

INTRAOSSEROUS ANESTHESIA

Intraosseous Anesthesia With the Stabident® and X-Tip® Systems

The intraosseous injection allows placement of a local anesthetic solution directly into the cancellous bone adjacent to the tooth to be anesthetized. Because infiltration injections with lidocaine solutions are not effective for anesthesia of the mandibular molar teeth due to the thickness of the cortical plate, dentists do not attempt infiltration anesthesia in the posterior mandible. The intraosseous injection overcomes this problem by allowing direct access to the cancellous bone.

How similar is an infiltration and intraosseous injection? Nusstein et al ¹²⁴ compared these two injection techniques, using 1.8 mL of 2% lidocaine with 1:100,000 epinephrine, in the maxillary lateral incisor. The two techniques were similar except the intraosseous technique had a quicker onset and a shorter duration of anesthesia.

There are two intraosseous systems that have been studied clinically—the Stabident® system (Fairfax Dental Inc., Miami, FL) and the X-tip® system (Dentsply, York, PA—the X-tip® system has recently been acquired by Dentsply International). Recently, two other anesthetic systems have been introduced—the IntraFlow® (Pro-Dex Inc., Santa Ana, CA) and the Comfort Control Syringe® (Dentsply International, York, PA). The IntraFlow® system combines a slow-speed handpiece with an anesthetic cartridge dispenser system and a rotating needle/drill. The anesthetic solution is delivered after the cortical bone is perforated. Reemers et al ¹²⁵ studied the IntraFlow® system as a primary technique in 15 patients with irreversible pulpitis and found an 87% success rate (two consecutive 80 readings with a pulp tester). While encouraging, more research on the IntraFlow® system is needed. The Comfort Control Syringe® is an electronic delivery system for local anesthesia and has 5 different injection rates that are preprogrammed into the system. No studies have evaluated the Comfort Control Syringe® systems in clinical dentistry.

The Stabident® system is comprised of a slow-speed handpiece driven perforator, a solid 27-gauge wire with a beveled end that when activated, drills a small hole through the cortical plate. The anesthetic solution is delivered to cancellous bone through the 27-gauge ultra-short injector needle placed into the hole made by the perforator.

The X-tip® anesthesia delivery system consists of an X-tip® that separates into two parts: the drill and guide sleeve component. The drill (a special hollow needle) leads the guide sleeve through the cortical plate, whereupon it is separated and withdrawn. The remaining guide sleeve is designed to accept a 27-gauge needle to inject the anesthetic solution. The guide sleeve is removed after the intraosseous injection is complete.

The technique of intraosseous anesthesia, using the Stabident® or X-tip® systems, can be reviewed in their respective instruction manuals and/or published papers. ^{110, 126-130}

Perforator Breakage With the Stabident® and X-tip® Systems

About 1% of perforators “separate” during use.^{19, 110, 126-130} That is, the metal perforator separates from the plastic shank. Each is easily removed with a hemostat. The “separation” usually occurs during a difficult perforation (e.g., dense cortical bone) and it is likely the metal is heated excessively, causing the plastic hub to melt. No perforator “breakage” (metal perforator breaking into parts) has been reported in numerous studies.^{19, 110, 126-130}

Optimal Injection Site Location for Anesthesia

It is important to remember that a site DISTAL to the tooth to be anesthetized will result in the best anesthesia.^{19, 27, 110, 111, 126-130} An *exception* to this rule would be in maxillary and mandibular second molars—a MESIAL site should be selected.^{19, 27, 110, 111, 126-130}

Onset of Anesthesia

Basically, the onset of anesthesia is immediate.^{19, 27, 110, 111, 126-131} Therefore, there is no “waiting period” for onset of anesthesia.

Site Selection—Attached Gingiva or Alveolar Mucosa?

Both the Stabident® and X-tip® intraosseous systems instruct the user to locate the perforation site in attached gingiva. The gingival site allows the perforation to be made through a minimal thickness of cortical bone and is generally equidistant between adjacent root structures. However, because the guide sleeve remains in place with the X-tip® system, two studies^{19, 127} have successfully used it in alveolar mucosa at a more apical location. The X-tip® system has a definite clinical advantage over the Stabident® system because the X-tip® perforation may be made at an apical location in unattached gingiva. That is, if the Stabident® system is used apically in alveolar mucosa, it is almost impossible to find the hole to deliver the anesthetic solution. Therefore, the clinician may want to consider using the X-tip® in an apical location in specific clinical situations. For example, when periodontal pocketing does not allow perforation into cancellous bone through the more coronal attached gingiva or there is a lack of interproximal space (roots are too close together), the X-tip® system can be used to achieve pulpal anesthesia. Furthermore, if the Stabident® system fails, the clinician may want to consider using the X-tip® apically to achieve pulpal anesthesia.

Success With the Inferior Alveolar Nerve Block in Patients With Irreversible Pulpitis

Clinical studies in endodontics^{9, 11, 12, 19, 50, 131} in patients with irreversible pulpitis have found success (mild or no pain upon endodontic access or initial instrumentation) with the inferior alveolar nerve block occurred between 19% and 56% of the time. These studies would indicate that anesthesia is often difficult to achieve in irreversible pulpitis with only the inferior alveolar nerve block.

Success With Articaine for Inferior Alveolar Nerve Blocks in Patients With Irreversible Pulpitis

Claffey and co-authors⁵⁰ found an articaine solution had a success rate of 24% and a lidocaine solution had a success rate of 26%, with no significant difference between the solutions. Neither solution resulted in an acceptable rate of anesthetic success in patients with irreversible pulpitis.

Success of Supplemental Intraosseous Anesthesia in Patients With Irreversible Pulpitis

Stabident® Success

Nusstein et al⁹ found a supplemental mandibular intraosseous injection using the Stabident® system and 1.8 mL of 2% lidocaine with 1:100,000 epinephrine was 91% successful in gaining total pulpal anesthesia for posterior teeth diagnosed with irreversible pulpitis. Parente et al¹⁸ used the Stabident® intraosseous injection in patients with irreversible pulpitis when conventional local anesthetic techniques failed. They found an initial supplemental intraosseous injection, using 0.45 to 0.9 mL of 2% lidocaine with 1:100,000 epinephrine, was successful in 79% of posterior mandibular teeth. A second intraosseous injection increased success to 91%. Reisman et al¹¹ reported the supplemental intraosseous injection of 1.8 mL of 3% mepivacaine increased success in mandibular teeth diagnosed with irreversible pulpitis to 80% when compared to the inferior alveolar nerve block alone (25% success). A repeated intraosseous injection of 3% mepivacaine increased success to 98%. Therefore, one cartridge of 3% mepivacaine plain is not as efficacious as one cartridge of 2% lidocaine with 1:100,000 epinephrine, but 3% mepivacaine does not have the heart rate increase seen with epinephrine-containing solutions.

Success With an Articaine Solution

Bigby and co-authors¹³¹ found that for posterior teeth diagnosed with irreversible pulpitis, the supplemental intraosseous injection of 1.8 mL of 4% articaine with 1:100,000 epinephrine was 86% successful when the inferior alveolar nerve block failed. Therefore, the success rate of the articaine solution was similar to a solution of lidocaine.

X-Tip® Success

Nusstein et al¹⁹ used an X-tip® supplemental intraosseous injection in patients with irreversible pulpitis when a conventional inferior alveolar nerve block failed. The X-tip injection site was 3-7 mm apical to the mucogingival junction of the mandibular molar or premolar tooth and 1.8 mL of 2% lidocaine with 1:100,000 epinephrine was administered. They found that 6 of the 33 (18%) X-tip® injections resulted in backflow of the anesthetic solution into the oral cavity—none were successful in obtaining anesthesia. Twenty-seven of the remaining 33 X-tip® injections (82%) were successful. They concluded that when the inferior alveolar nerve block fails to provide profound pulpal anesthesia, the X-tip® system, when used in an apical location and when there was no backflow of the anesthetic solution into the oral cavity, is successful in achieving pulpal anesthesia in mandibular posterior teeth of patients presenting with irreversible pulpitis.

The Key to Success With an Intraosseous Injection

The key to success with the intraosseous injection is flow of the anesthetic into the cancellous space. If anesthetic solution flows out of the perforation site into the oral cavity, naturally, no anesthetic effect will be realized. Reperforation or choosing another perforation site would be a good choice to gain access to the cancellous bone.

In less than 10% of intraosseous injections, constricted cancellous spaces may limit the distribution of the anesthetic solution around the apices of the teeth.^{9, 11, 19, 27, 50, 110, 111, 126-131} Therefore, failure may result even when the anesthetic solution is delivered intraosseously.

What do we Tell Patients When Administering Intraosseous Anesthesia?

An example would be, “Your tooth isn’t as numb as we would like, therefore, we are going to give additional numbing solution next to your tooth. You will feel some vibrations and possibly

your heart may beat a little faster.” We should not say, “We are going to drill through your gum and bone and then give you a shot of the anesthetic.” Basically, for the inferior alveolar nerve block we do not give detailed instructions such as, “We are going to go through the mucosal surface, then some tissue and possible muscle and then hit the bone and nerve.” We simply say, “We are going to get you comfortable by numbing your tooth.” Regarding details, the intraosseous injection should be no different than what we say when administering other local anesthetic injections.

Duration

With a *primary* IO injection, duration of pulpal anesthesia declines steadily over an hour.^{126, 127, 130} There is an even shorter duration with 3% mepivacaine or 1.5% etidocaine with 1:200,000 epinephrine compared with 2% lidocaine with 1:100,000 epinephrine.^{130, 132}

With a *supplemental* IO injection after the inferior alveolar nerve block in patients without pain, duration of pulpal anesthesia is very good when using anesthetic solutions with vasoconstrictors.^{27, 110} A solution of 3% mepivacaine will result in a shorter anesthetic duration.¹¹²

In patients with irreversible pulpitis, the supplemental intraosseous injection, using the Stabident® or X-tip® systems, provided anesthesia for the entire debridement appointment.^{9, 19, 131}

Repeating the Intraosseous Injection

Jensen et al¹³³ found that repeating the intraosseous injection, using 1.4 mL of 2% lidocaine with 1:100,000 epinephrine, 30 minutes after the initial intraosseous injection provided an additional 15-20 minutes of pulpal anesthesia, which was similar to the duration of the initial intraosseous injection.

When Should the Intraosseous Injection be Given?

Considering the high failure rate of the initial inferior alveolar nerve block, it would be prudent to give all patients with irreversible pulpitis a supplemental intraosseous injection following an inferior alveolar nerve block. That is, once we have signs of lip numbness, we administer an intraosseous injection. This procedure has significantly decreased patients’ pain and allowed a quicker onset of treatment.

Why don’t more dentists use this regimen? Basically, many clinicians do what they were taught in their initial clinical training and sometimes it is hard to change. For example, a 1998 study in the *Journal of the American Medical Association*¹³⁴ urges the use of anesthesia during circumcision. Currently, up to 96% of babies don’t receive anesthesia. The physicians were taught in their residencies not to administer anesthesia and consequently it will probably be a slow process to change them over. This is a common problem in many health care disciplines and emphasizes the need to stay current with new advances.

Success in Painful Teeth With Totally Necrotic Pulps and Radiolucent Areas

No published study has investigated the success rate in these teeth. In a preliminary study we performed at The Ohio State University, anesthetic solution deposition was very painful in these teeth and we had to terminate the study.

Success in Partially Vital Teeth

The intraosseous injection should work in teeth where the chamber is necrotic, the canals are vital or partially vital, and there is a widening of the periodontal ligament radiographically. A recent history of hot and cold sensitivity should differentiate this condition from one of a necrotic tooth experiencing an acute exacerbation (Phoenix abscess).

Systemic Effects With the Intraosseous Injection

Heart Rate Effects of Intraosseous Anesthesia

Various authors^{9, 19, 27, 110, 111, 126-129, 131, 135} have reported a transient increase in heart rate (46% to 93% of the time) with the Stabident® or X-tip® intraosseous injection of epinephrine- and levonordefrin-containing solutions. Replogle and co-authors¹³⁵ reported 67% of their subjects objectively (electrocardiogram recordings) had an increased heart rate with the Stabident® intraosseous injection of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine. The mean increase was 28 beats per minute. Chamberlain et al¹³⁶ found the Stabident® intraosseous injection of 2% lidocaine with 1:100,000 epinephrine resulted in a mean heart rate increase of 12 beats per minute. Guglielmo et al²⁷ reported that the supplemental Stabident® intraosseous injection of 1.8 mL of either 2% lidocaine with 1:100,000 epinephrine or 2% mepivacaine with 1:20,000 levonordefrin resulted in a mean increase in heart rate of 23-24 beats per minute (measured with a pulse oximeter) in 80% of the subjects. Stabile et al¹¹¹ found the supplemental intraosseous injection of 1.8 mL of 1.5% etidocaine with 1:200,000 epinephrine resulted in a mean increase in heart rate of 32 beats per minute (measured with a pulse oximeter) in 90% of the subjects. Bigby et al¹³¹ found a pulse rate increase of 32 beats per minute using 4% articaine with 1:100,000 epinephrine. Wood et al¹³⁷ found that a transient heart rate increase (measured with a pulse oximeter) will occur with the intraosseous injection but not with the infiltration injection of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine in the maxillary anterior region.

Generally, all these studies showed that the heart rate returned to baseline readings within four minutes in most patients. Therefore, injection of anesthetic solutions containing vasoconstrictors, using either the Stabident® or X-tip® systems, would result in a transient heart rate increase. No significant change in diastolic, systolic or mean arterial blood pressure will be observed with the intraosseous injection of 2% lidocaine with 1:100,000 epinephrine.^{135, 136}

Slowing the rate of the intraosseous solution deposition of 2% lidocaine with 1:100,000 epinephrine by utilizing the slow rate (4 minutes and 45 seconds) of a computer-assisted local anesthetic delivery system significantly lowered the heart rate (10 to 12 beats per minute) when compared to a fast rate (45 seconds) resulting in a heart rate of 25 beats per minute.¹³⁸

Clinical Significance of Heart Rate Increase

While the heart rate increase with the Stabident® or X-tip® intraosseous injection of 2% lidocaine with 1:100,000 epinephrine would likely be noticed by the patient, it would not be clinically significant in most healthy patients.¹³⁵ Replogle et al¹³⁵ discussed the clinical significance, cardiovascular effects and contraindications to the use of vasoconstrictors in intraosseous injections. The reader is referred to this article for review.

The Lack of Heart Rate Effect of 3% Mepivacaine in Intraosseous Anesthesia

There will be no significant increase in heart rate when 3% mepivacaine is used for intraosseous anesthesia.^{112, 135} Importantly, in those patients whose medical condition (moderate-to-severe cardiovascular disease) or drug therapies (patients taking tricyclic antidepressants or nonselective

β-adrenergic blocking agents) suggest caution in administering epinephrine- or levonordefrin-containing solutions, 3% mepivacaine would be an excellent alternative for intraosseous injections.^{112, 135}

Caution in the Use of Long-Acting Anesthetic Agents for Intraosseous Anesthesia

In an attempt to increase the duration of pulpal anesthesia with intraosseous injections, some clinicians may use long-acting anesthetic agents. Bupivacaine (Marcaine®) and etidocaine (Duranest®) are long-acting anesthetic agents but only for inferior alveolar nerve blocks. Long-acting anesthetic agents are not long-acting agents for intraosseous and maxillary infiltration anesthesia.^{111, 132, 139, 140} It is important to realize that bupivacaine and etidocaine have cardiotoxic effects¹⁴¹ and are basically equivalent to 2% lidocaine with epinephrine in terms of efficacy, duration and heart rate effects for intraosseous anesthesia. Therefore, bupivacaine and etidocaine offer no advantage clinically and should not be used for intraosseous anesthesia.

Plasma Levels of Lidocaine After Intraosseous Injection

Some authors¹⁴² have cautioned that administration of an overly large volume of local anesthetic with an intraosseous injection could lead to overdose reactions. Wood and co-authors¹³⁷ using human subjects and 1.8 mL of 2% lidocaine with 1:100,000 epinephrine found that the venous plasma levels of lidocaine were the same for maxillary anterior intraosseous and infiltration injections. While there is a short-lived effect on the heart rate due to the vasoconstrictor, the plasma concentration of lidocaine delivered with the intraosseous injection is no more than that delivered with an infiltration. Therefore, the intraosseous technique should not be considered an intravascular injection. Additionally, if it were an intravascular injection, little or no anesthetic effect would be demonstrated. That is, all the local anesthetic solution would be carried into the vascular system with none left for pulpal anesthesia. Obviously, clinical and experimental studies^{9, 19, 27, 110, 111, 126-129, 131, 135} have demonstrated clinical anesthesia with intraosseous techniques. In conclusion, the same precautions for the maximum amount of lidocaine given for an infiltration injection would seem to also apply to an intraosseous injection.

Postoperative Problems

For the Stabident® system, less than 5% of patients will develop swelling and/or exudate at the site of perforations.^{27, 126, 128, 129, 135} Gallatin et al¹⁴³ found that the X-tip® system may have a higher incidence of postoperative swelling clinically. With both systems, the swelling/exudate may be present for weeks after the injection but all resolve with time.^{27, 126, 128, 129, 135, 143} These slow healing perforation sites may be due to overheating of the bone caused by pressure during perforation.

With both the Stabident® and X-tip® systems, approximately 4% to 15% of patients will report that their tooth “feels high” when chewing for a few days.^{27, 126, 128, 129, 135, 143} This feeling is most likely an increased awareness to biting that results from soreness in the area caused by damage from perforation or inflammation of the bone. The incidence with the intraosseous injection is lower than reported with the periodontal ligament injection (36% to 49%).^{144, 145}