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Efficacy of Buffered Local Anaesthetics in Dental Practice: A Review

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ABSTRACT

Local pain management is a critical aspect of patient care in most dental procedures. Pain management is also of paramount importance to enable patient comfort which in turn results in patient compliance and satisfaction with the ongoing dental therapy. This overview of adjunctive equipment available today provides the practitioner an array of options to effectively manage the pain associated with dental procedures. The aim of this review is to study the role and advancements in buffered local anesthetics in Dental practice and its benefits. Buffered local anesthetics were found to be effective in local pain management. Further high-quality studies assessing the efficacy and cost-efficiency of various modes of administration are required to confirm the utility of buffered anesthetic techniques for intraoral anaesthesia.

Keywords: Adjusting pH, Buffered anaesthetics, Direct Injection, Local anesthetics, Onpharma technique

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INTRODUCTION

The pain experienced by a patient is experienced at three junctures i.e. during skin puncture with needle, during local anaesthetic deposition and with the acidic pH of the local anaesthetic solution which causes local irritation. Numerous attempts have been made to diminish this anaesthesia-associated pain, such as by using anaesthetic solution patches, chemically modifying anaesthetic agents, adding buffering agents, or changing the temperature of anaesthesia during administration [1]. Conventional syringes do not allow precise control of the flow rate, and while slow injections are possible, the mechanics are challenging [2]. Injections into dense tissues such as the palate may require pressures up to 660 psi, possibly making control of a syringe even more difficult and erratic [3].

Buffering of local anesthetics (alkalinization) has been suggested to achieve pain control [4]. Buffering will increase the dissociation rate of the local anesthetic molecule and thus increase the uncharged base form that crosses the nerve membrane to the intra- neuronal site where it exerts its action [5]. The most common method for buffering of local anesthetics is with the addition of sodium bicarbonate. It is an alkalinizing agent, which is most used for the treatment of metabolic acidosis.

The addition of sodium bicarbonate to local anesthetics not only will increase the pH of the solutionbut will also result in the production of carbon dioxide and water [6]. Several authors have reported on the effect of carbon dioxide on local anesthetics and anesthesia. Condouris et al. reported that carbon dioxide potentiated the action of local anesthetics by showing that in the presence of carbon dioxide, nerve conduction blockade was significantly greater than in its absence [7]. Bromage et al. suggested that carbon dioxide acts by increasing the flow of local anesthetic into the nerve and demonstrated that the addition of carbon dioxide to lignocaine shortened the time to onset and spread of analgesia by 20% to 30% in epidural anesthesia [8]. Bokesch et al. also studied the effects of carbon dioxide and concluded that its role in potentiating local anesthesia was related to either a direct effect on the nerve membrane or by indirect action on intracellular pH [9]. Catchlove et al. concluded that carbon dioxide potentiates local anesthesia by three mechanisms [10]:

1. A direct depressant effect of carbon dioxide on the axon.

2. Concentrating the local anesthetic inside the nerve trunk (ion trapping).

3. Converting the local anesthetic to the active cationic form within the nerve axoplasm by lowering its internal pH.

The aim of dental practitioners has always been to successfully render painless dental care and local anaesthesia has been used to achieve this objective. Henceforth, the painless and effective local anaesthetic administration has been paramount for any dental surgeon. To accomplish this, every dental surgeon should be critically updated about the newer local anaesthetic delivery techniques and equipment that have been introduced into the market. With a rich case bank established over 3 decades we have been able to publish extensively in our domain. Based on this inspiration the focus of this review is on newer and more improved techniques of using buffered local anesthetics to aid dentists in providing painless injections subsequently decreasing the dental anxiety and fear of patients.

METHODS OF ADMINISTRATION

Onpharma system

In 2010 the US Food and Drug Administration (FDA) approved the first chairside mixing device for buffering lidocaine known as Onset® (Onpharma, onpharma.com) [11]. The mixing system consists of three parts: the Onpharma® mixing pen, the Onpharma® cartridge connector, and the Onset® Sodium Bicarbonate Inj., 8.4%, USP Neutralizing Additive Solution. The desired amount of sodium bicarbonate can be selected on the mixing pen via a numbered volume dial; the manufacturer recommends the addition of 0.18 mL for a 9:1 ratio of 2% lidocaine with 1:100,000 epinephrine to 8.4% sodium bicarbonate.

Anutra system

In January 2015, Anutra Medical (anutramedical.com) received approval from the FDA for its disposable, feedback aspiration syringe [12]. The Anutra Feedback Aspiration Syringe® holds up to 5 mL of fluid and has been described as a major innovation, because most dental restorative procedures require the use of multiple local anesthetic cartridges and traditional aspiration dental syringes are limited to holding only one cartridge at a time (about 1.8 mL of fluid). Coupled with the new Anutra Local Anesthetic Delivery System®, which consists of the Anutra Cassette® (which allows for the mixing of lidocaine and 8.4% sodium bicarbonate in a closed, filtered environment) and the Anutra Dispenser® (that precisely buffers [mixes] at the correct ratio), the Anutra Feedback Aspiration Syringe provides local anesthesia onset within 45 seconds for infiltration and 2 to 3 minutes for blocks with buffered lidocaine. The Anutra system buffers the local anesthetic solution at a 10:1, lidocaine to 8.4% sodium bicarbonate, ratio.

Hand mixing technique

In dentistry, due to the prefilled, manufactured local anesthetic cartridge, it was difficult for the practitioner to buffer anesthetics prior to injection. The buffering process uses a sodium bicarbonate solution that is mixed with the cartridge of local anesthetic such as lidocaine with epinephrine. The interaction between the sodium bicarbonate ($NaHCO_3$) and the hydrochloric acid (HCL) in the local anesthetic creates water (H2O) and carbon dioxide (CO_2) [13]. The CO_2 diffuses out of solution immediately and continues after the solution has been injected [14]. Goodchild et al. however demonstrated a less complex, "direct injection" chairside hand mixing approach in 2% and 4% commercially available dental local anesthetic preparations known as 'Remove and Replace' strategy [15]. Their study showed no strategically significant difference in the outcome of buffering using the hand mixing technique and the buffered local anesthetic mixing systems.

Properties of buffered local anesthetics

Successful anesthesia

The primary outcome assessed was successful anesthesia that was based on each study's criteria. Success was defined in three studies [16-18] as no pain or mild/bearable pain/discomfort according to patient reported pain scores (eg.VAS) during endodontic treatment in access cavity preparation and instrumentation.

Another study defined successful anesthesia as no pain or mild/tolerable pain during procedure [19]. Success rates for buffered and non-buffered local anesthetics ranged from 32% and 40%, respectively, to 92.5% and 80%, respectively. Buffered local anesthetics were more likely than non-buffered solutions to achieve successful anesthesia. In studies on maxillary teeth, the success rate was generally higher than studies on mandibular posterior teeth. This can be attributed to the fact that maxillary anesthesia is more easily obtained and more successful than mandibular anesthesia [20]. The success of inferior alveolar block alone in cases of symptomatic irreversible pulpitis is between 19% to 56% which again was attributed to the difficulty in achieving mandibular anesthesia [21].

Onset and duration

Of the studies under review some used electric pulp tests (EPT) and different teeth were assessed including mandibular canines, mandibular incisors, molars and premolars [22,23], while some assessed gingival probing onset time [24,25]. Results showed a faster onset time(48 seconds) using buffered lidocaine compared to non-buffered lidocaine. The duration of anesthesia in one study was much longer for the buffered local anesthesia 5.6 (2.3 to 8.8) than for non-buffered local anesthesia 1.3 (0.8 to 3.3) hours [26].

Painless injections

The pain perception was recorded differently in the studies taken under review. While some studies assessed the pain perception using the Visual Analog Scale (VAS) another study considered the Numerical Rating Scale (NRS). Injection with buffered local anesthetic was assessed the least painful by the subjects and injection of the non-buffered local anesthetic was significantly more painful [25,27].

EFFECTS ON PEDIATRIC PATIENTS

Although the buffered anesthetics had lower VAS scores, there were no statistically significant differences in VAS scores between the buffered and non-buffered treatment group for local anesthetics in pediatric patients according to the study by Bunke et al. [26].However, this may be attributed to the difficulty in determining pain perception in pediatric patients. Comparison between injection pain on VAS scales between adults and pediatric patients as well displayed no statistically significant difference[28].

ADVERSE EFFECTS

Gupta et al. reported the absence of adverse events of buffered local anesthetics whereas the other studies have made no mention of any adverse effects[29].

CONCLUSION

In conclusion, the present review showed that in patients requiring dental therapy, buffered local anesthetics is more effective than non-buffered solutions when used for mandibular or maxillary anesthesia. Buffering local anesthetics has greater likelihood of achieving successful anesthesia, lesser pain on injection and shorter onset with longer duration of action. However, further comparative studies with other buffering agents and larger sample sizes are recommended.

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AUTHORS CONTRIBUTION

Kadambari Sriram contributed to the acquisition of data, analysis,literature collection, and in drafting the article and revising it critically for important intellectual content. Santhosh Kumar contributed in conception, study design, interpretation of data, manuscript preparation,supervision and guidance.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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