To Buffer or Not to Buffer

Buffered anesthetic usage in inferior alveolar blocks for 3rd-molar removal

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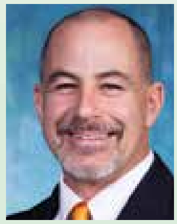
by Charles D. Schlesinger, DDS, FICOI



Charles Schlesinger, DDS, FICOI, is a dental implant educator and clinician who has been lecturing internationally for the past decade. He graduated with honors from The Ohio State College of Dentistry in 1996. After graduation, he completed a general practice residency at the VA Medical Center in San Diego and then went on to become the chief resident at the VAMC W. Los Angeles. During his time in Los Angeles, he completed extensive training in oral surgery, implantology and advanced restorative treatment. Schlesinger maintained a private practice in San Diego for 14 years before moving into an executive position for a dental implant company. In 2016, after leaving the corporate world, he founded The CD Schlesinger Group to continue educating doctors in implantology. Additionally, he continues to provide comprehensive implant care to patients in a private practice setting in Albuquerque, New Mexico.

Course description

This course details the concept of anesthetic buffering. The benefits are multifold and are not only supported by the science in the literature but also backed by clinical evidence.

Abstract

Attaining profound local anesthesia is the foundation of almost all that we do in dentistry. Without the crucial aspects of anesthesia, the benefits of modern dentistry would be unobtainable. In this clinical study, the effectiveness of buffered anesthetic was measured against standard unbuffered local anesthetic carpules. The conclusion of this limited study showed a 37–53 percent decrease in onset time, compared with standard anesthetic solution.

Educational objectives

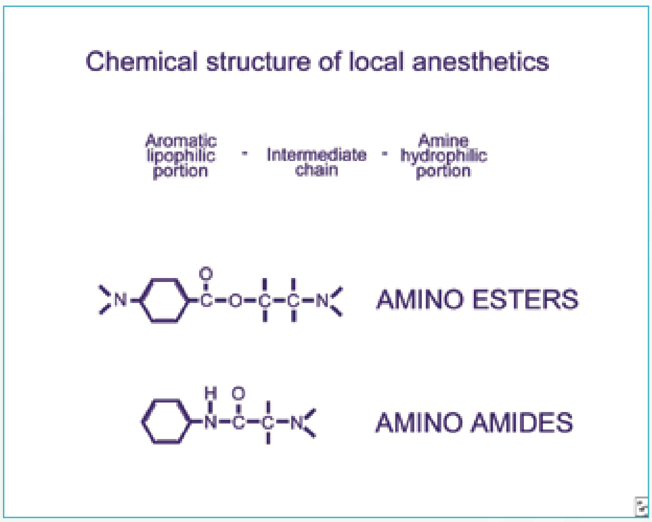
At the end of this program, participants will be able to:

- Understand the mechanism of nerve conduction.
- Review how local anesthetics work.
- Understand the deficiencies of acidulated anesthetic.
- Discuss the benefits of buffered anesthetic.

With the advent of modern local anesthesia materials and techniques, the dental practitioner can, in most cases, attain an effective level of anesthesia that allows the patient to remain comfortable for the duration of dental treatment. This reduction in pain has been reported to reduce the stress associated with dental encounters.

The use of buffered anesthetic has been well-documented in medical and dental journals. Local anesthetics form the backbone of pain control in dentistry; they are the safest, most effective drugs in medicine for the prevention and management of pain. Two basic classes of local anesthetics exist—amino esters and amino amides. Amino esters have the ester link between the intermediate chain and the aromatic end, while amino amides have an amide link between the intermediate chain and the aromatic end. (Fig. 1).

Fig. 1: Chemical structure of the two classes of local anesthetics

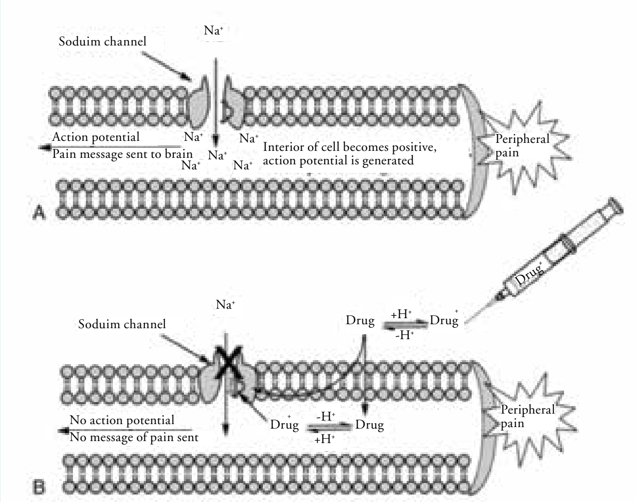


Long practiced and recommended in medicine, buffering is still a relatively new concept in dentistry. One reason has been that our pre-sealed, single-use anesthetic cartridges are not easily alkalinized. Unlike medicine, which routinely uses multiuse vials, dentists use carpule-based syringe systems.

For the local anesthetic base to be stable in solution, it is formulated as a hydrochloride salt. As such, the molecules exist in a quaternary, water-soluble state at the time of injection. However, this form will not penetrate the neuron, because this acidification decreases the bioavailability of the compound. The time for onset of local anesthesia is therefore predicated on the proportion of molecules that convert to the tertiary, lipid-soluble structure when exposed to physiologic pH (7.4).

Tortamano, et al., found that the mean onset of pulpal anesthesia

Fig. 2: How local anesthetics work



Friel CJ, et al: Local anesthetic use in perioperative areas, Perioperative Nurs Clin 5:203-214, 2010

Fig. 3: The Anutra system

Fig. 4: The Gow-Gates injection technique

for 2 percent lidocaine with 1:100K epinephrine was 8.7 minutes, with a standard deviation of 3.1 minutes.

Another issue with local anesthetics has always been the discomfort during injection and the unpredictability of the onset of profound pulpal anesthesia. A weakly basic amide, lidocaine is unstable at its pH of 7.9 and therefore is prepared in acidic formulations to increase its stability and shelf life. The resultant pH is typically 4.7.

For comparison, the human body has a neutral pH of approximately 7.4; that of lemon juice is a 2.0. The literature showed that lidocaine with epinephrine was approximately 1,000 times more acidic than subcutaneous tissue.

Buffering

So, how does buffering enhance the onset of local anesthesia? To understand buffering, we must first look at the physiology and mechanics of how local anesthetic works.

Local anesthetics produce anesthesia by inhibiting excitation of nerve endings or by blocking conduction in peripheral nerves. This is achieved by anesthetics reversibly binding to and inactivating sodium channels (Fig. 2). Sodium influx through these channels is necessary for the depolarization of nerve cell membranes and subsequent propagation of impulses along the course of the nerve. When a nerve loses depolarization and capacity to propagate an impulse, the individual loses sensation in the area supplied by the nerve. They get numb.

All local anesthetics except for cocaine are vasodilators; most anesthetics we use have epinephrine added to counteract this vasodilation. Without it, the duration of our blocks or infiltrates would be too short for most dental procedures. This adds another reason why the anesthetic solution must be acidic to maximize stability in solution and shelf-life.

In review, the reasons include:

- Local anesthetic solutions are aqueous solutions. If provided at a pH close to 7.4, the lipid-soluble uncharged form could precipitate out because of its lower water solubility.
- The uncharged base form is more unstable at physiological pH, so degradation is minimized at a low pH, where the drug is predominantly in the charged form.
- The adrenaline added to some local anesthetic solutions is unstable at the physiological pH and more stable at an acidic pH.

Buffering the anesthetic solutions before injections immediately increases the active form of the drug, facilitating more-rapid diffusion of the anesthetic through interstitial tissues and decreasing common latency periods associated with the patient's own physiology, anatomy, and kinetics toward the anesthetic solution. In addition,

buffering also raises the inherent pH of the local anesthetic toward physiologic pH, reducing the discomfort often associated with dental injections. Recent meta-analyses of the available research concluded that buffered local anesthetic solutions are associated with a statistically significant decrease in pain of infiltration, compared with unbuffered local anesthetic solutions. The addition of a concentration of 8.4 percent sodium bicarbonate to local anesthetic solution, regardless of presence of adrenaline and local anesthetic concentration, is enough to buffer the solution without risk of precipitation.

Though the act of buffering local anesthetics has been in the literature for years, most of the time this buffering was achieved by drawing local anesthetic solution from one vial or carpule and then pulling a bolus of buffering solution from another vial and mixing by hand. Clinically, this is effective in administering a buffered solution of anesthetic, but it was laborious and requird two different individual sources: one for anesthetic and one for buffering solution.

The Anutra System

The Anutra System from Anutra Medical is a self-contained system of 2 percent lidocaine and 8.4 percent sodium bicarbonate, which is mixed in an ergonomic dispenser by a system that includes everything from the buffering materials to the syringe and needles.

A closed-circuit internal mixing cartridge draws the optimum amount of buffering solution into each milliliter of anesthetic solution desired. The syringe is placed on the port, and buffered anesthetic is drawn into the hospital-type syringe. The doctor is now ready for administration (Fig. 3).

Another advantage of this system is the ability to draw up to 6ml into the syringe. This alleviates multiple carpule changes in cases that require three carpules or less.

Materials and methods

A single-blind, split-mouth protocol was used for this in-office study. All patients in the study presented for bilateral extraction of mandibular third molars. They were informed that I would be using two different anesthetic formulations and each would adequately anesthetize the area, but no mention of the differences of expected onset were discussed.

A 1.2cc injection of 2 percent lidocaine with 1:100K epinephrine from Cooke-Waite was given, utilizing a Gow-Gates technique (Fig. 4).

Approximately one-quarter of a carpule (0.5cc) was then used to deliver a long buccal block. On the contralateral side, a 2cc draw of anesthetic was used to deliver an IAN Block utilizing a Gow-Gates technique (1.0cc) and a separate long buccal block (0.5cc).

The patients were not told which type of anesthetic was being used for each side. A digital timer was started after completion of the administration of anesthetic for the Gow-Gates block and before the long buccal injection was administered.

To negate any technique or injection accuracy differences (the clinician is right-handed) to either side, the delivery of anesthetic with either buffered or nonbuffered solutions was alternated between sides for every patient.

The study consisted of 20 patients, with a total of 40 mandibular blocks given. The patients were asked to signal when they "felt" numb on their lips and chins. The numbness was verified with a tactile test of a cotton wisp in the area innervated by the mental nerve (Fig. 5, p. 108).

Eighteen of the 20 patients were adequately anesthetized with a single injection. If readministration of anesthetic was necessary, the patient was excluded from data collection. It is pertinent to note that in both patients who fell into this category, the failure occurred in the nonbuffered side.

Once anesthesia was attained, the patients' mandibular third molars were extracted. In none of the patients who were adequately anesthetized was a readministration of anesthetic necessary to complete the procedure.

Discussion

From the collected data, the use of buffered anesthetic appears to enhance the speed of anesthesia onset when delivering IAN Blocks. In this study, potential extraneous factors were removed and anesthesia of the area innervated by the mental nerve was an adequate indication of IAN anesthesia. This was confirmed by the

Fig. 4: *Peripheral innervation of the mental nerve*

Journal of Clinical and Experimental Dentistry

Fig. 5

Comparing speeds of buffered and nonbuffered anesthetics
(All times listed in seconds)

	Buffered	Nonbuffered		Buffered	Nonbuffered
Patient 1	362	575	Patient 12	334	325
Patient 2	207	409	Patient 13	Readministration necessary	
Patient 3	334	681	Patient 14	383	615
Patient 4	343	416	Patient 15	225	466
Patient 5	Readministration necessary		Patient 16	406	678
Patient 6	429	733	Patient 17	245	514
Patient 7	293	432	Patient 18	274	438
Patient 8	404	623	Patient 19	295	543
Patient 9	142	334	Patient 20	327	656
Patient 10	281	415	**Mean**	**305.5**	**512.6**
Patient 11	215	373	**SD**	**78.35**	**128.97**

ability to remove erupted, soft tissue and full bony impacted wisdom teeth.

Though not initially part of the study, patients also reported that one of the sides had a less painful injection. When reviewing the data, this corresponded to the side where buffered solution was utilized in 15 of 20 patients. A systematic literature review similarly found that the pain of intradermal injection of alkalinized local anesthetics was decreased as compared with "unbuffered" local anesthetics.

In the typical dental office, whether a general dentistry office or one of a specialist, a significant amount of time is spent either waiting for initial anesthesia to take effect or waiting for readministration to be accomplished.

The buffered side averaged 5:09 minutes to "feeling numb," compared with 8:54 minutes for the nonbuffered sides. When looking at buffered anesthetic providing 40 percent faster onset in this study, a practitioner is looking at a potential time savings of more than an hour over an eight-hour workday, depending on the number of patients or quadrants treated. Those lost minutes or hours—not to mention the enhancement in the patient experience with a perceived less painful injection and adequate pupal, hard- and soft-tissue anesthesia— can create a win-win situation.

Buffered anesthetic is a great efficiency booster. Imagine being able to give a block and be ready to work with a short delay without leaving the room to wait for the patient to get numb. Inject, talk to the patient about the procedure and begin treatment—this could be a fantastic time-saver that results in increased production and a significant time savings annually. The return on investment is exponentially great with buffered anesthetics and especially, with a system that makes buffering predictable and easy to do.

Do yourself, your staff and your patients a favor and consider buffering your local anesthetic. It has the potential to change the way you practice dentistry. ■

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1. What differentiates the two classes of anesthetic?
A. A sulfur molecule linked between the terminal ends.
B. An ester or amide link.
C. Water-based versus oil-based compounds.
D. An ester or amine link between the intermediate chain and the terminal end.

2. Why is typical carpule-based local anesthetic acidic?
A. Esters are acidic by nature.
B. Epinepherine is acidic.
C. Acid is added to preserve the anesthetic.
D. Anesthetic in carpules is not acidic.

3. How does a nerve impulse propagate down the axon?
A. Nitrogen channels.
B. Myelinization of the axon.
C. Sodium influx.
D. None of the above.

4. What is the downside of acidifying a local anesthetic?
A. The amide bond becomes an amine bond.
B. The anesthetic will precipitate out of solution.
C. The larger precipitated molecules cannot enter the axon.
D. Decreased diffusion through interstitial tissues and less bioavailability.

5. Which of the following local anesthetics is not a vasodilator?
A. Lidocaine.
B. Prilocaine.
C. Cocaine.
D. Septocaine.

6. Why is epinephrine added to most anesthetic solutions?
A. To increase the bioavailability of the anesthetic.
B. To increase the length of duration of anesthesia.
C. To increase the strength of the anesthetic.
D. To increase the blood flow to the area where the anesthetic is deposited.

7. Which of the following is not a benefit of anesthetic buffering?
A. Increased bioavailability.
B. Less painful injection.
C. Quicker return to a nonanesthetized state.
D. Faster onset.

8. What is used to make the buffered anesthetic compound?
A. 8.4 percent sodium bicarbonate and 2 percent lidocaine with 1:100K epi.
B. A 9.3 percent sodium bicarbonate solution.
C. Etidocaine is used in the solution.
D. There is no epinephrine added.

9. What type of clinical study was conducted in this course?
A. Double-blind study.
B. Cross-sectional study.
C. Cohort study.
D. Single-blind study.

10. What conclusion can be made from this study?
A. Buffered anesthetics have lower onset times and more discomfort on injection.
B. Buffered anesthetics have lower onset times and decreased duration.
C. Buffered anesthetics have lower onset times and increased duration.
D. Buffered anesthetics have lower onset times and less discomfort on injection.

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by Charles D. Schlesinger, DDS, FICOI

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11.	Handout materials enhanced course content	5	4	3	2	1
12.	Overall, I would rate this course (5 = Excellent to 1 = Poor):	5	4	3	2	1
13.	Overall, I would rate this instructor (5 = Excellent to 1 = Poor):	5	4	3	2	1
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