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Local anaesthesia: Buffered or non-buffered? A comparative study

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ABSTRACT

Introduction: An ideal local anesthetic should act swiftly and be efficacious without causing discomfort or toxicity. Buffered anesthetic is useful when it comes to limiting toxicity because of the reduced volume that is needed and the decreased time it takes to be effective when compared with other conventional means. Buffered anesthesia uses sodium bicarbonate mixed into lidocaine prior to injection to neutralize the acid.

Materials and Methods: All the patients were explicated about the study and its significance and valid informed consent was procured from those who were willing to participate in the study. Patients were divided into two groups according to the right and left sides of patient – side A and side B. Side A included patients that were injected with buffered solution [combination of LA with adrenaline 1:80,000 & sodium bicarbonate] and side B included patients that were injected with LA with adrenaline 1:80,000.

Result: The results of this study confirm that the routine use of alkalinized local anesthetic solution in cases of acute head and neck infections may improve patients' comfort and speed up the time of onset of anesthesia. In conclusion, the use of sodium bicarbonate as an adjunct in local anesthetics is convenient, safe, easy to dispense, and readily available.

1. Introduction

An ideal local anesthetic should act swiftly and be efficacious without causing discomfort or toxicity.[1] Buffered anesthetic is useful when it comes to limiting toxicity because of the reduced volume that is needed and the decreased time it takes to be effective when compared with other conventional means. Buffered anesthesia uses sodium bicarbonate mixed into lidocaine prior to injection to neutralize the acid.[2] Using buffered anesthesia permits dentists to save time, reduce patients' pain and increase the proceeds due to improved efficiency.[3] After depositing the local anesthetic solution into the tissues there is a delay until the anesthetic block shows its effects. This delay is referred to as 'alkalinization' of the local anesthetic solution. This includes adding a predetermined amount of a basic solution (typically sodium bicarbonate) to the local anesthetic solution before injecting it into the target tissues.[4]

Local anesthetic solutions have an acidic pH to redouble their water solubility and chemical stability. This increases their shelf-life.[5] Anesthetic activity is contingent on having both the ionized and non-ionized forms of the drug present after injection. Administering acid into the tissue can give rise to operative sensitivity and because of repeated injections often needed when administering traditional local anesthesia, the body's natural buffering capacity can get further depleted leading to acidosis of the tissue.

Alkalinization increases the proportion of non-ionized drug and this could be beneficial. When sodium bicarbonate is mixed with lidocaine, the byproduct formed is carbon dioxide (CO2). CO2-rich solutions may have various benefits relative to the anesthetic effect, which includes the creation of a CO2 microbubble that has an anesthetic topical

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effect leading to desensitization of the tissue and easing the pain felt during the deposition of a buffered solution.[6] Once the base form crosses the nerve membrane, CO2 helps to convert it to its acidic form. The converted anesthetic molecules cannot effortlessly traverse the membrane and exit the nerve; thus, resulting in a profound anesthetic effect.[5] The body will need to transfigure the anesthetic back to its base form before it can exit the membrane. Carbonated solutions appear to improve the depth of sensory and motor blockade, producing a more complete blockade.

Care must be taken, because if too much alkali is added, the local anesthetic precipitates.[7]

One of the possible reasons that surgeons do not use buffered lidocaine is that most hospital pharmacies only use premix bicarbonate and lidocaine without epinephrine, which is not as useful as buffered solutions containing epinephrine. There is nescience about how exactly one is required to mix bicarbonate with the local anesthetic and what ratio of the mixture is ideal.[2]

We therefore carried forth this study in order to know whether buffered anesthesia with sodium bicarbonate actually makes a difference with respect to pain as well as prolonging the effect of it.

2. Materials and Methods

The research study was approved by the institutional ethics committee. In this prospective, double-blind and split-mouth study, a sample size of 40 participants was considered. The inclusion criteria were patients in the age range of 18-30 years who were having bilaterally identical position of premolars indicated for orthodontic extraction. All the patients were explicated about the study and its significance and valid informed consent was procured from those who were willing to participate in the study.

Patients were divided into two groups according to the right and left sides of patient – side A and side B that included 40 patients each thus a total of 80 patients.

Side A included 40 patients that were injected with buffered solution [combination of LA (Lignocaine) with adrenaline 1:80,000 & sodium bicarbonate] and side B included 40 patients that were injected with LA (Lignocaine) with adrenaline 1:80,000.

The following parameters were assessed:

1. Pain on injection: This was measured on visual analog scale and verbal response scale measured right after the injection.
2. Onset of anesthesia: Time elapsed from the point of injection till the emergence of numbness and tingling sensation on ipsilateral lower lip and anterior 2/3rd of the tongue. This was measured using a stop watch in minutes.
3. Pain during the extraction: This was also measured visual analog scale and verbal response scale was measured immediately after the extraction of the teeth.
4. Duration of anesthesia: Time elapsed from the point of emergence of numbness and tingling sensation of lower lip and anterior 2/3rd of the tongue till the patient had to take the first analgesic, this was measured in hours. The patient was recalled after 24 hours to know when the anesthesia had weaned off. (Figures 1 and 2)

Fig. 1:

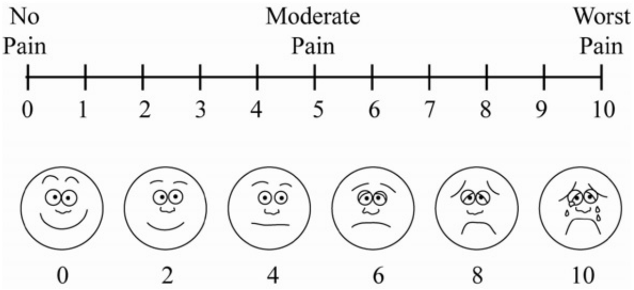
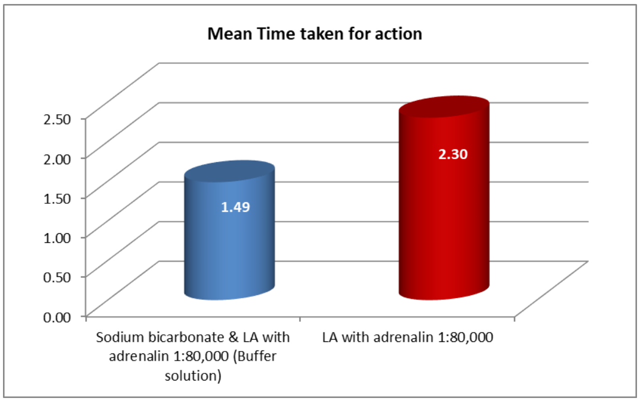


Fig. 2:

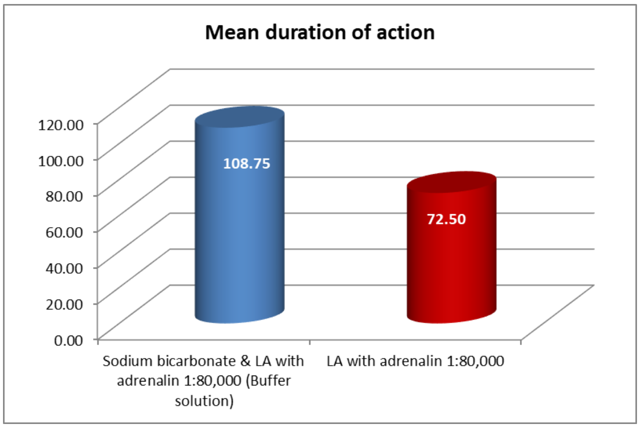
3. Results

The mean Time taken for action shown in Graph 1 was compared between Sodium bicarbonate & LA with adrenalin and LA with adrenalin using the unpaired t-test. The mean Time taken for action was significantly more among LA with adrenalin compared to Sodium bicarbonate & LA with adrenalin.

The mean duration of action shown in Graph 2 was compared between Sodium bicarbonate & LA with

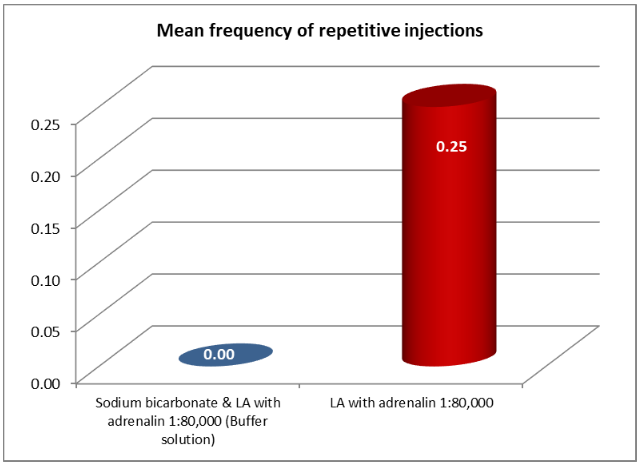


Graph 1: Mean time taken for action



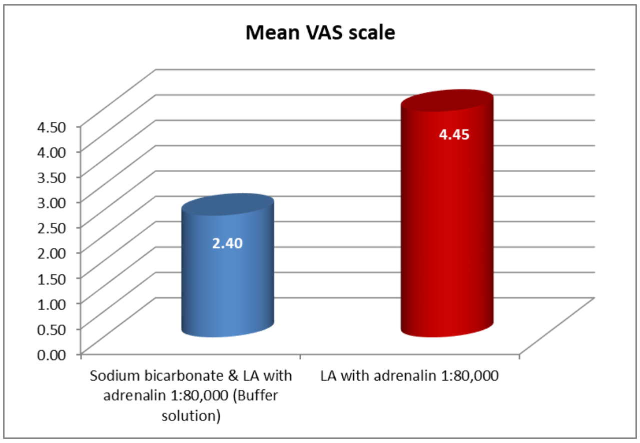
Graph 2: Mean duration of action

adrenalin and LA with adrenalin using the unpaired t-test. The mean duration of action was significantly more among Sodium bicarbonate & LA with adrenalin compared to LA with adrenalin.



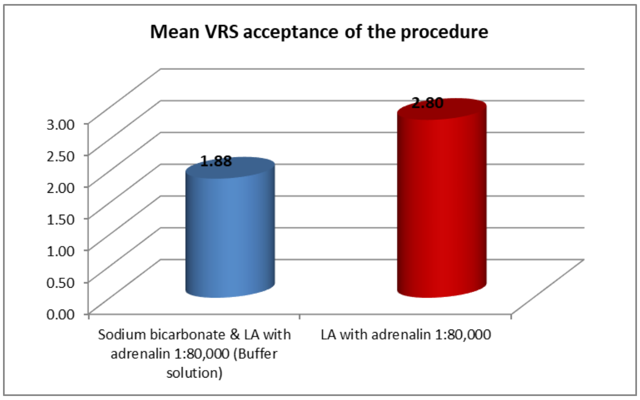
Graph 3: Mean frequency of repetitive injections

The mean frequency of repetitive injections shown in Graph 3 was compared between Sodium bicarbonate & LA with adrenalin and LA with adrenalin using the unpaired t-test. The mean Frequency of repetitive injections was significantly more among LA with adrenalin compared to Sodium bicarbonate & LA with adrenalin.



Graph 4: Mean VAS scale

The mean VAS scale shown in Graph 4 was compared between Sodium bicarbonate & LA with adrenalin and LA with adrenalin using the unpaired t-test. The mean VAS scale was significantly more among LA with adrenalin compared to Sodium bicarbonate & LA with adrenalin.



Graph 5: Mean VRS acceptance of the procedure

The mean VRS acceptance of the procedure shown in Graph 5 was compared between Sodium bicarbonate & LA with adrenalin and LA with adrenalin using the unpaired t-test. The mean VRS acceptance of the procedure was significantly more among LA with adrenalin compared to Sodium bicarbonate & LA with adrenalin.

4. Discussion

Pain is defined as an unpleasant emotional experience usually initiated by a noxious stimulus and transmitted over a specialized neural network to the central nervous system where it is interpreted as such.[8] It is one of the most stereotypical symptoms in dentistry, and a serious issue for the dentist. The pain of the local anesthetic injection is attributable to various reasons, the acidity of the solution being one of them.

Speed of depositing the solution also plays an important role; pain is caused by the increase in volume in the tissues that causes pressure.[9] Though painless injections can be given when the solution is injected slowly, acidity can be dealt with by altering the pH of the solution.

There is a consensus that, for nerves with intact sheaths, local anesthetics are more potent in alkaline, than in neutral or acid, conditions.[10,11] This was achieved in the present study by adding sodium bicarbonate to the solution.

Sodium bicarbonate is a systemic alkalinizing agent. It increases the plasma bicarbonate concentration, buffers excess hydrogen ions and raises the pH of the blood, thereby reversing clinical signs of acidosis.[12] We used sodium bicarbonate to increase the pH of the local anesthetic solution to a more physiological pH.

Lidocaine is the most commonly and widely used injectable local anesthetic. Local anesthetics are weak bases (amides and amines) that are commercially available as hydrochloride salts and marketed at a pH between 4 and 6 in order to increase their shelf life and solubility.[13,14]

Previous studies have shown that buffering of acidic local anesthetics with sterile sodium bicarbonate decreases the discomfort associated with infiltration without affecting the hemostatic effects of epinephrine, the duration of anesthetic effects or slowing the speed of onset of anesthesia effect. This finding has caused a shift in clinical practice in recent years towards buffering of local anesthetics.[4,6]

Thus, increasing the pH of local anesthetic solutions speeds up the onset of its action, increases its clinical effectiveness, and makes the injection more comfortable.[13,14]

The present study demonstrates a statistically significant reduction in pain with buffering of local anesthetic, although on average, pain scores were lower for the buffered lidocaine side than the nonbuffered solution as well as the with the onset of action with buffered lidocaine. The duration of action was increased and the number of repetitive injections were reduced with the buffered solution. It is possible that the effect of buffering is overestimated in the face, a particularly sensitive area with numerous nerve endings. Furthermore, it is possible that buffering local anesthetic in the face reduces pain by an order of magnitude that is too small to be detected by our chosen sample size, despite prerecruitment power calculations. Other possible limitations of our study include the fact that the injections were performed by two separate injectors. We did our best to maintain the angle of the needle penetration, to stabilize the syringe before the needle site was anesthetized and the rate at which the solution was deposited.

Several factors have been shown to affect the pain of administering the local anesthesia. Smaller needle sizes, the needle perpendicular to the skin, slower rate of deposition and warming the anesthetic solution are all factors that decrease the pain of injection.[15]

5. Conclusion

It is recommended that local anesthetic buffering should be done immediately before the local anesthetic is given, to eliminate concerns about the shortened shelf-life of the anesthetic caused by the buffering. The results of this study confirm that the routine use of alkalinized local anesthetic solution in cases of acute head and neck infections may improve patients' comfort and speed up the time of onset of anesthesia. In conclusion, the use of sodium bicarbonate as an adjunct in local anesthetics is convenient, safe, easy to dispense, and readily available. Alkalinization of local anesthetic solutions reduces the pain of infiltration. It also reduces the onset of anesthesia, but the time saved is small.

6. Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This article does not contain any studies with animals performed by any of the authors.

7. Informed Consent

Informed consent was obtained from all individual participants included in the study.

8. Source of Funding

None

9. Conflict of Interest

The authors declare that they have no conflict of interest.

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