarbonate (Group I, n = 50), or 2% lignocaine with 1: 100,000 adrenaline alone (Group II, n = 50). Buffering was achieved by adding 0.18 ml of 8.4 percent sodium bicarbonate solution (Meylon 84, Otsuka Pakistan Ltd) to a 1.8 ml cartridge of 2 percent lignocaine solution leading to a 1:10 dilution as recommended by previous studies.[8] Pain perception was measured using a Visual analog scale before and immediately after the administration of anesthesia. The onset of anesthesia was measured by placing a probe in the gingiva to check for numbness after withdrawal of the needle in 30-second intervals. A p-value of 0.05 or less was deemed statistically significant. Using SPSS 24.0, the collected data underwent analysis, and the results were interpreted.

RESULTS

We assessed 158 individuals for eligibility. Of these, 46 were excluded. We thus randomized 112 individuals (Buffered group, n = 56; Control group or Non-buffered, n = 56). An additional 12 were excluded due to various medical reasons during the duration of the intervention. Therefore, there were 100 participants in each group, all were included the analysis. Fig 1 presents a CONSORT flow chart.

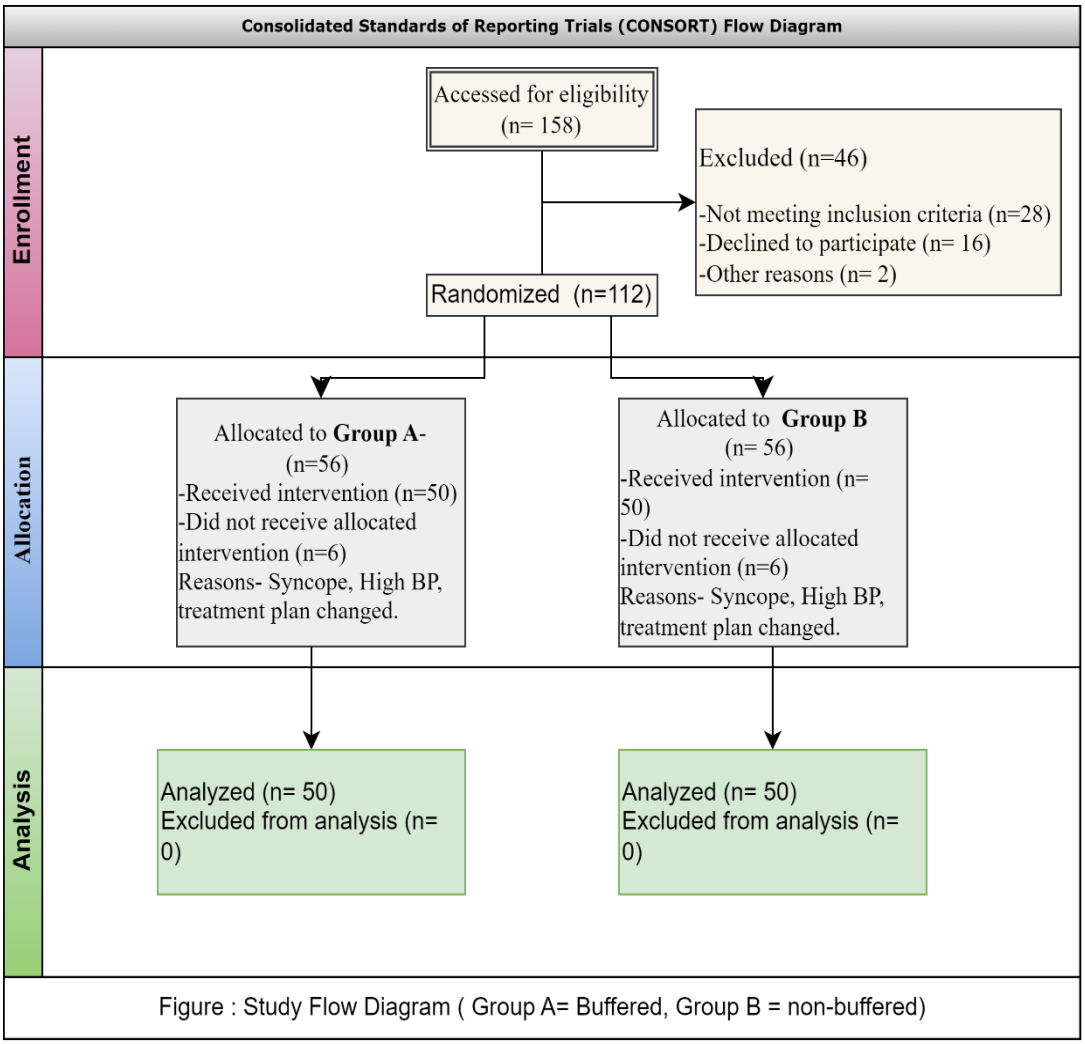

Figure-1: CONSORT flow diagram.

Table I shows the baseline characteristics of patients enrolled in the trial. The distribution suggests that there was a relatively balanced representation of both genders in the study, with a slightly higher percentage of females compared to males (Table I).

Table-I: Demographic distribution

Gender and Age Range	**Number of Patients**
Male	48
Female	52
18–25 years	14
26–36 years	33
37–46 years	29
47–60 years	24

The mean VAS (SD) after the injection had been given in group I was 2.80 ±0.83 and in group II was 4.067 ±1.65 (Table-II). These findings collectively suggest that Buffered group experienced substantial reductions in pain scores after treatment when compared to the non-buffered group.

Table-II: Pre and Post-Pain Injection (VAS) Score

Group	Variables	Mean ±SD	P-value
Buffered	VAS Pre	8.24 ±0.95	<0.001
	VAS Post	2.80 ±0.83	
Non-Buffered	VAS Pre	8.66 ±0.63	<0.001
	VAS Post	4.07 ±1.65	

The pain ratings before injection are categorized into four levels: No Pain, Mild Pain, Moderate Pain, and Severe Pain for both groups. Table-III shows a statistically significant difference between the two groups. Most of the patients presented with moderate to severe pain in both groups.

Table- III: Pain before injection

Groups	No Pain	Mild Pain	Moderate Pain	Severe Pain	P-value
Buffered	2(4%)	4(8%)	15(30%)	29(58%)	0.001
Non-Buffered	0(0%)	2(4%)	29(58%)	19(38%)	

In the Buffered group, the mean onset of anesthesia was 1.32 minutes with a standard deviation of ±0.41, indicating a statistically significant difference compared to a reference value (p-value= < 0.0001). Conversely, in the Non-Buffered group, the mean onset of anesthesia was 2.82 minutes with a standard deviation of ±0.45.

Table- IV: Onset of Anesthesia

Variables	Group	Mean ±SD	p-value
Onset of anesthesia	Buffered	1.32±0.41	0.0001
	Non-Buffered	2.82±0.45	

DISCUSSION

A total of 100 adult patients participated in this randomized controlled trial who reported a significant decrease in pain perception after anesthesia in localized acute odontogenic infections such as acute periapical abscesses or periodontitis with a buffered 1:10 dilution of lignocaine dental cartridge with sodium bicarbonate. The addition of sodium bicarbonate alkalinized the solution to a more physiological pH without risk of precipitation or denaturation. As a result, most patients reported painless maxillary and mandibular infiltration of local anesthetic solution. Our study showed a mean visual analog scale of 2.80±0.83 for pain in Group I compared to 4.07±1.65 in Group II. It depicts a significant reduction in pain and faster onset of anesthesia.

Nociceptive pain occurs in response to an intense noxious stimulus that travels over a specialized neural network to emerge as an unpleasant sensation. Pain is also one of the cardinal features of inflammation. Innocuous stimuli may cause sharp pain in an already infected tissue.[9]

A paramount concern for the dentist is the symptom of pain. Methods to prevent pain on injection in an already infected tissue warrant our immediate attention.[10] Saeed SA et al. reported the ways to reduce pain on infiltration is warming of local anesthetic agent to the body's temperature, topical anesthesia usage before injection, or slower rate of administration.[11] Market preparations of local anesthetics are stored at an acidic pH to increase shelf life and keep them stable. Buffering the pH to a more physiological range of 7-10 showed less pain on injection in the US and some European countries.[12] Our study collaborated with this fact, thus encouraging dentists to adopt premixing sodium bicarbonate to local anesthetic cartridges immediately before the procedure to aid patients' comfort by providing a painless experience.

Sanchez et al. studied 151 patients with severe odontogenic infections and stated that the average clinical course was seven days. The presenting signs and symptoms of patients with odontogenic infection were pain, swelling, trismus, and lymphadenopathy. In the presence of inflammation and pus, the pH drops to 5.[13,14] Madeswaren S et al. reported the role of sodium bicarbonate role as the principal buffer of the human body of extracellular fluid and saliva. It effectively neutralizes the acid acting as an alkalinizing agent.[15] Sodium bicarbonate dissociates to form sodium (Na) and bicarbonate (HCO3) ions. The essence of buffering involves increasing plasma bicarbonate ion levels which then react with hydrogen ions to release water and carbon dioxide. [16] This dissolved CO2 may have several benefits, including the creation of a CO2 microbubble that has a topical anesthetic effect. It also plays a role in diffusion trapping. A high level of the C02 produced enters the nerve membrane, creating an acidic environment that facilitates the conversion of the base form to the acid form, ultimately critical in blocking nerve receptor sites.[6] Arora et al. studied 60 patients with acute head and neck infections who reported pain-free infiltration with buffered anesthesia and faster onset of anesthesia.[14] We premixed 8.4 % sodium bicarbonate to local anesthetic solution in a 1/10 dilution (0.18 ml of sodium bicarbonate solution to 1.8 ml local anesthetic cartridge). When the pH increased from 3.05 to 7.38, the solution's proximity to the physiological tissue pH of 7.4 surged the availability of the base, or lipophilic uncharged lidocaine molecules (RN), for diffusion into the neuron membrane.[10]

M. Bala et al. conducted a randomized study and found buffered lignocaine more effective than non-buffered LA of the same composition for IANB injections.[18] Tirupathi SP et al. found that buffering local anesthetics solutions leads to less discomfort during injection and faster onset times ($P = 0.00001$, MD: −12.38, 95% CI: −17.64 to −7.13). Dhake P et al. reported less pain on injection and faster onset of anesthesia when they used buffered articaine for maxillary deciduous molar extraction in pediatric patients.[19] More studies using different types of local anesthetic solutions with different clinical settings are needed to push the boundaries of safe and pain-free dental practice.[20]

CONCLUSION

Using local anesthetic cartridges buffered with 8.4% sodium bicarbonate solution not only ameliorates patients' pain perception but also potentiates the efficacy of anesthesia in the presence of infection. Moreover, this study promotes further research to explore the synergistic effects of warming and buffering local anesthetic solutions before administration, which could potentiate the benefits and revolutionize the landscape of dental anesthesia practice.

CONFLICT OF INTEREST

None.

AUTHORS CONTRIBUTIONS

SMF: conceptualization of study design, data collection, literature research, manuscript writing.
MI: data analysis, article writing, finalization of manuscript.
AAK: final approval and editing of article data.
RN: collection, data analysis, interpretation of results.
ZS: literature research, article drafting.

SSZ: data collection, article editing.

REFERENCES

1. Becker DE, Reed KL. Local Anesthetics: Review of Pharmacological Considerations. Anesthesia Prog. 2012;59(2):90–102. https://doi.org/10.2344/0003-3006-59.2.90
2. Körner J, Albani S, Sudha Bhagavath Eswaran V, Roehl AB, Rossetti G, Lampert A. Sodium Channels and Local Anesthetics—Old Friends With New Perspectives. Front. Pharmacol. 2022;13: 837088. https://doi.org/10.3389/fphar.2022.837088
3. Cherobin AC, Tavares GT. Safety of local anesthetics. An Bras Dermatol. 2020;95(1):82-90. https://doi.org/10.1016/j.abd.2019.09.025
4. Strazar AR, Leynes PG, Lalonde DH. Minimizing the pain of local anesthesia injection. Plast Reconstr Surg. 2013;132(3):675-84. https://doi.org/10.1097/PRS.0b013e31829ad1e2
5. Bartfield JM, Gennis P, Barbera J, Breuer B, Gallagher EJ. Buffered versus plain lidocaine as a local anesthetic for simple laceration repair. Ann Emerg Med. 1990;19(12):1387-9. https://doi.org/10.1016/s0196-0644(05)82603-4
6. Senthoor P, Janani K, Ravindran C. A Prospective, Randomized Double-Blinded Study to Evaluate the Efficacy of Buffered Local Anesthetics in Infected and Inflamed Pulp and Periapical Tissues. J Maxillofac Oral Surg. 2020;19(2):246-50. https://doi.org/10.1007/s12663-019-01188-y
7. Best CA, Best AA, Best TJ, Hamilton DA. Buffered lidocaine and bupivacaine mixture - the ideal local anesthetic solution?. Plast Surg (Oakv). 2015;23(2):87-90. https://doi.org/10.4172/plastic-surgery.1000913
8. Frank SG, Lalonde DH. How acidic is the lidocaine we are injecting, and how much bicarbonate should we add? Can J Plast Surg. 2012;20(2):71-3. https://doi.org/10.1177/229255031202000207
9. Woolf CJ. What is this thing called pain? J Clin Invest. 2010;120(11):3742-4. https://doi.org/10.1172/JCI45178
10. Kashyap VM, Desai R, Reddy PB, Menon S. Effect of alkalinisation of lignocaine for intraoral nerve block on pain during injection, and speed of onset of anaesthesia. Br J Oral Maxillofac Surg. 2011;49(8):72-5 https://doi.org/10.1016/j.bjoms.2011.04.068
11. Saeed SA. Mahmood S. Baig NJ. Khan NA. Rasheed N. Kakar NA. Effect of warming anesthetic solution on pain perception during maxillary infiltration: a split mouth randomized controlled trial. Pak Armed Forces Med J. 2022;72(1):240-3 https://doi.org/10.51253/pafmj.v72i1.6860
12. Fitton AR. Ragbir M. Milling MAP. The use of pH adjusted lignocaine in controlling operative pain in the day surgery unit: a prospective, randomised trial. Br J Plast Surg. 1996;49(6):404-8. https://doi.org/10.1016/s0007-1226(96)90011-9
13. Keswani ES, Venkateshwar G. Odontogenic Maxillofacial Space Infections: A 5-Year Retrospective Review in Navi Mumbai. J Maxillofac Oral Surg. 2019;18(3):345-3. https://doi.org/10.1007/s12663-018-1152-x
14. Arora G, Degala S. Dasukil S. Efficacy of buffered local anaesthetics in head and neck infections. Br J Oral Maxillofac Surg. 2019; 57(9); 857-60. https://doi.org/10.1016/j.bjoms.2019.06.021
15. Madeswaran. Sathyasree. Jayachandran. Sivakumarl. Sodium Bicarbonate: A Review and its Uses in Dentistry. Indian Journal of Dental Research. 2018;29(5):672-7. https://doi.org/10.4103/ijdr.IJDR_30_17
16. Senewiratne NL, Woodall A, Can AS. Sodium Bicarbonate [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2023 Dec 1]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559139/#__NBK559139_ai_
17. Bala M. Taiwo AO. Ibikunle AA. Olasoji HO. Sulaiman AO.Chukwuma BC et al. Effectiveness of buffered and non-buffered local anaesthetic in inferior alveolar nerve block: a randomised study. Br J Oral Maxillofac Surg. 2023;61(5):351-5. https://doi.org/10.1016/j.bjoms.2023.03.015

18. Tirupathi SP, Rajasekhar S. Buffered versus unbuffered local anesthesia for inferior alveolar nerve block injections in children: a systematic review. J Dent Anesth Pain Med. 2020;20(5):271-9. https://doi.org/10.17245/jdapm.2020.20.5.271
19. Dhake P, Nagpal D, Chaudhari P, Lamba G, Hotwani K, Singh P. Buffered articaine infiltration for primary maxillary molar extractions: a randomized controlled study. J Dent Anesth Pain Med. 2022 Oct;22(5):387-94. https://doi.org/10.17245/jdapm.2022.22.5.387