

Intraosseous Anesthesia of the Mandibular Molars: A Critical Literature Review

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Abstract

Objective of this critical literature review was to analyze, systematize and summarize the literature reference on the anesthetic effectiveness, heart rate changes and the pain during and after application of Stabident, X-tip and Quicksleeper systems of intraosseous anesthesia of the mandibular molars.

This bibliographic search was carried out in PubMed and Scopus databases, using the following search keywords "Stabident System", "X-tip System", Quicksleeper System", "success rate of intraosseous anesthesia", "increase of heart rate after intraosseous anesthesia", "pain during and after intraosseous anesthesia".

Original research publications were included. Data were grouped and rearranged in tables in Microsoft Word 7 for Windows and descriptively presented.

Review (J Int Dent Med Res 2021; 14(4): 1604-1610)

Keywords: Intraosseous anesthesia, Intraosseous anesthesia systems, Intraosseous anesthesia effectiveness.

Received date: 08 July 2021

Accept date: 23 August 2021

Introduction

Achieving adequate pulp anesthesia of the mandibular molars is often a challenge for the dentist. Local infiltration anesthesia is ineffective in the area of the masticatory teeth due to the high density and the lack of holes in the compact bone of the mandible. The most commonly used method for mandibular anesthesia in adult patients is inferior alveolar nerve block (IANB). In studies of many authors, it is reported that the failure of IANB of mandibular molars with intact pulp is about 5 - 15%, and in irreversible pulpitis - about 44 - 81%.¹⁻³ The ectopic location of the mandibular foramen, the bifid inferior alveolar nerve, the presence of a retromolar foramen, the accessory nerve supply of the dental pulp, inflammation and hyperalgesia, improper technique, fear and anxiety of the patient are the causes of the IANB failure.^{2, 4-9} There is a need to use additional analgesic techniques. Periodontal ligament anesthesia, intrapulp anesthesia and

intraosseous anesthesia (IA) are described in the literature as the most commonly used supplemental techniques after failure of IANB.¹⁰

The original technique of IA involves dissection of the mucoperiosteal flap and subsequent perforation of the cortical bone using a small round burr. It did not become popular due to its invasive approach and the difficulty in inserting and tightening the needle into the perforation.

Lilienthal (1975) describes a technique in which a machine endodontic reamer is used to perforate the cortical bone. This is the first contemporary technique for IA, on which all current intraosseous systems and are based.^{11,12}

There are two intraosseous systems that have been mostly studied clinically – the Stabident system (Fairfax Dental Inc., Miami, FL) and the X-tip system (Dentsply, York, PA). Recently, one other anesthetic system has been introduced - a new device that combines computerized needle rotation for osseous perforation and an anaesthetic delivery system – QuickSleeper (Dental Hi Tec, Cholet Cedex, France).

- 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

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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.¹³

- The computerized system Quicksleeper deposits the anesthetic solution in the cancellous bone of the tooth to be treated, after perforating the cortical layer in a single step and without having to change needle, thanks to the use of instrumentation specifically designed for this purpose. This system consists of an electronic control unit which determines the injection and rotation parameters), a dual pedal (for starting injection or rotation), and a manual device housing the motors for injection and rotation.¹⁴

Objective: This critical review aims at analysis and systematization of literature reference on the anesthetic effectiveness, heart rate changes and the pain during and after application of Stabident, X-tip and Quicksleeper systems of IA of the mandibular molars.

Materials and methods

This bibliographic search was carried out in PubMed and Scopus databases, using the following search keywords "Stabident System", "X-tip System", Quicksleeper System", "success rate of IA", "increase of heart rate after IA", "pain during and after IA".

Twenty-six original research publications were included. Data were grouped and rearranged in tables in Microsoft Word 7 for Windows and descriptively presented.

Results

A summary of the literature reference on the anesthetic efficacy, heart rate changes, pain during and after IA of mandibular molars are presented in tables (Tables 1, 2, 3). In the reviewed literature, there is a summary of the effectiveness of IA presented by Pereira L et al.

(2013)¹⁵ for the period 1975-2008. In our results we present authors who were not the subject of his research for the specified period, as well as published results after 2008.

The cited authors record the effectiveness of IA through a pulp test or the presence / absence of pain during treatment. A pulse oximeter is used to register the change in heart rate. A Visual Analogue Scale is used to record the pain during and after anesthesia.

Discussion

Intraosseous anesthesia has been described in the literature as an additional method of analgesia.^{16, 17, 19-21, 23, 24, 28, 29, 31, 33, 34, 36} Numerous studies have been performed IA as primary method of analgesia.^{12, 15, 22, 25-27, 35, 40-44}

In addition to the immediate anesthetic effect, another advantage of IA compared to IANB is the use of a smaller amount of anesthetic solution (usually about 1 mL is sufficient). When used as primary anesthesia, the range of anesthetized soft tissues is smaller than with local infiltration and IANB, thus reducing the risk of self-injury trauma.^{10, 27, 42}

Many researchers believe that local anesthetic containing a vasoconstrictor injected intraosseously are rapidly absorbed into the systemic circulation and can cause changes in heart rate. The mean increase in heart rate was 28 bpm.^{31, 35, 39, 45, 46} The main stimulator of this reaction is the adrenaline in the anesthetic solution. The reaction takes place under the tip of the needle. The increase in heart rate is transient. It returns to its original state within 3 to 4 min in most patients. The half-life of adrenaline is 4 min.

The significant increase in heart rate is accompanied by a subjective feeling of palpitations and fear. Sometimes it causes the patient panic, anxiety and fear of cardiac death. This specific symptom of IA distinguishes it from classical anesthesia techniques. Such a condition is perceived as a complication and/or a precursor to more serious complications. The severity of the reaction also depends on the rate at which the anesthetic is injected into the bone. Faster infiltration causes a greater increase in heart rate.^{30, 47, 48}

According to Russian researchers, the increase in heart rate in the first minute after the injection is due to the direct entry of adrenaline into the venous blood flow. Under the action of

adrenaline, alpha-adrenoceptors are activated at the injection site, thus creating a venous-capillary depot of anesthetic in the bone tissue, which leads to blockage of the pulpo-periodontal complex.^{47, 49}

In order to avoid complications from the cardiovascular system, most companies recommend the use of an anesthetic without a vasoconstrictor.

Another complication of IA is pain both during and after the procedure.^{46, 50} In a study by Reisman et al. (1997) noted that 27% of patients reported moderate pain and 6% severe pain during anesthesia. In 2% to 15% of cases, postoperative pain on the injection side is reported, which passes in a short time, and in 4%

to 5% - swelling, bruising or suppuration within 2 weeks.^{27, 28, 51-53}

Conclusion

The established anesthetic effectiveness of IA by clinicians and patients, as well as the improvement of intraosseous systems, has led to its use as primary method of anesthesia. The observed changes in heart rate and pain during and after anesthesia are transient and do not affect the increasing use of IA.

Declaration of Interest

The authors report no conflict of interest.

Author	n	Type of IO	Local anesthetic, mL	Success rate
Reisman et al. ¹⁶ , 1997	48	Supplemental Stabident	1,8 mL 3% Mepivacaine	80%- first intraosseous injection 98%- second intraosseous injection
Parente et al. ¹⁷ , 1998	34	supplemental Stabident	0,45 – 0,9 mL 2% Lidocaine 1:100 000 Epinephrine	91%
Reitz et al. ¹⁸ , 1998	38	Supplemental Stabident	0,9 mL 2% Lidocaine 1:100 000 Epinephrine	95% -first molar 87% - second molar
Nusstein et al. ¹⁹ , 2003	33	supplemental X-Tip	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	82%
Zarei et al. ²⁰ , 2012	20	supplemental X-Tip	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	100%
Pereira et al. ¹⁵ , 2013	60	primary X-Tip	0,9 mL 4% Articaine 1:100 000 Epinephrine 0,9 mL 4% Articaine 1:200 000 Epinephrine	96,8% 93,1%
Verma et al. ²¹ , 2013	30	supplemental X-Tip	1,8 mL 2% Lidocaine 1:180 000 Epinephrine	93%
Razavian et al. ²² , 2013	20	primary X-Tip	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	85%
Bhuyan et al. ²³ , 2014	30	supplemental X-Tip	1,7 mL 4% Articaine 1:100 000 Epinephrine	83,33%
Idris et al. ²⁴ , 2014	24	supplemental X-Tip	0,9 mL 4% Articaine 1:100 000 Epinephrine	87,5%
Farhad et al. ²⁵ , 2018	30	primary X-Tip	1,8 mL 3% Mepivacaine	56,7%
Simeonova et al. ²⁶ , 2020	30	primary Quicksleeper	0,9 mL 4% Articaine 1:100 000 Adrenaline	83%

Table 1. References on the intraosseous anesthesia effectiveness of the mandibular molars.

Author	N	Anesthetic/ vasoconstrictor	% patients	increase in heart rate
Coggins et al. ²⁷ , 1996	40	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	75%	No data
Dunbar et al. ²⁸ , 1996	20	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	80%	No data
Nusstein et al. ²⁹ , 1998	21	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	46%	No data
Reitz et al. ¹⁸ , 1998	38	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	68%	No data
Replogle et al. ³⁰ , 1999	42 42	1,8 mL 2% Lidocaine 1:100 000 Epinephrine 1,8 mL 3% Mepivacaine	67% 31%	28 bpm 4 bpm
Guglielmo et al. ³¹ , 1999	40 40	1,8 mL 2% Mepivacaine 1:20 000 Levonordefrine 1,8 mL 2% Lidocaine 1:100 000 Epinephrine	73% 78%	23 – 24 bpm 23 – 24 bpm
Chamberlain et al. ³² , 2000	20	1,5 mL 2% Lidocaine 1:100 000 Epinephrine	-----	12 bpm
Stabile et al. ³³ , 2000	48	1,8 mL 1,5% Etidocaine 1:200 000 Epinephrine	90%	32 bpm
Gallatin et al. ³⁴ , 2000	48	1,8 mL 3% Mepivacaine	-----	Minimal increase
Gallatin et al. ³⁵ , 2003	41	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	85%	No data
Bigby et al. ³⁶ , 2006	37	1,8 mL 4% Articaine 1:100 000 Epinephrine	83%	32 bpm
Yakupova ³⁷ , 2006	76	0,4 mL 4% Articaine 1:100 000 Epinephrine 0,4 mL 4% Articaine 1:200 000 Epinephrine	83% 83%	13,4 bpm 9,6 bpm
Susi et al. ³⁸ , 2008	61 61	1,4 mL 2% Lidocaine 1:100 000 Epinephrine Infiltration for 45 s 1,4 mL 2% Lidocaine 1:100 000 Epinephrine Infiltration for 4,75 min	96% 73%	21-28 bpm 10-12 bpm
Peñarrocha-Oltra et al. ³⁹ , 2012	49	1,8 mL 3% Mepivacaine	----	1,6 bpm
Zarei et al. ²⁰ , 2012	20	1,8 mL 2% Lidocaine 1:100 000 Epinephrine	-----	9-10 bpm
Pereira et al. ¹⁵ , 2013	60 60	0,9 mL 4% Articaine 1:100 000 Epinephrine 0,9 mL 4% Articaine 1:200 000 Epinephrine	No statistical difference between the two concentrations	No statistical difference between the two concentrations

Table 2. References on the changes in heart rate after intraosseous infiltration of a local anesthetic.

Author	N	Perforation / infiltration pain	Postoperative pain
Coggins et al. ²⁷, 1996 (Stabident)	40	Perforation- no pain to mild pain	3% – slow perforation healing
Dunbar et al. ²⁸, 1996 (Stabident)	20	Perforation: 92% – no pain 8% – mild pain	After 24 h: 78% – no pain 20% – mild pain 2% – moderate pain After 3 days: 98% – no pain 2% – mild pain
Nusstein et al. ²⁹, 1998 (Stabident)	21	Perforation: 81% – no pain 19% – mild pain Infiltration: 76% – no pain 19% – mild pain 5% – severe pain	No data
Reitz et al. ¹⁸, 1998 (X-Tip)	38	Perforation: 71% – no pain 18% – mild pain 11% – moderate pain	After 24 h: 71% – no pain 24% – mild pain 5% – moderate pain After 3 days: 92% – no pain 8% – mild pain
Guglielmo et al. ³¹, 1999 (Stabident)	40	Mepivacaine Perforation: 75% – no pain 20% – mild pain 5% – moderate pain Infiltration: 73% – no pain 20% – mild pain 5% – moderate pain 3% – severe pain Lidocaine Perforation: 70% – no pain 25% – mild pain 5% – moderate pain Infiltration: 67% – no pain 25% – mild pain 7% – moderate pain	After 24 h: 57% – no pain 30% – mild pain 10% – moderate pain After 3 days: 97% – no pain 3% – mild pain After 24 h: 37% – no pain 53% – mild pain 10% – moderate pain After 3 days: 80% – no pain 17% – mild pain 3% – moderate pain
Gallatin et al. ³⁵, 2003	41 41	Stabident Perforation: 20% – no pain 54% – mild pain 24% – moderate pain 2% – severe pain X-Tip Perforation: 15% – no pain 60% – mild pain 25% – moderate pain	No data No data
Bigby et al. ³⁶, 2006 (Stabident)	37	Perforation: 32% – no pain 51% – mild pain 11% – moderate pain 5% – severe pain Infiltration: 16% – no pain 62% – mild pain 14% – moderate pain 8% – severe pain	No data
Beneito-Brotos et al. ¹⁴, 2012 (Quicksleeper)	30	Perforation: 53,5% – no pain 32% – slight pain 10,7% – moderate pain 3,6% – severe pain	No data
Verma et al. ²¹, 2013 (X-Tip)	30	Perforation: 96,6% – no pain to slight pain 3,34% – moderate to severe pain Infiltration: 74,99% – no pain to slight pain 24,92% – moderate to severe pain	No data

Table 3. References on pain during and after intraosseous anesthesia.

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