

Role of intraseptal anesthesia for pain-free dental treatment

ABSTRACT

Pain control during the dental procedure is essential and challenging. A complete efficacious pulp anesthesia has not been attained yet. The regional anesthesia such as inferior alveolar nerve block (IANB) only does not guarantee the effective anesthesia with patients suffering from irreversible pulpitis. This main aim of this review was to discuss various aspects of intraseptal dental anesthesia and its role significance in pain-free treatment in the dental office. In addition, reasons of failure and limitations of this technique have been highlighted. Literature search was conducted for peer-reviewed articles published in English language in last 30 years. Search words such as dental anesthesia, pain control, intraseptal, and nerve block were entered using a web of knowledge and Google scholar databases. Various dental local anesthesia techniques were reviewed. A combination of block anesthesia, buccal infiltration and intraligamentary injection resulted in deep anesthesia ($P = 0.003$), and higher success rate compared to IANB. For pain-free management of conditions such as irreversible pulpitis, buccal infiltration (4% articaine), and intraosseous injection (2% lidocaine) are better than intraligamentary and IANB injections. Similarly, nerve block is not always effective for pain-free root canal treatment hence, needing supplemental anesthesia. Intraseptal anesthesia is an efficient and effective technique that can be used in maxillary and mandibular adult dentition. This technique is also beneficial when used in conjunction to the regional block or local dental anesthesia.

Key words: Dental anesthesia; intraseptal injection; medullary diffusion

Introduction

In order to be a successful dentist, you have to implement a pain-free dental treatment. This can be merely achieved by effective local anesthetic techniques.^[1-4] Considering the complex nature of oral and dental tissues, attaining effective dental local anesthesia may be challenging in certain circumstances. For example, the failure of local anesthetic injections in irreversible pulpitis can be 8 times higher than health teeth. Such issues cannot be ignored as a good number of patients with endodontic complaints attend the dental clinics on a daily basis. Failure of the local anesthetic injections using inferior alveolar nerve block

(IANB) for lower dentition and buccal infiltration for upper teeth in asymptomatic and symptomatic patients requires additional back-up strategies to achieve pain-free dental treatment.^[5,6] Otherwise, the patient complains of severe pain and hindering the clinician to proceed to the dental treatment.^[7]

In the light of these facts and dilemma, supplemental injection techniques are the solution that can help the dentist to carry out the pain-free dental treatment. On the basis of anatomical site of injection, commonly used supplemental local anesthetic techniques are termed as intraligamentary

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(periodontal ligament), interosseous (alveolar bone), intrapulpal (pulp), and intraseptal (bony septum) injections.^[8] Intraligamentary injections are used for cavity preparation and caused no complications regarding the hemorrhage and hematoma formation in hemophiliac patients.^[8,9] However, intraligamentary anesthesia is not recommended for treating deciduous teeth because it may damage un-erupted teeth.^[10] The pressure used during intraligamentary injections causes the anesthetic solution to spread into underlying tooth germs.^[11] A defective enamel formation has been reported in monkeys following intraligamentary injections.^[12] However, in humans, there are no studies reporting cases of defective enamel formation.^[10] Intrapulpal anesthesia technique has limited applications as it can only be used if the pulp is exposed. Intrapulpal anesthesia used for pulpotomy did not interfere with the healing process of pulpotomized teeth.^[13] The method of intraosseous anesthesia is technically more difficult than infiltration, and intraseptal anesthesia (ISA), and specialized equipment may be required. Intraosseous technique can lead to rapid absorption of local anesthetic and vasoconstrictor in the circulation. Hence, cardiovascular changes are attributable to adrenaline entry into the circulation that may occur immediately after intraosseous injection.^[14]

Intraseptal injection has been reported to be more effective for controlling postoperative pain compared to intraosseous and intraligamentary injections.^[15] The efficacy of ISA is similar to intraosseous injection, and they are both more successful than the intraligamentary injection because a greater amount of anesthetic solution can be delivered during the injection.^[16] Supplementary techniques might have a negative effect on the cardiovascular system, for example, increased heart rate for a couple of minutes after intraosseous injection.^[17] Brkovic *et al.*^[15] indicated that the use of both intraseptal and periodontal ligament techniques is beneficial and appropriate for the routine tooth/teeth removal. Intraseptal technique provides local anesthesia of one tooth including the soft-tissues. Intraseptal technique anesthetizes surrounding nerve endings in the tissues of a particular tooth.^[18] There are a few contraindications such as acute inflammation or infection at injection site. However, ISA remains a convenient local anesthesia practice for a general dental surgeon.^[19]

The protocol used for the administration of ISA has been described briefly. Patient ought to be placed in the supine position. Considering the thickness of soft-tissues, a short injection needle is usually proffered. The target region is located 2-3 mm apical to the apex of the papillary triangle [Figure 1a and b].



Figure 1: Intraseptal injection technique; (a) marking for the administration of anesthesia (b) positioning of the needle 3 mm apical to the apex of the papillary triangle (c) ischemia of the soft-tissue surrounding the injection site

The needle is introduced into the soft-tissue and advanced until contact with bone is made. Pressure must be applied to the syringe and drive the barb slightly deeper (1-2 mm) into the interdental septum. Afterward, anesthetic solution (0.2-0.4 ml) is deposited in a minimum of 20 s time. Prevailing resistance to the flow/movement of the anesthetic solution and ischemic discoloration of the neighboring soft-tissues are main signs of success of this technique.^[20,21] This is illustrated in Figure 1c. This main aim of this review was to discuss various aspects of intraseptal dental anesthesia and its role significance in pain-free treatment in the dental office. In addition, reasons of failure and limitations of this technique have been highlighted.

Failure of Conventional Local Anesthetic Techniques

The pain is considered an important defense mechanism of the body,^[22] however, pain control can be challenging in certain clinical conditions. For example, failure of local anesthetic injections is deemed the most severe task especially for mandibular teeth with reversible pulpitis. Attainment of IANB is indicated by numbness of soft-tissue and lip.^[5,23,24] However, failure blocks associated to the lack of lip numbness happens in approximately 5% of cases and requiring another injection before commencing the treatment.^[25] In light of this fact, few options regarding injection techniques or anesthetic solutions are available in order to achieve anesthetic success. Anesthetic success for mandibular anesthesia is determined by the percentage of subjects who achieve 2 consecutive electrical pulp tester readings of 80 or 64 within 15 min and continue these readings for 60 min/1 h.^[26-28] Clinically, anesthetic success is considered if a dentist can work on the patient no later than 15 min after giving the IANB and having pulpal anesthesia for 1 h.^[29,30] Success rates of maxillary infiltration anesthetic

injection techniques are about 95% or higher. However, the success rates for IANBs generally are 80-85%.^[31,32] Lower success rates in the mandible could be as the results of the greater density of the buccal alveolar plate (which prevents supraperiosteal infiltration), limited access to the inferior alveolar nerve and a wide variation in neuroanatomy.^[33]

There were no positive effects for increasing both the volume of the local anesthetic and the concentration of epinephrine delivered during the administration of IANB on the incidence of pulpal anesthesia.^[23,29,34,35] Occasionally, patients with asymptomatic teeth may have difficulties in achieving successful anesthesia for mandibular anterior teeth. One possible theory that is considered the best explanation stated that the nerve trunk of the inferior alveolar nerve is consisted of superficial and deep fibers. The outer nerves supply the molar teeth, while the anterior teeth nerves lie deeper. If the anesthetic solutions cannot diffuse the nerve stalk to approach all the nerves, they will not be able to provide an adequate block in the mandibular anterior teeth.^[25,36] Patients diagnosed with irreversible pulpitis may encounter extra difficulties to obtain pulpal anesthesia. The anesthetic failure can be due to pulpitis that results in hyperalgesia in enclosed pulp tissues.^[37] Inflamed tissues may alter the nerves' resting membrane potentials and decrease excitability thresholds. Therefore, routine local anesthetic techniques may not prevent nerve transmission adequately because of the lowered excitability thresholds.

Mechanism of Action for Intraseptal Injection

The route of diffusion and distribution of the anesthetic solution in the intraseptal technique is most likely through the medullary bone [Figure 1b]. It offers anesthesia to the bone, delicate/soft-tissues, and root structure in the region of infusion. It is best when both pain control and hemostasis are wanted for delicate/soft-tissue and bony periodontal treatment.^[10,28,34,38]

Advantages of intraseptal injection

In contrast to IANB and local infiltration, the intraseptal technique prevents the anesthesia of tissues such as lips and tongue hence, decreases the chances of cheek or lip biting (self-trauma). It necessitates minimum or least dosage of local anesthetic and minimizes bleeding during the surgical procedure. This technique being less traumatic has immediate or instantaneous (<30 s) onset of action and comparatively less number of postsurgical complications.^[10,16,39] Intravascular injection is extremely unlikely to occur^[31] compared to IANB or infiltration. Assertions that ISA is immediate are properly consistent with previous clinical results. Their findings

reported that the onset of action for anesthesia was within 1 min after injection. Hence, the onset time can be considered rapid if not immediate.^[40-43]

Disadvantages of intraseptal injection

Clinical experience and multiple tissue punctures may be necessary to perform this technique. During the anesthetic procedure, the anesthetic solution may leak into the oral cavity resulting discomfort and an unpleasant or bitter taste. The effective period anesthesia for pulpal and soft-tissues is very limited^[10,16,44] hence multiple repeats may be required for longer surgical procedures.

Results and Discussion

Different supplementary local anesthetic techniques for patients have been compared [Table 1]. Parirokh *et al.*^[45] evaluated the depth of anesthesia for lower molars for irreversible pulpitis using IANB injection supplemented with or without intraligamentary injection and buccal infiltration. Patients who received IANB, buccal infiltration, and intraligamentary injection in a combination had more deep anesthesia ($P = 0.003$) and higher success rate than those who received only IANB.^[45] The effectiveness of additional lingual infiltration on the depth of anesthesia for mandibular teeth has been reviewed recently.^[49] Previous clinical studies were searched, and the information regarding the advantages of using supplemental lingual infiltration on the pulpal anesthesia of lower teeth was extracted by two investigators using a designed extraction form. This systematic review reported that there were no advantages in adding lingual injection to buccal infiltration for mandibular canines, premolars, and molars in terms of onset and period of pulpal anesthesia. However, the depth of pulpal anesthesia for the mandibular incisors improved by giving an additional lingual infiltration following buccal infiltration.^[49] According to Kanaa *et al.*^[28] and Shabazfar *et al.*,^[50] IANB is not always enough for achieving free pain root canal treatment for irreversible pulpitis in the lower molars teeth. In order to achieve pain-free management irreversible pulpitis, buccal infiltration (4% articaine), and intraosseous injection (2% lidocaine) are better than intraligamentary and IANB injections.^[28] On the other hand, intraosseous injections have been reported to raise the heart rate transitory (Stabident and X-Tip systems). The escalation in heart rate increased from 12 to 32 beats/min using local anesthesia (2% lidocaine; 1:100,000 epinephrine).^[42,51-54] However, the use of 3% mepivacaine did not cause any significant rise in the heart rate^[53,55] and can be considered the choice of anesthetic for medically compromised patients. Cardiovascular changes associated with supplementary dental injections have been discussed [Table 2].

Table 1: Supplemental anesthesia techniques and combinations

Researcher	Anesthesia techniques	Outcome	Reference
Parirokh <i>et al.</i> Randomized double-blind controlled trial	2% lidocaine IL + BI + IANB or only conventional IANB injection	In the combination group, the success rate of anesthesia was remarkably greater than the traditional IANB	[45]
Dou <i>et al.</i> Prospective study	Standard IANB injection with 2% lidocaine + 4% articaine BI or BLI	Statistically no difference was observed between the two groups. The success rates for the (BI) and (BLI) remain 70% and 62.5%, individually	[46]
Kanaa <i>et al.</i> Randomized clinical trial	Group 1: repeat IANB with 2% lidocaine Group 2: IANB + 4% articaine BI Group 3: IANB + IL injection with 2% lidocaine Group 4: IANB + IO injection with 2% lidocaine	Supplementary 4% articaine (BI) with and (IO) injection allowed more successful than repeat IANB or PDL supplementary techniques; this was statistically significant ($P=0.001$)	[28]
Biocanin <i>et al.</i> Randomized single-blind controlled trial	Group 1: 4% articaine ISA and Group 2: 4% articaine PLA Computer-controlled local anesthetic delivery system was used	Groups 1, the success rate, duration of both pulpal and soft-tissue anesthesia, were significantly better compared to Group 2	[47]
Doman Prospective study	4% articaine ISA	80 (71%) patients reported pain-free treatment and 18 (16%) experienced very minor pain during treatment. provides a level of anesthesia equivalent to IANB	[48]

BLI: Buccal lingual infiltration; BI: Buccal infiltration; IANB: Inferior alveolar nerve block; IO: Intraosseous; ISA: Intraseptal anesthesia; PLA: Periodontal ligament anesthesia; IL: Intraligamentary

Table 2: Complications associated to supplemental anesthesia techniques

Researcher	Supplemental dental anesthetic technique and vital signs observation	Complications associated with supplemental dental anesthesia	Reference
Biocanin <i>et al.</i> Randomized single-blinded study	Group 1: 4% articaine ISA and Group 2: 4% articaine PLA. Blood pressure and heart rate were reported	There were no major cardiovascular variations seen in any of the groups	[47]
Zarei <i>et al.</i> Single-blind randomized clinical trial	Group 1: IANB + 2% lidocaine IL Group 2: IANB + IO injection with 2% lidocaine	There was transient increase in heart rate following the IO injection ($P=0.001$)	[44]
Brkovic <i>et al.</i> Prospective randomized clinical trial	Group 1: ISA Group 2: periodontal anesthesia for extraction of maxillary teeth/patients' hemodynamic response was recorded after injections	Clinically, heart rate rises in both groups, but statistically it was not significant	[15]
Borodina and Petrkas Prospective clinical trial	4% articaine ISA For treatment upper and lower teeth with carries/arterial pressure and heart rate were investigated	There was strong reaction of cardiovascular system occurred with intraseptal injections	[56]
Gallatin <i>et al.</i> Randomized single-blinded crossover study	Group 1: IANB (3% mepivacaine) + IO injection (3% mepivacaine) Group 2: IANB (3% mepivacaine) + mock IO injection. Monitoring of heart rate using a pulse oximeter	Participants in IO injection of mepivacaine had insignificant rise in heart rate	[55]

IANB: Inferior alveolar nerve block; ISA: Intraseptal anesthesia; PLA: Periodontal ligament anesthesia; IL: Intraligamentary; IO: Intraosseous

A single-blinded study^[47] was conducted to assess the effectiveness and safety of intraseptal and periodontal ligament anesthesia (PLA) using computer-regulated articaine and adrenaline dispersals in human mandibular premolars. One hundred and eighty volunteers were included in this study. Success rate, depth of anesthesia, and time of pulpal and soft-tissue anesthesia were considerably improved in case of ISA compared to the PLA. Moreover, there were no noteworthy cardiovascular variations seen in any groups.

Zarei *et al.*^[44] reported a temporary rise in heart rate while using intraosseous injections (X-Tip) for lower molar irreversible pulpitis patients. A total of 40 patients with failure of IANB were recruited in and randomly allocated to two groups. First group received an intraosseous injection (X-Tip

system) and the second group received periodontal injections. Visual analog scale was used to assess the discomfort of needle prick at each step of injection, and a pulse oximeter was attached to monitor the heart rate. The findings of this study stated that the anesthetic success was 100% in the intraosseous group and 70% in intraligamentary.^[44] In a similar study,^[57] the uneasiness of injection or infusion, heart rate changes, and postoperative pain of the intraligamentary injection (4% articaine and 2% lidocaine with epinephrine, 1:100,000) administered using a computer-controlled local anesthetic delivery system were evaluated. In terms of anesthetic solutions, there were no remarkable variations for both articaine and lidocaine solutions. Both solutions did not affect to increase in heart rate over baseline evaluations.^[57]

Gallatin *et al.*^[55] compared the relationship of anesthetic effectiveness and heart rate for subjects receiving an intraosseous injection (3% mepivacaine), supplemented to IANB augmented with the mock intraosseous injection. For 3% mepivacaine intraosseous injection group, there was a significant increase in anesthetic success for half an hour in the 1st molar and participants described a minimal rise in heart rate. Borodina and Petrkas^[56] administered dental local anesthetic using intraseptal injection technique in dental carries patients. Complete pain relief was observed in 135 (out of 154) patients. Intraseptal injection did not affect in seven cases only. The success rate of intraseptal injections was similar for upper and lower teeth. Brkovic *et al.*^[15] conducted a study to compare the effectiveness of intraseptal technique with PLA for extraction of maxillary teeth. Postoperative pain was reduced in ISA group than in the PLA group, but variations were insignificant. Clinically, the heart rate increased in either groups; however, insignificant alterations in the hemodynamic response for ISA and PLA. Both systems considered valuable and have been recommended for the usual dental extractions.^[15]

Likewise, Idris *et al.*^[16] used intraosseous infusion/injection as a subordinate to conventional local anesthetic techniques for treatment of lower molars with irreversible pulpitis. Their findings uncovered that the intraosseous injection method was effective in 87.5% of patients. However, Doman^[48] carried out a study to evaluate the effectiveness of 4% articaine intraseptal local anesthetic injection for cavity preparation in mandibular molar and premolar (113 patients). Pain-free dental treatment was completed in 71% patients whereas 16% experienced a very minor pain during treatment. In addition, no side-effects were reported.^[16] The first author has been using the intraseptal injection technique as standard injection techniques for last two decades for treating upper and lower teeth regardless of the type of dental procedure. Clinically, he found this technique was 100% successful for dental extractions of upper and lower teeth with no complications. It is the author's belief that is consistence with previous studies showing the superiority and safety of this technique.^[15,47,55,56,58]

Conclusion

Dental techniques demanding significant pulpal, bone, and soft-tissue anesthesia can be adequately and securely acquired using ISA. It can be a first choice anesthesia for teeth extractions and restorative dental procedures. Intraseptal injection is likewise helpful for giving hemostasis for surgical flap procedures and periodontal curettage.

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Conflicts of interest

There are no conflicts of interest.

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