Introduction to Intraosseous Anesthesia in Dentistry using the QuickSleeper 5® device:

a Practical Approach

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This manual does "not" replace or intends to replace the manufacturer's manual on the QuickSleeper 5® (Dental Hi Tec, France). This manual is an adjunct to the manufacturer's and is written from a clinical perspective.

Intra-osseous anesthesia in dentistry is a very efficient way to achieve a deep, effective and thorough local dental anesthesia, especially in the mandible. The traditional inferior alveolar nerve block fails in about 30% (Aps, 2009) of cases, due to anatomical variations, infection and technique related issues. Research focusing on the anatomy of the mandible has shown so-called accessory or nutrient canals passing through the buccal and/or lingual cortex to be more present than previously thought. Nerve branches from the buccal nerve, lingual nerve, mylohyoid nerve, retro-auricular nerve, facial nerve, hypoglossal nerve, glossopharyngeal nerve and the first cervical nerve have been mentioned in the literature to be passing through these canals.

The latter explains perfectly the problems encountered in clinical dentistry where dentists are confronted with a "hot" tooth or a tooth that does not seem to be susceptible (one cannot touch one specific spot in a tooth without causing pain to the patient, while all the rest is perfectly anesthetized) to local anesthetic after administering a mandibular nerve block with whatever technique (Halsted, Gow-Gates or Akinosi-Vazirani). If a tooth is supplied by one of the above mentioned nerve branches, the mandibular nerve block will not be efficient enough and painless dentistry will be impossible.

Intra-osseous local anesthesia overrules these anatomical issues, encountered with teeth receiving a nerve branch from another nerve than the inferior alveolar nerve. By administering the local anesthetic directly into the cancellous bone, the teeth can be perfectly anesthetized, as all nerve branches will be efficiently numbed. This is all achieved with minimal 'collateral' anesthesia of the soft tissues. An intraosseous injection results in pulpal, periodontal and attached gingiva anesthesia.

By choosing the correct combination of amide anesthetic and the correct concentration of vasoconstrictor, the depth and the duration of pulpal anesthesia can be controlled. The volume injected will determine the number of teeth being affected, while the vasoconstrictor will influence the duration and depth of the anesthesia. The use of mepivacaine 3%, lidocaine 2% and articaine 4% is perfectly possible, as long as they are combined with a vasoconstrictor (epinephrine or adrenaline).

This practical manual focuses on clinical examples in which intra-osseous anesthesia, administered with the QuickSleeper® device, is applied.

Acknowledgements:

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Introduction

This manual is not a substitute for the QuickSleeper®'s manufacturer manual. The aim of the present manual is to present a clinical guide, written by an experienced QuickSleeper®user and instructor. For technical details with regard to this device, the reader is kindly referred to the manufacturer (http://www.dentalhitec.com) and the manufacturer's (Dental Hi Tec) manual.

Local anesthesia in dental school is sometimes treated very briefly and superficially. Depending on which University and on who is teaching the course (e.g. surgeon or a pediatric dentist for instance), the student's knowledge and finally the dentist's will be shaped. The latter explains why sometimes dentists have no idea why certain patients seem to be harder to be anesthetized than others. Patients often tell the dentist they are hard to get 'numbed up'. A story about the fact that one needs multiple injections before a treatment can be performed pain free or even not entirely painless, sounds very familiar to many dental professionals.

Another typical feature is the patient who reports pain during treatment when one particular spot in a tooth is touched, while the rest of the tooth seems to be well anesthetized. Children with hypomineralized enamel, e.g. molar-incisor-hypomineralization (MIH), are also known to be a tough category to be anesthetized efficiently with traditional mandibular nerve blocks (Halsted block).

The above mentioned cases necessitate the dentist often to inject multiple times at various sites is an attempt to achieve thorough local anesthesia during treatment. Empirically some dentists have learned that an intraligamentary injection may be useful, while others swear to use additional infiltrations around the affected tooth. Some dentists get frustrated, as certain particular patients never seem to get total local anesthesia. This frustration also lives with these patients, who often develop dental fear, because of this.

Experience shows that most problems occur in the mandible. The latter implies that additional infiltrations with local anesthetic will not be as efficient as hoped, due to the massive thick cortex of the mandible distal of the mental foramen. As most issues occur with the lower molars, the alternative infiltrations are problematic and not efficient.

Several publications indicate that the failure rate of the mandibular nerve block varies from 5 to 30% (Aps, 2009). The latter is attributed to technique issues, infections and anatomical variations. If general anesthesia was as unpredictable as the inferior alveolar nerve block technique, not many patients would agree upon undergoing surgery. Still, often in dentistry we do not seem to be able to achieve 100% anesthesia. However, intra-osseous anesthesia can achieve this and therefore deserves to be accepted as the preferred anesthesia technique.

The present instruction manual offers an up-to-date and expert "cook book" to achieve proper effective anesthesia without having to inject multiple times and with minimal 'collateral' soft tissue anesthesia. Intra-osseous anesthesia (IOA) was described more than a hundred years ago and therefore is nothing new or heterodox. In fact, every infiltration anesthesia is also an IOA. The only difference with the direct IOA is that with infiltrations, a certain volume of anesthetic is injected into the soft tissues and one awaits for it to be diffused through the cortical plate of the jaw and subsequently into the cancellous bone. Actually, also every intraligamentary injection is an IOA. The anesthetic injected into the periodontal ligament space, will eventually diffuse into the cancellous bone after having penetrated through the lamina dura (also a cortical plate), surrounding the root of the tooth. Many practitioners don't like this technique because it requires patience, as otherwise a forced injection will cause the fluid to exit the periodontal ligament space again through the crevicular space. It is not unusual to witness a fountain of anesthetic solution when injecting under pressure. The QuickSleeper® also offers a possibility to perform the intraligamentary injection under pressure controlled (computer aided injection) conditions. It is paramount that the injection is as gentle as possible, as too high a pressure causes pain and discomfort. Key for a painless injection is slow injection speed. This will extensively be addressed in this manual.

Literature references are given at the end and are not specifically mentioned in this clinical manual. The interested reader can find additional information in the reference list. Articles are ordered in author's alphabetical order.

In order to understand better why IOA works more efficient than infiltrations and nerve blocks, it is important to briefly visit the anatomy of the human skull again.

Nerve supply to teeth in the maxilla

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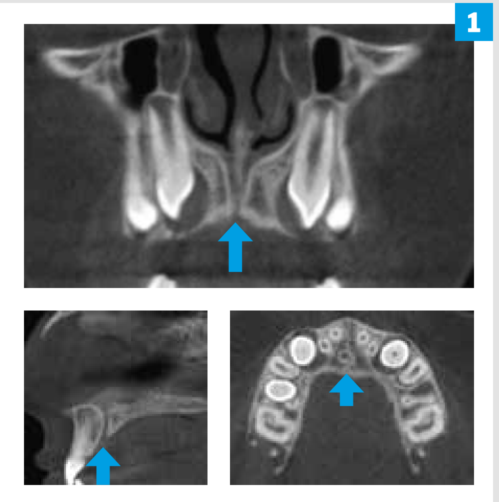


The nasopalatine canal in coronal, sagittal and axial view (from the left to the right) in a 10 year old child.

The distance between the buccal roots and the palatal root in a maxillary molar can be substantial (10 mm in this case) – this is a coronal view of the first left maxillary molar.

All teeth in the maxilla receive nerve branches derived from the superior alveolar nerve, a branch of N.Vb (Maxillary nerve) or the second branch of the Trigeminal nerve (N.V.). Although that is what we assume, sometimes maxillary incisors may receive a nerve branch derived from the nasopalatine nerve, which descends from the nasal septum into the nasopalatine canal, and subsequently opens just posterior of the maxillary incisors. **Figure 1** shows a schematic drawing of this particular anatomy. Variations in anatomy occur more often than one might think. Cone-beam CT studies have shown that.

As the buccal cortical plate of the maxilla has numerous porosities, an anesthetic injected into the buccal fold will easily diffuse through the cortical bone and subsequently into the spongy or cancellous bone. However, some maxillary molars might prove difficult to anesthetize. From **figure 2** it is clear that in some cases the distance between the palatal root and the buccal roots is substantially large, with or without a protruding maxillary sinus between them, and that a buccal infiltration may be insufficient for obtaining a profound anesthetic effect of the nerve branch entering the palatal root of the tooth.

A closer look at the anatomy of the hard palate on a dried human skull, reveals numerous porosities. The latter can be used to anesthetize the tooth from the palate adequately. However, many dental practitioners do not like to inject into the palate, because of the dense character of the mucosa, and because they have experienced that application of force seems to be needed to enable injection into these tissues. Besides this practical issue, patients almost always complain of discomfort, because of this unnecessary applied force during injection. The density of the palatal mucosa requires slow injection. The latter is easily achieved with computer-controlled-injection devices. Some examples of such devices include in 2017, the QuickSleeper®, the SleeperOne®, the Anaeject®, the Wand® and the STA® (Single Tooth Anesthesia). Later in this manual, the correct injection site and correct angulation of the needle will be discussed. Another reason for one having to inject into the palatal mucosa, is because the greater palatine nerve, might have a branch that runs to a tooth and hence a buccal infiltration only would be insufficient.

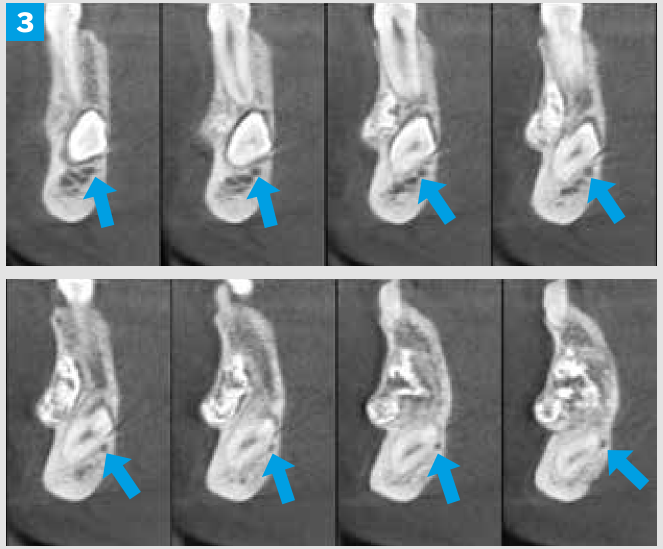
Overall conclusion from a clinical standpoint is that achieving pulpal anesthesia in the maxilla is almost 100% achievable with a single buccal infiltration. If the latter is not successful enough, a slow speed palatal injection is needed, preferably with a computer controlled injection device.

The ideal alternative is the intra-osseous administration of the anesthetic, which overrules the buccal and/or the palatal infiltration injection.

Nerve supply to teeth in the mandible

2

The mandibular teeth are receiving nerve branches from the inferior alveolar nerve, which is a branch of the mandibular nerve or N.Vc (Mandibular nerve). The traditional way to anesthetize mandibular molars and premolars is to administer a mandibular nerve block, also called a Halsted block. This is achieved by injecting a certain volume of anesthetic in the immediate proximity of the lingual foramen on the medial side of the ramus of the mandible. The foramen is protected anteriorly with the lingula mandibulae (known as the thorn of Spix in some countries). The mandibular canal splits in the premolar zone, at the mental foramen. It is a misconception to think that the nerve exits the mandible and becomes the mental nerve. There is effectively a branch that runs forward inside the mandible, branching off towards the other teeth [**fig.3**]. The incisors and canines, however, can often be sufficiently anesthetized using infiltration anesthesia, because the cortical plate is substantially thinner than in the molar area where the external oblique ridge is situated.



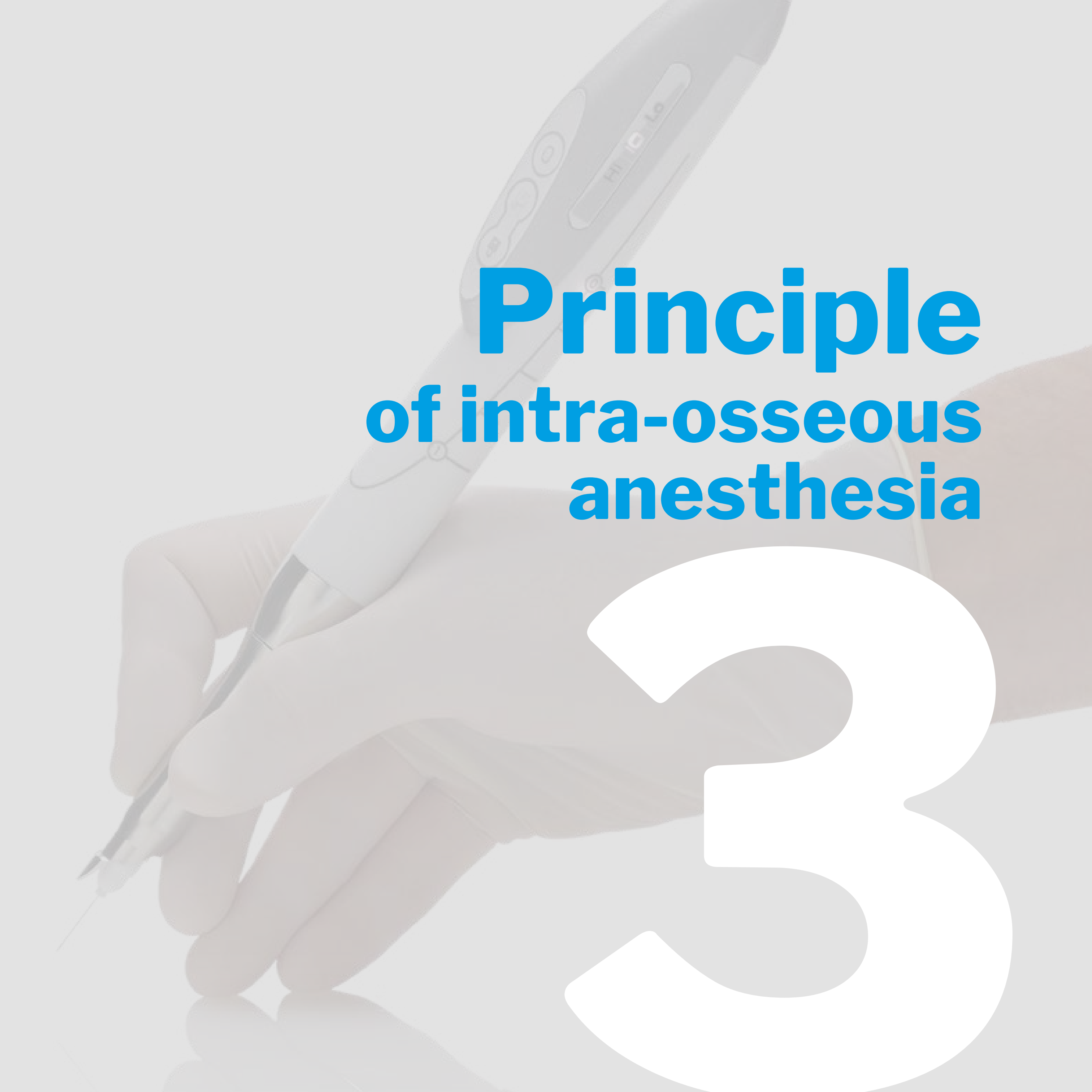
Anterior branch of the inferior alveolar nerve in a 20 year old patient with an impacted canine and a complex odontome. These images are 5 micron thick and 1 mm apart. Notice the canal running lingual to the impacted canine (arrows).

The literature on failing mandibular nerve blocks, supports what clinicians are experiencing in some patients: namely one tooth or more mandibular teeth are very difficult to anesthetize or one specific area in the tooth never seems to be anesthetized efficient enough. Typically, the soft tissues are very numb, the patient feels the anesthesia is working, but upon the first contact with the dentine, the patient reports (excruciating) pain. This sounds very familiar to many dental practitioners. Empirical collected evidence has lead many dentists to start injecting additional anesthetic either and or both into the buccal and lingual fold adjacent to the problematic tooth. Most times this is not sufficient and the patient keeps reporting pain during the treatment.

Literature has shown that many people have more than one nerve branch running to a tooth. If that nerve branch does not belong to the inferior alveolar nerve, the inferior alveolar nerve block will not be as effective as expected. Studies have shown that several nerves can be identified that branch off into the mandible: the nerve to the mylohyoid, the lingual nerve, the buccal nerve, the hypoglossal nerve, the glossopharyngeal nerve, the auriculo-temporal nerve, the facial nerve and the first cervical or spinal nerve (Suboccipital nerve). Where most studies focus on the number of accessory canals or also called nutrient canals in the anterior mandible, one study looked at the number of nutrient canals in the entire mandible. This study showed that 5.4% of the subjects had no accessory canals whatsoever, while 94.6 had at least one accessory canal perforating the buccal and/or lingual cortex of the mandible. There does not seem to be a gender dominance or left or right dominance in the presence of accessory canals.

The latter explains the observed difficulties when a mandibular nerve block is insufficient. Alternative techniques to the Halsted mandibular nerve block, are the Gow-Gates and the Vazirani-Akinosi techniques. Both try to aim as high up on the mandibular nerve (N.Vc), which comes down to as close as possible to the foramen ovale, where the mandibular nerve exits the base of the skull. However, as the majority of the above mentioned nerve branches are not derived from this trunk, these mandibular nerve block techniques will not provide sufficient local anesthesia either.

The ideal alternative is the intra-osseous administration of the anesthetic. If one applies an intraosseous injection, it does not matter where the nerve branches come from that innervate that particular tooth.



Principle of intra-osseous anesthesia

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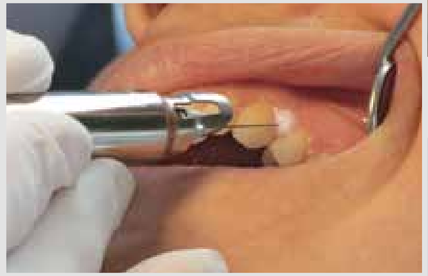

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In order to be able to inject an anesthetic into the cancellous bone, there are 4 basic steps to be respected.

One has first to anesthetize the periosteum that covers the cortical bone [**fig. 4**]. To achieve that a few drops of anesthetic are injected into the mucosa, near where the perforation and penetration into the bone will be performed.

When that is achieved, the perforation of the cortical plate is performed and subsequently the penetration of the cortical bone can be performed painlessly for the patient. Ideally the penetration orifice width and the needle that is used to inject the anesthetic should have the same diameter. The latter is necessary to avoid leakage from the orifice and to be able to determine how much fluid has actually been injected. This can be achieved with Dental Hi Tec's QuickSleeper® for instance [**fig. 5**].

Once the desired depth is acquired, the injection should be performed as slow as possible, to allow the fluid to disperse within the cancellous bone. Another reason why the injection has to be performed slowly is to minimize the tachycardia effect caused by the vasoconstrictor (epinephrine or adrenaline) in the anesthetic solution. It is necessary to use an anesthetic with a vasoconstrictor, as this will keep the anesthesia local, enhance and prolong the effect of the anesthesia, but most importantly keep the systemic toxicity to a minimum. The latter means that the presence of a vasoconstrictor will keep peak serum dose of the amide anesthetic to a minimum, allowing the liver and the kidneys to metabolize the amide anesthetic more gradually and easily. Prevention of high serum peak doses (overdose risk) is therefore safer. Injecting a solution that does not contain a vasoconstrictor will allow the amide anesthetic to enter the bloodstream fast and at an instant high concentration, enabling a potential overdose. The latter is especially the case when drugs or medical conditions impair liver and/or kidneys to metabolize the anesthesia molecules, as can be the case in medically compromised patients.

The American Heart Association also supports the use of a vasoconstrictor in dental local anesthesia as it prevents painful events during treatment, which subsequently cause stress for the patient, which in turn is translated into an endogenous release of adrenaline. This uncontrolled amount of adrenaline may cause more harm to the patient, as the latter may suffer instant cardiac arrhythmia and perhaps failure.

The amount of injected fluid will determine the number of teeth that will be anesthetized. Ideally the injection should be performed distally of the tooth or teeth that one wants to treat. However, in the maxilla, a mesial intra-osseous injection will also be successful. It has to be emphasized that when infection is present, a distal injection is to be preferred. A thorough vasoconstriction distal of the 'hot' tooth will enable an efficient pulpal and periodontal anesthetic effect. The concentration of vasoconstrictor will not only determine the depth of the anesthesia but also its duration (a product with a 1:100,000 epinephrine concentration will work more thorough and longer than one with a 1:200,000 epinephrine concentration). This allows the practitioner to have a certain level of control over the anesthesia and to estimate the volume needed for a particular treatment. It is therefore important to have several products with different concentrations of vasoconstrictors.

Practical use of amide anesthetics in dentistry

4

Today's amides used in dentistry are bupivacaine, ropivacaine, lidocaine, articaine, mepivacaine and prilocaine. The first two cause a very long lasting local anesthesia (>5 hours) and should be reserved for long treatments or when a long duration of local anesthesia is desirable for the patient's post operative comfort. For instance after periodontal surgery or extraction of an impacted tooth. The potential side effects of these long acting products are iatrogenic injuries, such as lip, cheek and/or tongue biting. The latter should especially be taken into account with pediatric patients. Articaine, which is in use in Europe since 1976, has also become available to the American dental market since 2000. This is the reason why bupivacaine and ropivacaine are so well known among dentists in the USA and not in Europe. The need for a long lasting local anesthesia dictated the choice of the product. Articaine works for about 4 hours and can be considered as the product of choice when longer duration of local dental anesthesia is required or desired. Bupivacaine and ropivacaine are, in the opinion of the author, not really suited for regular dental procedures. Lidocaine can be considered as the gold standard of all local dental anesthetics. It causes pulpal anesthesia for about 45 to 60 minutes. Mepivacaine works a bit longer than lidocaine and prilocaine has the shortest effect.

Esters are no longer used for injectable local anesthetics. They are however still used as topical anesthetic (e.g. benzocaine).
Benzocaine and prilocaine have been reported in connection to methemoglobinemia. This is the effect that occurs when the number of binding sites for oxygen on hemoglobin is decreased. The latter two molecules seem to be able to cause this phenomenon, which implies that one should be cautious not to overdose the patient when using these products. It is the opinion of the author that, as there are good alternatives for benzocaine and prilocaine, the two latter can be easily left out of the armamentarium of the dental professional.

All amides cause a vasodilation, which implies that it is very difficult to keep the products local and that if used without a vasoconstrictor the systemic toxicity can be easily reached. Therefore, as mentioned before, vasoconstrictors are indicated. The catecholamine adrenaline or epinephrine (the same substance) is a natural product and therefore patients cannot be allergic to it. It is a misperception if patients report being allergic to epinephrine, as this would mean them being allergic to a substance they secrete themselves under normal and stressed conditions. A patient can, however be very sensitive to slight increases in the concentration of epinephrine.

The other vasoconstrictor, a synthetic polypeptide, felipressin, can however cause an allergic or adverse biological reaction. Therefore prudence is needed when choosing a product for your patient. Again, to be safe, it is better to use epinephrine containing combinations in order to avoid adverse reactions. Coincidentally prilocaine is only combined with felipressin. Keeping in mind the above recommendation of not using prilocaine, also covers the felipressin issue.

With respect to intraosseous anesthesia one can now appreciate better the correct choices that have to be made for each dental procedure.

> Using a 4% articaine with 1:100,000 epinephrine solution is ideal for long procedures, when long duration of the local anesthesia is desired, or when treating a pulpitis. The high concentration of vasoconstrictor will ensure a deep and efficient pulpal anesthesia. An entire cartridge injected intraosseously will enable the dentist to obtain pulpal anesthesia on a large number of teeth and for at least 60 minutes. Depending upon the site of injection, the anesthesia will cross the jaw's midline.

> A 2% lidocaine with 1:80,000 or even 1:50,000 epinephrine solution will come in handy for acute irreversible pulpitis cases (also referred to as the 'hot' tooth). It should be emphasized, for safety reasons, that the latter combinations should not be used routinely and certainly not in pediatric or medically compromised patients.

> On the other end is the 2% lidocaine with 1:100,000 epinephrine solution or the 4% articaine with 1:200,000 epinephrine solution, that will ensure pulpal anesthesia for a little shorter time (45 minutes). These combinations are ideal for simple restorative procedures. Depending on the number of teeth one wishes to treat, one can either inject a half, three quarters or a whole cartridge.

Once the injection is performed, the anesthesia sets on instantaneous and one can start the procedure right away. Patients will report the anesthetized teeth to feel "higher, bigger and not fitting with the antagonists". This is what one wanted to achieve: pulpal and periodontal anesthesia.

Tachyphylaxis, the desensitization effect that can occur when one injects several cartridges of local anesthetic into the soft tissues, at short time intervals, especially when a mandibular block, appears not successful, is a phenomenon that rarely occurs with IOA. One will rarely require a second IO injection, unless the treatment takes longer than anticipated or one chose a too low vasoconstrictor concentration for the initial injection (e.g. irriversible pulpitis and injection performed with 4% articaine and 1;200,000 epinephrine).

Intraosseous anesthesia provides only profound anesthesia of the dental pulp, the periodontal ligament and the attached gingiva around every tooth that has been affected by the anesthesia.

This is important to know, as all soft tissue beyond the attached gingiva is “not” numb at all. One should pay attention to that during the dental procedure. This also implies that rubber dam clasps can be used without concern and that simple tooth extractions can easily be performed after one single intraosseous injection.

Because the local intraosseous anesthesia really works locally and the soft tissues are not collaterally anesthetized, bilateral treatments in the mandible can easily be performed. Slight anesthesia of the soft tissues may occur due to the porosities and leakage through the metal foramen and accessory canals in the cortical bone. However, when asking the patient if it would be possible to injure the lip or cheek, the answer will be negative. The soft tissues will not be as numb as under infiltration anesthesia or nerve block anesthesia circumstances. The latter necessitates additional infiltration injections in the surrounding soft tissues if needed so for the planned procedure (e.g. removal of a root fragment next to a tooth that one wishes to restore).

Six steps to perform intraosseous anesthesia

5

Step 1

Select IO mode on the QuickSleeper handpiece, using upper right pedal.

Topical anesthesia is not needed, as the technique allows the fluid in the needle to contact with the mucosa, which causes superficial topical anesthesia, just the same as would be achieved by applying a topical anesthetizing solution or gel of lidocaine or benzocaine.

Pick out the correct needle for the technique that will be performed. Transcortical, osteocentral and pediatric needles all have different gauge, length and a different colored plastic hub [**fig. 6**]. Never perform a transcortical injection with a pediatric or osteocentral needle!

Verify if the needle is filled with anesthetic solution (step-on the injection pedal and check for fluid dripping from the needle). A small drop of anesthetic is allowed to be dangling from the needle's bevel [**fig. 7**]. This drop will be serving as topical anesthetic.

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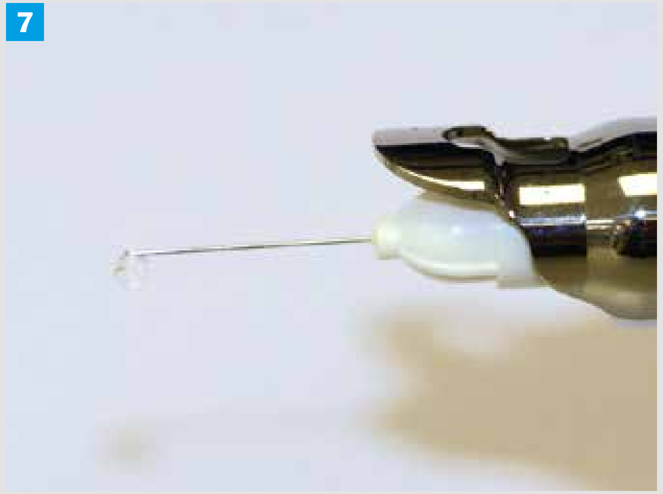

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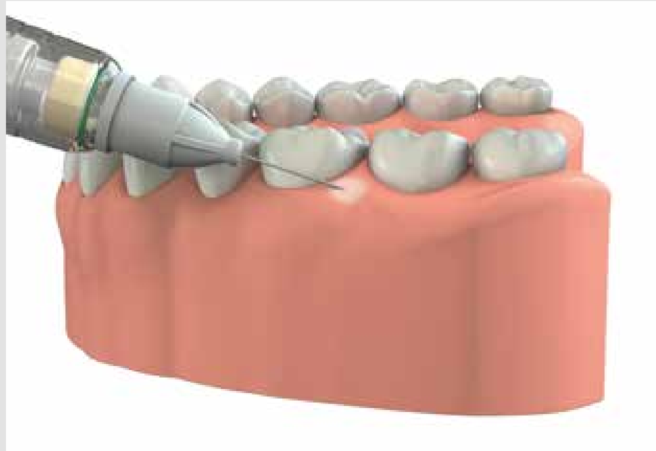


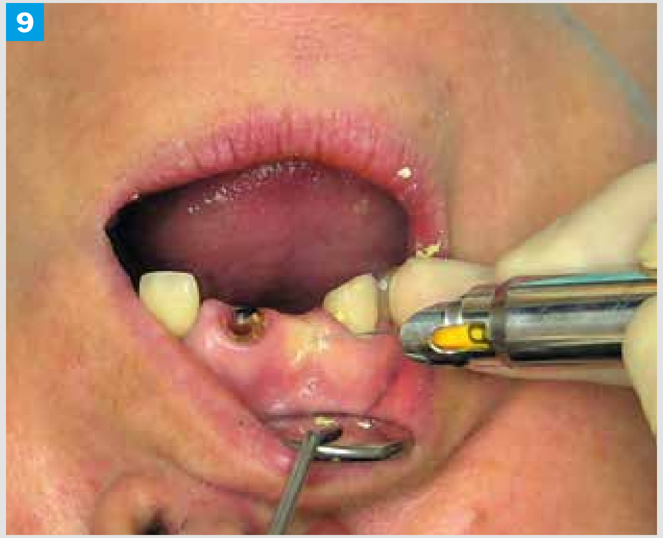
Step 2

Position the needle with the bevel against the soft tissues where you will perform the cortical penetration. If the bevel faces the mucosa, the needle makes a 15° angle with the mucosa [**fig. 4 - p13**]. The drop of anesthetic is now on top of the mucosa. As the needle is double beveled, it can cut through the mucosa instead of shred it, which is much less painful or sensitive for the patient. Having experienced a cut from a knife into skin, one knows that it takes a few seconds before one actually feels the physical injury. On the contrary being subjected to a scraping injury, is known to cause instant pain and bleeding. Going back to our double beveled needle, it can be easily understood that making sure the needle is filled with anesthetic solution and that the bevel is in contact with the mucosa, the insertion of the needle is painless because the anesthetic will be working instantaneously.

Hold the large inferior pedal for injection down and start injecting for about 5 to 10 seconds anesthetic solution into the soft tissue covering the site of cortical bone penetration. That amount is enough to cause slight blanching of the local mucosa, which is the sign that the periosteum is well anesthetized [**fig. 8**]. Release the pedal while keeping the needle in situ. This allows for the anesthetic to diffuse in the soft tissue better and for the fluid not to be spraying out of the mucosa when the needle is withdrawn. Withdraw the needle after 4 to 5 seconds. There will be very few fluid exiting the insertion orifice in the mucosa.

For the osteocentral technique the periosteum is anesthetized by inserting the needle at the base of the interdental papilla [**fig. 8**]. If the transcortical technique is performed, the attached mucosa perpendicular from the interproximal contact, 2 to 3 mm below the cervical edges of the teeth, needs to be anesthetized [**fig. 9**].

If one wishes to perforate the retromandibular pad or trigonum (Trigonum Retromolare), the soft tissues covering the trigonum need to be anesthetized. Because of the substantial larger thickness of the mucosa on this site, compared to a dental papilla, at least 1/8 of a cartridge is needed to obtain sufficient periosteal anesthesia [**fig. 10**].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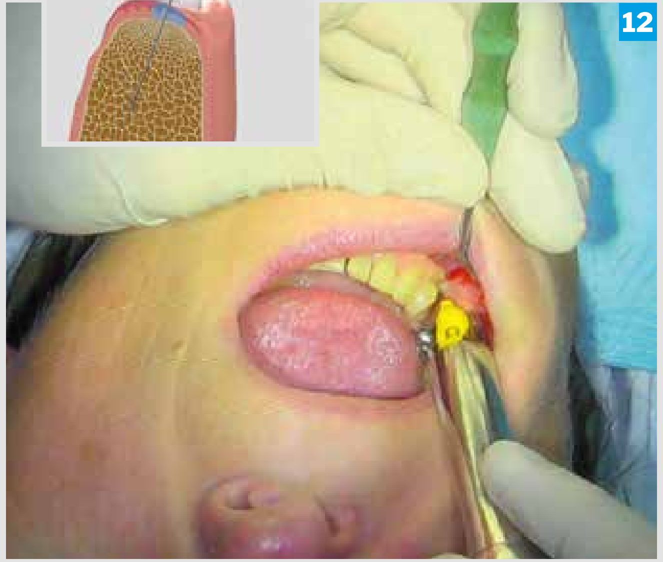
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Step 3

Proceed immediately to the next step in the process after changing your position and/or the position of the patient's head if needed. It is necessary that you have a perfect view of the needle because you have to assess the angle of insertion or penetration into the bone. For the osteocentral technique position the tip of the needle in contact with the interproximal bone, very close under the contact point in the embrasure. Make a 20 to 45° angle with the tooth's axis. This allows the needle to pass between the roots of adjacent teeth approximately up to the level of the apices. The orientation of the bevel of the needle is not important for this step. If the transcortical technique approach is performed, a 90° angle with the cortical bone has to be achieved at the correct site [**fig. 11 and fig. 12**]

Always make sure the needle is in contact with the bone before engaging the perforation of the cortical plate, because if there is no contact, the needle will cause an unnecessary circular cut in the soft tissue when it starts to rotate. The rotation of the "loose" needle will cause the tip to flare out slightly and as it is equipped with a double bevel, a cylinder like cut will be performed. This would be iatrogenic damage and is not the correct way to perform this procedure.

Step 4

Now tell the patient that the device will cause a slight vibration in the jaw or a little noise. A warned patient will not react unexpectedly to this "new" experience for him or her.

Hold down the central pedal for rotation. The device will ensure intermittent rotations with short breaks, while the needle is constantly purged to avoid bone from blocking the needle's orifice. Never apply any pressure during this action. Pressure will cause built up of bone inside the needle, which will disable needle lumen purging by the device's automatic purge.

By just holding and guiding the hand piece, the needle will gradually find its way through the cortical bone and into the cancellous bone. The weight of the hand piece is sufficient to ensure penetration into the bone. One will be able to feel each time a bone septum of the trabecular bone is passed. In low density bone, this motion will be almost unnoticed, while in dense bone one will feel it more explicitly. If in case of highly dense bone, the needle rotation appears to slow down, simply lift the handpiece a little and continue. The usual rotation speed will resume.

> For the osteocentral technique, under healthy periodontal conditions, the needle needs to be at least 75% inside the bone.

> For the transcortical approach, one has to make sure the needle is 2 to 3 mm through the cortical bone (this feels exactly like "falling" with the burr into the pulp chamber during an endodontic procedure). That is deep enough to start the injection (step 5).

If the needle is at the correct depth, take your foot off the central pedal and withdraw the needle one millimeter to allow a little space at the tip of the needle, making sure the orifice of the needle is not in direct contact with a bony septum [**fig. 13**]. This action also allows for bone being trapped near the orifice of the needle to be purged without the patient feeling too much pressure and discomfort.

13

14

Step 5

Prior to starting the injection you have to tell the patient that it is normal to experience a slight increase in heart rate and that it will pass automatically after 20 to 30 seconds. This is logical as one injects an anesthetic with a vasoconstrictor and a small volume will get into the bloodstream immediately at the start of the injection. The latter is prevented, once the local vasoconstriction is working.

Put your foot on the large lower pedal again to start the injection. The injection will start at one drop per second and will gradually increase depending upon the density of the bone where the injection is taking place. Never use Hi speed mode! This will cause a significant tachycardia and discomfort for the patient [**fig. 14**].

Keep your eye on the white LED-light on the hand piece. This will flash fast if the pressure from the bone is high or if the needle is blocked with bone. If the needle is blocked the device will detect such a high pressure and it will stop the injection. In that case the device will produce a monotone sound. You will have to withdraw the needle from the bone, replace the needle and proceed again at step 3.

Inject the volume you consider right for the planned procedure (see further in this manual). Take your foot off the injection pedal.

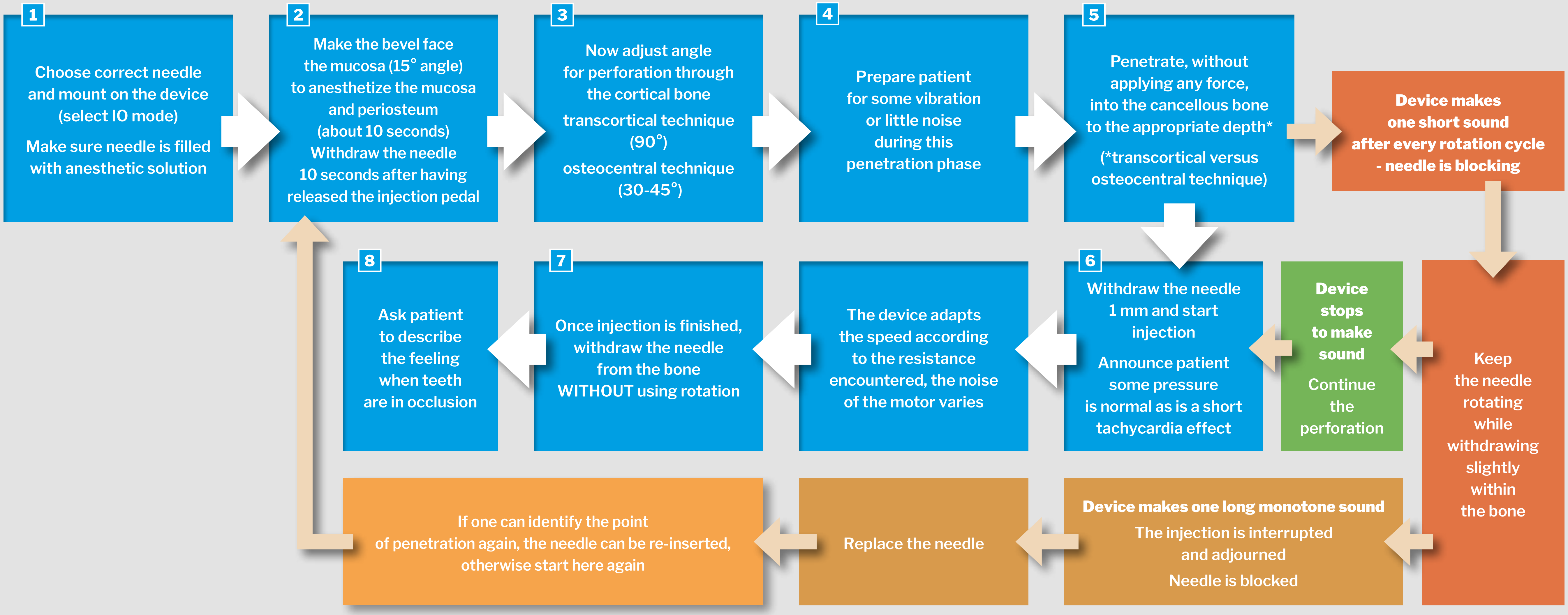
Step 6

You have finished the injection. The needle has the same exact diameter as the orifice into the bone, which means that the needle is well embraced by cortical bone. The latter implies that one will have to apply a little force to overcome the resistance when pulling the device back and hence the needle out of the bone. **Do not use any rotation** to withdraw the needle from the bone, because this will allow the needle to break if the angulation under which the penetration was performed has been altered. That is also the reason why the needle should at no time ever be entirely submerged into the bone.

If you have injected a whole cartridge, the device will automatically withdraw the plunger from the cartridge.

Six steps to perform intraosseous anesthesia

Scheme to perform intraosseous anesthesia with QuickSleeper 5®



6 Practical examples of intraosseous anesthesia in the maxilla

15

16

The examples below will not go into detail about how to inject. This has been covered in the above sections. It should be emphasized that the use of this device does not narrow down the options for administering local anesthesia. The device allows to perform infiltration and intraligamentary anesthesia if wished by the clinician. The main reasons to prefer intraosseous anesthesia is the fact that there is minimal collateral soft tissue anesthesia, that the anesthesia's onset is immediate and profound and that one can easily treat more than one quadrant in the same visit.

Maxillary molar and premolar

There are two ways to perform an IOA in this region. The buccal [**fig. 15**] and the palatal approach [**fig. 16**]. The patient's commissural flexibility and opening will dictate the choice of approach: buccal (osteocentral) or palatal (transcortical).

An osteocentral anesthesia requires a buccal approach and is only possible if the anatomy of the patient allows correct angulation and positioning of the needle. After having anesthetized the papilla (preferably distal of the tooth, which is not essential, unless in case of a pulpitis) and hence the periosteum, the needle should be placed under a 30 to 45° angle with the long axis of the tooth. In periodontal healthy conditions, insert the needle at least 75% to obtain adequate result.

Under periodontally compromised conditions, one has to assess the level of the apices to decide the insertion depth of the needle. The space between the buccal roots of the adjacent teeth needs to be large enough in order to be able to reach the correct site.

However, the distance between the palatal roots of adjacent molars and premolars is usually much larger and therefore the palatal approach, to perform a transcortical injection, is often easier.

For the palatal approach, the palatal mucosa should be anesthetized first. One should place the bevel of the needle against the palatal mucosa at a 15 degree angle, while applying gentle pressure with a blunt instrument very close to the tip of the needle. Gently slide the needle in the mucosa and inject anesthetic solution until local blanching (anemia) appears, which indicates that the periosteum is sufficiently anesthetized. Stop the injection and leave the needle in the mucosa for about 5 seconds, then withdraw the needle. The latter avoids the anesthetic solution to squirt out of the mucosa and cause a foul taste. Now place the tip of the needle at a 90° angle against the palate's cortical plate, at 2 to 3 mm more apically of the palatal margins of the teeth at an imaginary line dropped from the contact point. Start the perforation until the needle is 2 to 3 mm through the cortical plate. One can then start injecting at slow speed.

It is important that the patient's head is positioned correctly, so the hand piece can be positioned at a 90° angle to the palate without applying any pressure whatsoever. The device's weight should be sufficient to penetrate the bone.


17

Maxillary canine

Obtaining a good local anesthetic effect can be obtained either by injecting just distal of the canine or adjacent premolar or either at the midline, between the two central incisors [**fig. 17**]. All will be efficient if enough volume is injected. Injecting in the incisors' area results in local anesthesia from canine to canine and should be used if this is really necessary.

To anesthetize primarily the canine the first step is to anesthetize the distal papilla and local periosteum. Put the bevel against the buccal mucosa near the papilla and insert while injecting to perform the mucosal and periosteal anesthesia. Inject until blanching occurs of the mucosa. Leave the needle in for about the same time before withdrawing. Subsequently put the needle coming from the buccal in a 20 to 30° angle with the long axis of the tooth. Make sure to perforate deep enough into the cancellous bone (needle must be inserted at least 75%).

Maxillary incisor

One can either choose to inject distal of the tooth one wishes to treat or if more incisors need to be worked on, one can opt to inject in between the two central incisors. However, the position of the incisors may make this sometimes awkward because the apices are pointing to the midline. A position between the lateral and central incisor is preferred in those cases.

In case the intermaxillary (between the two central incisors – **fig. 18**) approach is preferred, one can choose either for the transcortical technique or for the osteocentral technique. The transcortical technique demands adequate periosteal anesthesia near the base of the frenulum. Inject for about 5 to 10 seconds to make sure the periosteum is well anesthetized. Then place the tip of the needle perpendicular to the cortical bone at a level 2 to 3 mm below the cervical borders of the two central incisors at a line dropped from the interproximal contact. Perforate the cortical plate and when the needle is 2 mm inside the cancellous bone, one can inject.

The interdental papilla between the central incisors needs to be well anesthetized if one prefers the osteocentral technique. After having anesthetized the periosteum, the needle is placed at a 30 to 45° angle with the long axis of the incisors on top of the papilla. Make sure the needle is inserted 75% of its length into the cancellous bone. One can start the injection now.

For both approaches, it is essential that the patient lies down in the chair, with the occlusal plane of the maxilla perpendicular to the floor. This allows the device to be used without pressure. For the osteocentral technique the patient can he asked to tilt the head a bit more backwards (tilt the chin up). The latter makes penetration of the bone easier without applying pressure.


18

Practical examples of intraosseous anesthesia in the mandible

7

Practical examples of intraosseous anesthesia in the mandible

Mandibular molar

There are two approaches possible for mandibular molars. The first one is the osteocentral approach [**fig 19**]. Anesthetize the gingiva and periosteum distal of the molar one wishes to treat by positioning the needle at a 15° angle against the mucosa. Then change position to make a 30 to 45° angle with the long axis of the tooth. Make sure the needle penetrates into the cancellous bone at least 75%. Inject the anesthetic solution. This technique is only possible if the patient's lips and cheeks allow the device to be positioned at a 30 to 45° angle with the long axis of the tooth.

Otherwise the retromolar pad (retromolar trigonum – **fig 20**) must be penetrated with a transcortical needle. The latter can be easily located by using a finger to trace the external oblique ridge, which starts buccal of the first molar. Move your finger now distally along the external oblique ridge. A trough or ditch or depression behind the most distal molar can be appreciated. That is the trigonum or retromolar pad. Here the cortical plate is the thinnest. Make sure the patient lies down with the occlusal plane of the maxilla perpendicular to the floor. Let the patient open the mouth wide so you have full access to the trigonum. Anesthetize the soft tissue over the trigonum with enough local anesthetic (about 1/8 of a cartridge) to ensure the periosteum is fully anesthetized. The bevel of the needle should obviously be facing the bone.

Now, position the needle perpendicular into the trigonum, in touch with the cortical plate. One will notice that to reach this position, one has to aim perpendicular to the floor, coming just buccal of the maxillary molars. Start the perforation of the cortical bone. Make sure that the needle is at least 2 mm into the cancellous bone. The injection can be engaged. The volume will determine the number of teeth that will be anesthetized. If one intends to work on more than one molar, always start working on the most distal tooth first.

Mandibular premolar and canine

These teeth can be anesthetized using the osteocentral technique as described for the molars. The injection site should be distal of the tooth or teeth one wishes to treat.

Mandibular incisor

As for the maxilla, mandibular incisors can either be approached by injecting immediately distal of the tooth one wishes to treat or distal of the adjacent distal tooth or one can choose to anesthetize at the midline in order to anesthetize more teeth. Since the anesthetic effect will spread left and right from the injection site, a central injection position on the mandible, may result in canine-to canine anesthesia, if one injected an entire cartridge.

Be aware of the fact that the long axes of the incisors may be pointing with their apices at each other and as such the space available to insert a needle safely may be limited. However, to obtain a thorough local anesthesia one can inject at any site inside the bone, even between a lateral and a canine to achieve local anesthesia for a central incisor.

Position the patient horizontal in the chair and anesthetize the papilla where one wishes to perforate the bone. Once the periosteum is anesthetized, position the needle at a 30° to 45° angle with the long axis of the tooth. Perforate the cortical bone and make sure the needle is at least 75% inside the cancellous bone. Due to anatomy the bone can be very thin from buccal to lingual and pear shaped. In that case a slightly steeper angle (30°) might be better. [**fig. 21**]

The transcortical technique in this location is also possible [**fig. 22**]. Perforate the bone at a level 2 to 3 mm below the cervical borders of the teeth on a line dropped from their contact points. Make sure not to perforate more than 2 mm into the cancellous bone and to use a transcortical needle only.

8 Failure to achieve anesthesia

Needle blockage

If one encounters a needle blockage, it is usually because pressure was applied to the needle during the perforation of the cortical and cancellous bone. In that case one has to change the needle.

Pain during perforation

If the patient reports pain when the needle is put in contact with the bone, it means that the periosteum is insufficiently anesthetized.

If the patient reports pain during perforation and penetration of the cancellous bone, one has not the correct angle. The needle may have been placed in the crevicular sulcus and the patient experiences pain from the periodontal ligament. The needle may have been placed under a wrong angle and is pointing at the lamina dura of the adjacent tooth. One will eventually perforate the buccal cortical plate, subsequently the cancellous bone and finally the lamina dura of the alveolar socket. When that happens, the needle will contact the non anesthetized periodontal ligament and the patient will abruptly report pain. No major or irreversible damage has been done, but the perforation needs to be performed again under a correct angle this time.

Patient cannot report anesthesia of the teeth

In that case, one has probably not injected any or very little fluid into the cancellous bone. Check the white LED light on the hand piece, which indicates the cartridge content. If the fluid has been injected, check the soft tissue anesthesia. It is possible, one penetrated the lingual cortical plate due to a wrong angulation. Ask the patient to describe the feeling when the teeth are in occlusion. If the teeth feel 'normal', the injection was not performed into the cancellous bone.

Anesthesia is quickly worn off

Either one has accidentally used a cartridge without vasoconstrictor, which causes the anesthetic to wear off quickly, due to its initial vasodilation effect, or one has injected a too low concentration of vasoconstrictor in a patient with a fast amide metabolism.

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