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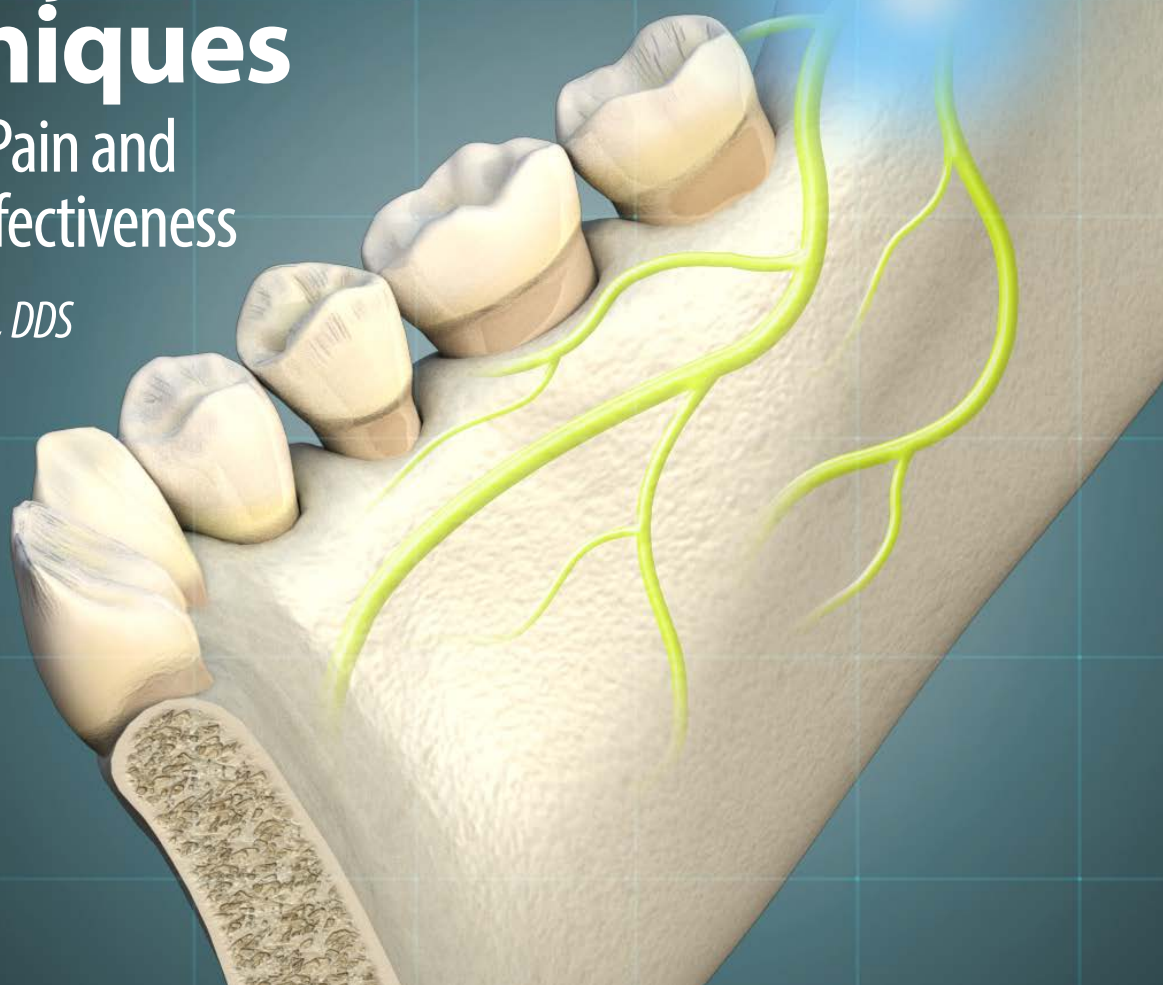
ANESTHETICS

# Using Buffered Anesthesia and Injection Techniques
## to Reduce Pain and Improve Effectiveness

*Daniel Davidian, DDS*



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# Using Buffered Anesthesia and Injection Techniques

## to Reduce Pain and Improve Effectiveness

Daniel Davidian, DDS

### ABSTRACT

Good local anesthesia should work quickly and be 100% effective while causing no pain or toxicity. Although no anesthetic can provide the perfect combination of these attributes, a buffered anesthetic is beneficial when it comes to limiting toxicity because of the reduced volume needed and the substantial decrease in the time it takes to be effective when compared with more traditional means. Unlike other local anesthetics that have high acidity, buffered anesthesia uses sodium bicarbonate mixed into lidocaine prior to injection to neutralize the acid. By understanding the Henderson-Hasselbalch equation and applying it to a buffered anesthetic solution, one can see we can hasten the anesthetic effect and decrease pain. Learning different injection techniques such as the Halstead, Varizani-Akinosi nerve block, and Gow-Gates nerve block, can help improve accuracy, reduce pain, and improve patient experience. Buffered Anesthesia can be injected with less discomfort for the patient. Using buffered anesthesia allows dentists to save time, reduce patients' pain, and increase revenue due to improved efficiency.

### LEARNING OBJECTIVES

- Discuss the history, evolution, and purposes of local anesthetics.
- Describe best practices for injections and administration of local anesthetics.
- Explain how to utilize modern technology to administer local anesthetic for optimal care and practice efficiency.

Local anesthesia has progressed considerably since cocaine was used as the first primary numbing agent in 1884. Today, lidocaine and articaine are the most commonly used local anesthetics. In order to maximize water solubility, these anesthetics are stored and marketed as hydrochloride salts with a pH between 3.5 and 6.0.[1,2] The downside of using lidocaine with epinephrine, however, is that it has an approximate pH of 3.9 (or that of a lemon), whereas the human body has a more neutral pH of approximately 7.2 to 7.4 (Figure 1). Administering acid into tissue can cause operative sensitivity, and due to the repeated injections often needed when administering traditional local anesthesia, the body's natural buffering capacity can become depleted, resulting in acidosis of the tissue. Tachyphylaxis is a common problem associated with the use of traditional local anesthesia.[3]

Buffered anesthesia, however, can eliminate some of the common problems found with the use of traditional agents like lidocaine and articaine.[4,5] To buffer anesthesia, sodium bicarbonate is mixed into lidocaine prior to injection, neutralizing the acid.[4] When sodium bicarbonate is mixed with lidocaine the byproduct is carbon dioxide ($CO_2$). $CO_2$-rich solutions may have several benefits relative to the anesthetic effect, including the creation of a $CO_2$ microbubble that has an anesthetic topical effect that can be leveraged, numbing the tissue and easing pain felt during the injection of a buffered solution. Additional topical applications that can be used

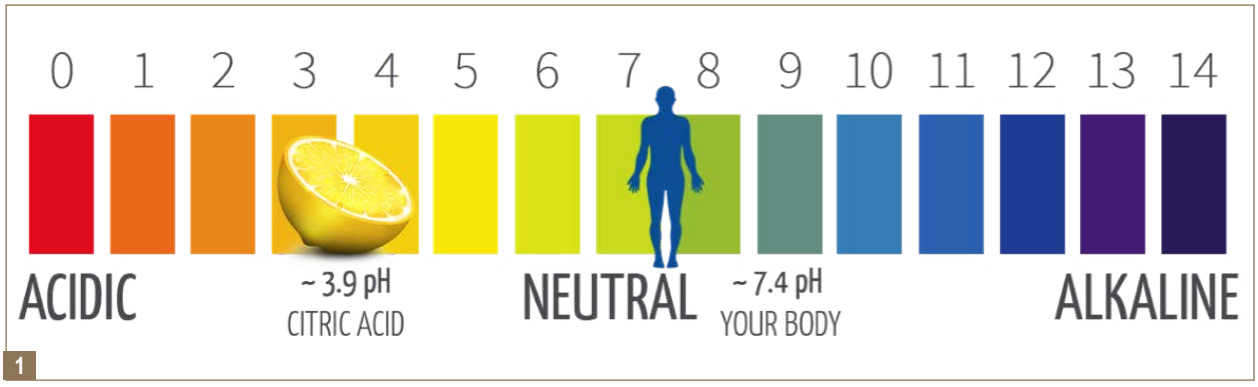


**Fig 1.** pH scale from acidic to alkaline.

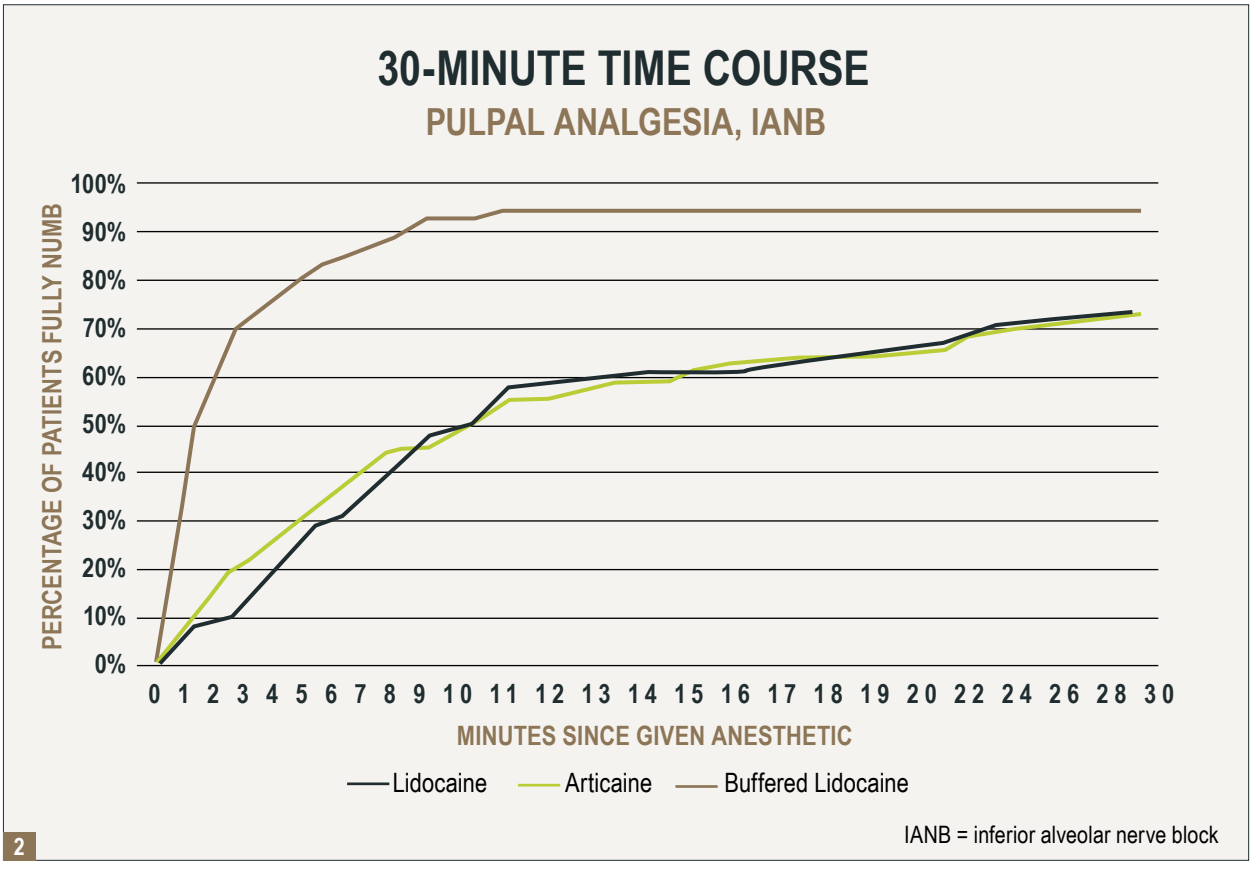


**Fig 2.** Comparison of time to fully numb with use of lidocaine, articaine, and buffered lidocaine. Graph shows that buffering saves time.[9]
*(Adapted from Malamed SF, Tavana S, Falkel M. Compend Contin Educ Dent. 2013;34 spec no 1:10-20. Used with permission.)*

are benzocaine and compounded anesthetics, each with their own benefits and disadvantages, including psychosomatic effects and increased toxicity, respectively.[6,7]

In addition to acting as a topical anesthetic, $CO_2$ also plays a role in diffusion trapping.[8] Once the base form is across the nerve membrane, $CO_2$ helps to convert it to its acidic form. The converted anesthetic molecules cannot easily cross the membrane and leave the nerve; this results in a profound anesthetic effect. The body will need to convert the anesthetic back to its base form before it can leave the membrane.

Carbonated solutions appear to improve the

depth of sensory and motor blockade, producing a more complete blockade.[1,6]

## BENEFITS OF BUFFERED ANESTHESIA

One of the main benefits of using a buffered anesthesia is its ability to work quickly.[4] It has been estimated that buffering can save up to 30 minutes (Figure 2).[9] When an anesthetic such as lidocaine or articaine is used, it takes on average 15 minutes for the patient to get numb, whereas it can take as little as 2 minutes for a buffered anesthetic to take effect.[7]

In addition to timeliness, because of a patient's individual buffering capacity, between 30% and 40% of patients will not get numb after the initial shot with a traditional anesthetic.[9] Often an additional shots will need to be administered, increasing the total amount of time it takes for the full anesthetic effect to happen and increasing toxicity levels. While no anesthesia is 100% effective on the first injection, because buffered anesthesia works so quickly, the time it takes to realize a patient has not gone numb and administer a second shot is much less than that with an unbuffered anesthetic.

Reducing the amount of time it takes for anesthesia to take effect can increase patient satisfaction as well as practice efficiency and revenue. More procedures can be done during a 1-hour appointment block and patients can be pulled out of hygiene to have procedures done as a result of anesthesia taking effect quickly. Because only a few minutes are needed until the patient becomes numb, practitioners can wait with the patient, assuaging fears and creating a better experience. Additionally, buffered anesthesia also helps to reduce pain[10] and minimize the burn felt during injection.

## INJECTION TECHNIQUES

Various mandibular injection techniques can be used in an effort to provide a reduced pain injection.[11] Regardless of the anesthetic used, if it is not administered in the right place it will not work properly. Understanding the anatomy is critical to needle placement.

The main nerve trunk of the lower jaw splits into three segments—the inferior alveolar nerve, the lingual nerve, and the long buccal nerve (Figure 3). The lingual nerve runs alongside the inferior alveolar nerve and in the same vicinity as the long buccal nerve. This can cause an issue when performing a Halstead injection technique, because the long buccal nerve can be easily missed, resulting in failed or partial anesthesia. Many dentists may attempt to give a second shot in this scenario to catch the long buccal nerve in the area by the lower molars.

To perform the Halstead injection technique, the clinician locates the pterygo-mandibular raphe, places his or her thumb on the coronoid notch, and, at a 45-degree angle, aims to hit the bone on the mandibular ramus. Although the patient could experience pain when the bone is hit, this technique provides anatomic structure and the ability to use diffusion to get to the long buccal nerve.

Another injection technique is the Varizani-Akinosi nerve block. During this injection patients keep their mouth closed. The injection is done above the gingival margin of the maxillary molars, while the clinician's thumb is on the mandible and the tissue is pulled tight; the goal is to hit the space that runs along the mandible (Figure 4). Small amounts of anesthetic should be deposited as the needle advances, achieving all three nerve blocks.

When patients are encountered who are difficult to get numb, such as those who are overweight or have obvious anatomic deformities, volume is often used to overcome placement. Instead, by initially utilizing a Varizani-Akinosi nerve block technique, if the clinician chooses to administer supplemental anesthesia the soft tissue is numb and the focus can be on more consistent placement. If the initial shot is done

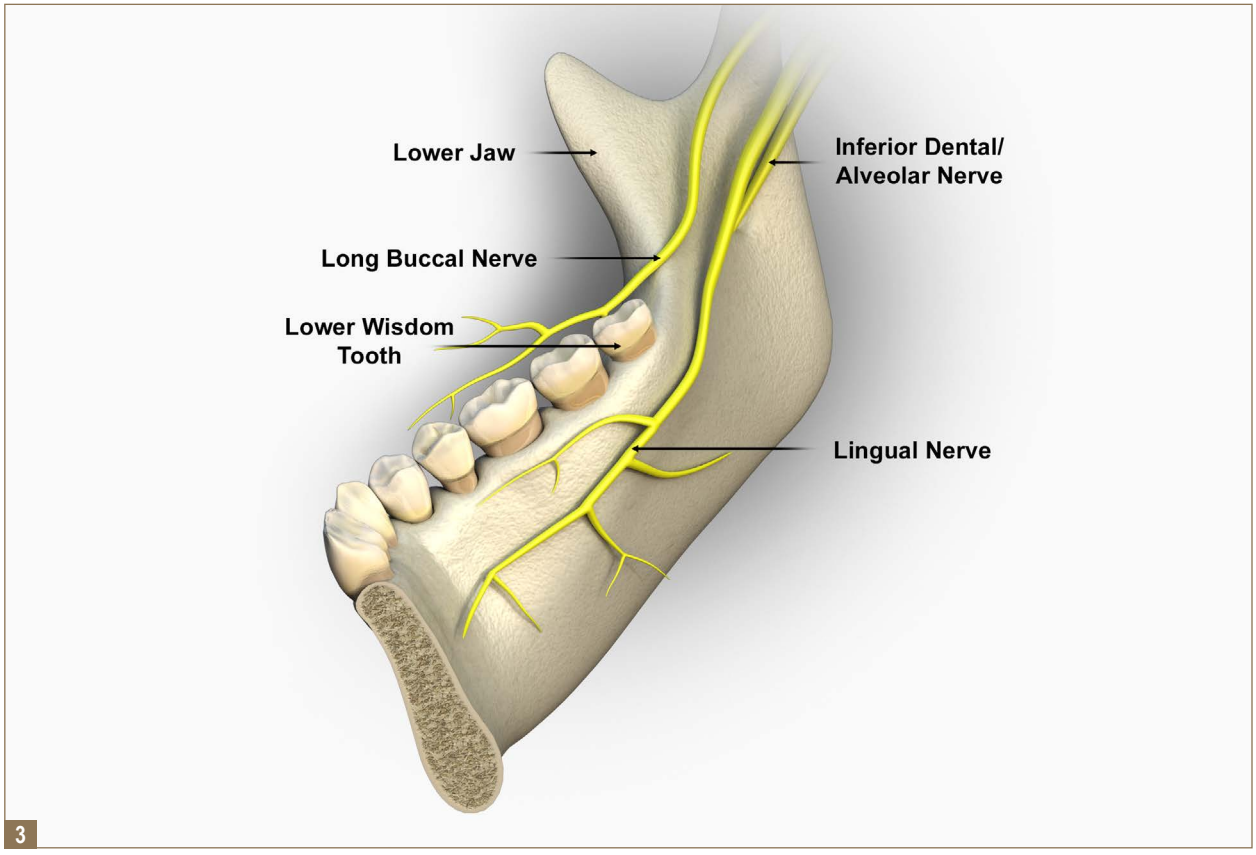


**Fig 3.** The main nerve trunk of the lower jaw, including the inferior dental/alveolar nerve, lingual nerve, and long buccal nerve.

with a Halstead injection technique and the long buccal nerve is frequently missed, a second shot will need to be administered into non-numb tissue. Using the Varizani-Akinosi nerve block technique allows for a better patient experience.

The Gow-Gates nerve block injection technique is often used when previous injections are unsuccessful. To complete this technique, the injection is aimed toward the condylar neck in an attempt to catch the nerve trunk before it branches off into the three separate nerves. A drawback with this technique, however, is that the injection goes through numerous anatomic structures, resulting in postoperative sensitivity and potential damage.

## ADMINISTERING "PAINLESS" INJECTION

The Varizani-Akinosi nerve block technique is a good option for administering a less painful shot; this is, in part, because the patient keeps his or her mouth closed during the injection. Most patients expect to receive the anesthesia while their mouth is open, so, with this technique, they typically do not tense up as they might with other injection techniques because they are not expecting the injection.

Neutralizing pain before the injection takes place is also important. Using a buffered $CO_2$ bubble drop on the tissue gives the patient the added psychosomatic effect of a topical anesthesia, which results in less pain during the injection.[12] Providers can also pull the tissue tight to alleviate the pressure felt on the tissue.

An additional technique to help administer a painless injection is to slow the pace in which the anesthesia is injected. Too quick of an injection can lead to tissue expansion, which can

**Fig 4.** Administration of the Varizani-Akinosi nerve block.

cause postoperative sensitivity. Remembering to go slowly can be difficult when using buffered anesthesia because it works rapidly.

## LOCAL ANESTHESIA SYSTEMS

Many dentists' reliance on a 1.8-ml carpule for injections of local anesthesia can be a hindrance to the acceptance and use of buffered anesthesia. Many times less than 1.8-ml is needed so the ability to measure in more standard volumes can also help the clinician dose more accurately. Buffered anesthesia uses sodium bicarbonate to neutralize the anesthetic. Sodium bicarbonate can be difficult to convey into a 1.8-ml carpule; if air gets into the sodium bicarbonate, its shelf-life becomes depleted and its buffering capacity will be altered due to the loss of $CO_2$. Eliminating the 1.8-ml carpule can simplify and streamline the process for administering local anesthesia.

Two ways to buffer anesthesia include the Onset® system (Valeant Pharmaceuticals International, Inc., www.valeant.com) and the Anutra system (Anutra Medical Inc., http://anutramedical.com).

The Onset system uses a traditional local anesthetic cartridge with a mixing pen, which is optimal for practitioners who prefer using a 1.8-ml cartridge. With this system, a sodium bicarbonate cartridge is added to the mixing pen, secured in place, and then connected to the 1.8-ml cartridge. A dial on the mixing pen can be set to the recommended buffering ratio based on the size of the cartridge. The specified amount of bicarbonate solution is transferred into the anesthetic by pushing a button.

The Anutra Local Anesthetic Delivery System is modeled more closely to the method used when buffering anesthesia for medical purposes, as

opposed to dentistry. A disposable aspiration syringe that can draw anywhere from 1 ml to 6 ml is used, allowing for an alternative to the traditional 1.8-ml dose. This allows for more variations, as multiple doses can be given without needing to reload the syringe.

Other local anesthesia options include the Wand® Single Tooth Anesthesia (STA®) (Milestone Scientific, www.milestonescientific.com), Kovanaze™ Nasal Spray (St. Renatus, LLC, http://st-renatus.com), and Vibraject (Vibraject EU, www.vibraject.eu). The Wand STA system focuses on allowing the dentist to administer a slow flow of anesthesia, helping to eliminate the painful burn felt by patients. The FDA-approved Kovanaze (tetracaine hydrogen chloride [HCl] and oxymetazoline HCl) Nasal Spray is administered nasally, without the use of a needle. The anesthesia can take approximately 20 minutes to fully take effect,[13] and a small percentage of patients will need an additional method of local anesthesia to be administered. The Vibraject system is attached to a standard syringe, making the needle vibrate. The shaking or vibrating of the patient's cheek acts as a distraction technique and a way to mitigate pain on injection.

## MANAGING PATIENT EXPECTATIONS

In addition to providing a painless injection, managing patients' expectations is an important aspect in improving their overall experience. When using a new technique, it is important to explain to the patient that this is different from traditional anesthesia. For example, when administering buffered anesthesia, the patient should be told the anesthetic is being used as a topical and that it works in 2-3 minutes so they will not become concerned when the procedure is started quickly. Providers should be aware of patient pain levels and adjust local anesthesia and pharmacological interventions accordingly.

Chairside manner also impacts the patient experience. A previously discussed benefit of buffered anesthesia is how rapidly it takes effect—as quickly as 2 minutes—allowing the provider to stay with patients while they are receiving the shot and the anesthesia is taking effect. Showing genuine concern for the patient's comfort level at chairside can make a positive impression. Similarly, following up with patients by phone after the procedure to see if they are feeling alright or are experiencing any sensitivity is another way to show concern.

Along with giving a painless injection, keeping patients as relaxed as possible throughout the procedure can help improve their overall experience. The patient's attention when providing the shot to help alleviate any fear he or she may have of receiving the injection.

## PATIENT BUFFERING CAPACITY

While all people can become numb, patients' buffering capacities will differ. This is often why varying lengths of time are needed for anesthesia to be effective. Certain conditions, such as chronic fatigue, have already been shown to have a negative effect on a patient's buffering capacity.[14] Additional research is being done to determine if other groups of patients, such as those with uncontrolled diabetes or chronic stress, have lower buffering capacity as well. Developing research also indicates that stress may alter buffering capacity for the short-term.

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