Efficacy of intraosseous injections of anesthetic in children and adolescents

Jean-Louis Sixou, DDS, PhD,[a] and Maria Elizena Barbosa-Rogier, DDS,[b] Rennes, France
DEPARTMENT OF PEDIATRIC DENTISTRY, UNITÉ D'ENSEIGNEMENT ET DE RECHERCHE D'ODONTOLOGIE DE L'UNIVERSITÉ DE RENNES 1 AND CENTRE HOSPITALIER UNIVERSITAIRE DE RENNES

Objective. The goal of this study was to determine the efficacy of the intraosseous (IO) injections of anesthetic as a primary technique in children and adolescents.
Study design. A cohort of 181 children and adolescents underwent a total of 225 sessions of IO injections of 4% articaine with 1:200,000 epinephrine using the Quick Sleeper 2 system.
Results. Evaluations could be performed in 215 sessions (171 patients, 247 teeth), yielding success rates of 91.2% (sessions) and 91.9% (teeth). The success rate was 95% (133 of 140) for temporary teeth (endodontics 96.6%, restorations 100%, extractions 88%) and 87.9% (94 of 107) for permanent teeth (endodontics 92.3%, restorations 89.9%, extractions 75%). No difference was noted in terms of age ($P > .05$). No cases of biting of mucosa or postinjection pain were noted.
Conclusions. The IO injection of anesthetic using a computer-controlled osseous perforation and delivery system can be considered as a good alternative or supplement to classic infiltration techniques in children and adolescents. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;xx:xxx)**

Although pain management during dental treatments in children and adolescents has progressed over the past several decades, performing local anesthesia can still be a problem for practitioners, mainly because of the fear of syringes and the risk of self-biting of numbed soft tissues. Intraosseous (IO) injections make it possible to place local anesthetic solutions directly into the cancellous bone adjacent to the tooth to be anesthetized. Because the anesthesia is restricted to the tooth, the surrounding soft tissue should remain unaffected. Most recent articles have reported results obtained with 3 proven commercial delivery systems: Stabident (Fairfax Dental, Miami, FL),[1-11] X-Tip (X-Tip Technologies, Lakewood, NJ),[3,12] and Quick Sleeper 2 (DHT, Cholet, France).[13] The effect of 2% lidocaine with 1:100,000 epinephrine in adults has been evaluated, with the exception of 2 studies in which 3% mepivacaine[11] and 4% articaine with 1:100,000 epinephrine[13] were used. Success rates ranging from 41% to 96% were reported, depending on the teeth, pathologies, treatments, and evaluations. These studies showed that IO injection is an efficient primary or a supplemental technique for local anesthesia in adults that combines efficacy and a lower risk of soft tissue injuries by self-biting. Intraosseous injections may thus also be a good alternative to classic infiltration techniques in children.

The aim of the present study was to evaluate the efficacy of injecting intraosseous anesthetics using the Quick Sleeper 2 system in a population of children and adolescents aged 4 to 16 years and to assess the risk of soft tissue biting.

PATIENTS AND METHODS

Population

Children and adolescents attending the Department of Pediatric Dentistry at Rennes University Dental Hospital (Brittany, France) were recruited for this study. They were free of general pathologies and were treated for usual dental diseases. Primary teeth were excluded from the study when there was a risk of damaging the permanent germs during insertion of the needle. The patients and/or their parents received explanations of the differences between infiltration methods, and anesthesia was performed after they provided informed consent.

Materials

The Quick Sleeper 2 system is an all-in-one system that combines needle rotation (for osseous perforation) and a computer-controlled anesthetic delivery system (Fig. 1). A foot pedal is pressed to activate the computer-controlled rotation of the needle, which lasts for

[a]DDS, PhD, Professor, Department of Pediatric Dentistry, UFR d'Odontologie de l'Université de Rennes 1 and CHU de Rennes, France.
[b]DDS, Assistant Lecturer, Department of Pediatric Dentistry, UFR d'Odontologie de l'Université de Rennes 1 and CHU de Rennes, France.
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Fig. 1. Quick Sleeper 2: General aspect. From left to right: computer, syringe, and double foot pedal for needle rotation (left) and anesthetic solution delivery (right).

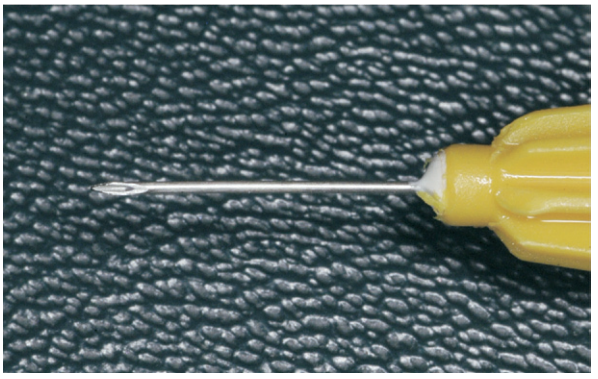

Fig. 2. Flat surface of the bevel of the needle.

1 s, with an automatic 1-s delay between rotations. A second foot pedal is pressed to activate the slow computer-controlled injection of anesthetic. Pressing the foot pedal twice increases the injection rate. Audible chimes and indicator lights on the front of the unit indicate the volume of anesthetic being delivered. A 27-gauge, 12-mm Sofiject needle (BP 282, 81209; Sofic, Mazamet, France) was used for IO injections of 4% articaine with 1:200,000 epinephrine.

Intraosseous injection procedure

A single operator performed all of the IO injections The same operator assisted by students in the Department of Pediatric Dentistry at Rennes University Dental Hospital performed most of the treatments. A 2-step procedure was used for the injections. First, the mucosa was anesthetized by inserting the needle at a 15°-20° angle to the buccal mucosa, with the flat part of the bevel facing the mucosal surface, 1 to 3 mm below the mesial or distal septum adjacent to the tooth (teeth) to be anesthetized (Figs. 2 and 3). The injection of a few drops of anesthetic solution led to superficial anesthesia, allowing the needle to be inserted at a 90° angle (Fig. 4). The needle was then rotated until it penetrated the cancellous bone (Fig. 5). Anesthetic solution (0.4 mL) was then injected. Anesthesia was assessed by touching the buccal and lingual/palatal surfaces of the mucosa adjacent to the tooth (teeth) with a small spatula. More anesthetic solution was immediately injected if sensitivity persisted or later if the patient reported sensitivity/pain during the treatment. The duration of the anesthesia procedure, the volume of anesthetic solution delivered, the type and duration of the treatment, and the efficacy of anesthesia were recorded.

Efficacy was scored as 0 when the anesthesia did not allow the treatment to be completed, 1 when the treatment was completed with no pain or sensitivity, 2 when the treatment was completed despite mild sensitivity, and 3 when the assessment could not be performed.

Fig. 3. First step: The needle is inserted with the flat surface of the bevel facing the mucosal surface at a 15°-20° angle.

Statistical analysis

The results were analyzed using the chi-squared test, and comparisons were considered to be significant at $P < .05$.

Fig. 4. Second step: The needle is inserted until it comes in contact with bone. The plastic circle is positioned to protect soft tissues (lip and cheek) when the needle is rotated.

Fig. 5. Once the needle has been rotated and has penetrated the cancellous bone, the anesthetic is injected.

RESULTS

A total of 225 sessions were performed involving 181 children and adolescents (89 girls and 92 boys, mean age 8.4 ± 3.2 years). Efficacy could not be assessed in 10 cases owing to the behavior of the children. The remaining 215 sessions were assessed. The distribution of patients is shown in Fig. 6. In 44 of 215 sessions (20.5%, mean age 6.4 ± 2.3 years), the IO injections were performed under conscious sedation. In this latter group, sedation was performed using fixed concentrations of oxygen (50%) and nitrous oxide (50%). None of the patients was too sedated to be able to report sensitivity or pain or to be cooperative.

A single tooth was treated in 184 sessions, 2 teeth in 30 sessions, and 3 teeth in 1 session, for a total of 247 teeth treated and assessed (140 primary teeth and 107 permanent teeth). In 166 sessions, of the 193 teeth treated, none presented any signs of inflammation or infection. In 40 sessions, 45 teeth were associated with previous experience of pain. This group included 6 sessions involving 6 teeth with molar incisor hypomineralization and 8 sessions involving 9 teeth with acute pain. A single session involved 1 painless tooth and 1 tooth with previous experience of pain. Maxillary and mandibular teeth were involved in 109 (44.1%) and 138 (55.9%) cases, respectively. One hundred fifteen sessions (53.5%) involved primary teeth only, 96 (44.6%) permanent teeth only, and 4 (1.9%) at least both a primary and a permanent tooth. Primary teeth could be divided into restorative (27, 19.3%), endodontic (88, 62.9%, including 82 pulpotomies), and surgical extraction (25, 17.8%) treatments. Restorations represented 73.8% (79 of 107) of the treatments of permanent teeth. More than half (43) involved deep carious lesions that had cavities close to the pulp or that needed pulp capping. Endodontic treatments and extractions were each performed in 16 (14.9%) and 12 (11.2%) cases involving temporary and permanent teeth, respectively.

The mean duration of the sessions after the anesthetic had been injected was 28.0 ± 15.5 min (range 1-75 min) with no decrease in anesthesia.

The main results are reported in Table I. In most cases, a single 1-s rotation of the needle was required for IO perforation. The mean volume of anesthetic solution injected was 0.80 ± 0.28 mL, which corresponded to a 0.45 cartridge. Patients reported sensitivity or pain during injection in 52 sessions (24.1%). In most cases, the patients said that they felt the anesthetic solution being injected rather than pain itself.

Treatments were successfully completed (scores 1 and 2) in 196 sessions (91.2%) with a 95.5% success rate for patients treated under conscious sedation (42 of 44). Success rates according to the type of treatment are given in Table II. The overall success rate for the 247

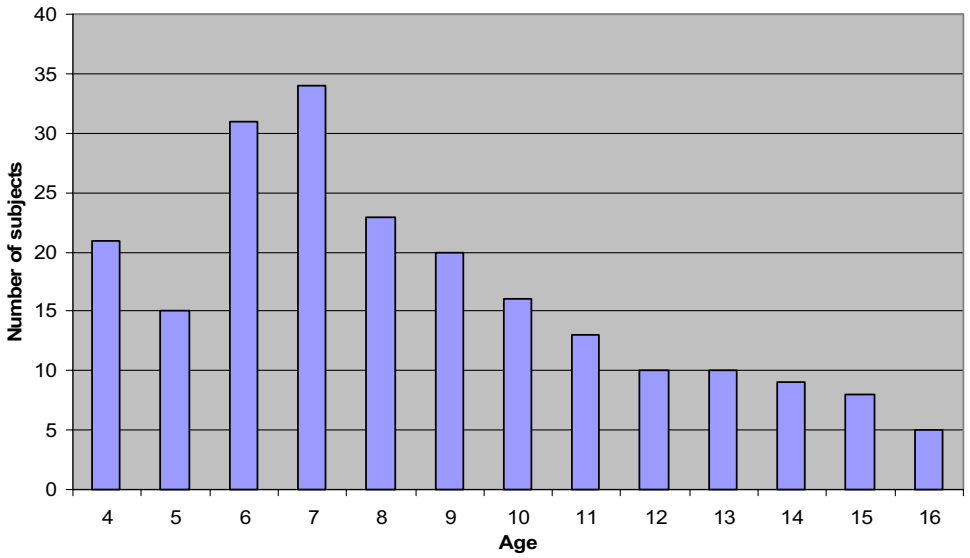

Fig. 6. Age distribution of the patients.

Table I. Efficacy of intraosseous anesthesia

Results	*Total (n)*	*Total (%)*
Complete anesthesia (score 1)	175	81.4
Persistent sensibility allowing treatments (score 2)	21	9.8
Failure (score 0)	19	8.8
Total sessions	215	100

Table II. Success/failure rates according to tooth type and treatment

Treatment	*Success (score 1)*	*Success (score 2)*	*Failure (score 0)*	*Total*
Primary teeth				
Endodontic	81	4	3	88
Restorative	22	5	0	27
Extraction	19	2	4	25
Total	122	11	7	140
Permanent teeth				
Endodontic	22	2	2	26
Deep restorative	36	3	4	43
Restorative	27	5	4	36
Extraction	7	2	3	12
Total	82	12	13	117

teeth treated during the 215 sessions was 91.9% (227 of 247). The success rate was 95% (133 of 140) for temporary teeth, with better results for endodontic (96.6%, 85 of 88) and restorative (100%, 27 of 27) treatments than for extractions (84%, 21 of 25). The distribution was slightly different in permanent teeth, with success rates of 87.9% (overall, 94 of 107), 92.3% (endodontics, 24 of 26), 89.9% (restorations, 71 of 79), and 75% (extractions, 9 of 12). The success rate was significantly higher for maxillary (95.7%, 90 of 94) than for mandibular (87.6%, 106 of 121) treatments ($P = .036$).

The success rate was 94.3% (182 of 193) in initially painless teeth, 80% (36 of 45) in teeth with previous experience of pain, and 100% (9 of 9) in initially painful teeth.

There was no statistical difference related to age ($P > .05$). The IO injections could be evaluated in 42 of the 44 cases performed under conscious sedation, and had a 95.2% success rate (40 of 42).

Mild lip numbing was noted in 14 cases (6.5%), all of which were related to anesthesia performed for mandibular teeth. However, no biting or injury of the mucosa was recorded.

No postinjection pain or injury at the site of injection was recorded.

DISCUSSION

The present study is the first to evaluate IO injections of anesthetic in children and adolescents. Several factors can make evaluating the efficacy of dental anesthesia in children very challenging, including psychologic aspects (strong anxiety possibly leading to panic), difficulty in evaluating pain in some young patients, and limited access to some areas in small oral cavities. Evaluations of IO injections could not be performed for 10 patients (4.4%) for the first 2 reasons. Although the Quick Sleeper 2 system is not syringe shaped and is readily accepted by younger patients as a "magical pen," anxiety may increase owing to the bad taste of the

anesthetic solution if it escapes into the mouth or the vibrations while the needle is rotating. However, the Quick Sleeper 2 system was accepted by most patients (215 of 225), including dental fear–prone patients treated under conscious sedation (44 of 215).

Effective anesthesia was achieved for most restorative and endodontic treatments of primary teeth using an average 0.80 mL of anesthetic solution. There were no soft tissue injuries due to self-biting after mucosal numbing. In most cases, a single 1-s rotation of the needle was needed to insert it in the cancellous bone. Using the same system, Villette et al.[13] showed that an average of 2.1 (maxillary) and 3.26 (mandible) rotations were needed in adults. The difference is likely due to the lower bone density in children and adolescents. The shorter time required to insert the needle may also have decreased any potential discomfort or fear. In the present study, 24.1% of the patients said that they could feel the arrival of the anesthetic solution or, more rarely, pain during the infiltration. Mild to moderate discomfort during the deposition of the anesthetic solution has been reported by 11% to 82% of adults, depending on the clinical and methodologic circumstances.[1,2,10-12]

The mean low volume of anesthetic solution needed to achieve local anesthesia (0.80 mL), and therefore the low quantity of epinephrine administered, as well as the slow computer-controlled delivery rate decreased the risk of having local epinephrine-related damage due to vascular constriction or intraosseous pressure. This may explain why no local tissue damage occurred in the highly vascularized tissues of our young patients.

The efficacy rates (91.2% for sessions and 91.9% for teeth) were similar to those previously reported in the literature. Failure rates of anesthesia performed by infiltration ranging from 6% to 50% have been reported, depending on the study population and the materials and techniques used.[14-19] One study reported a perception of failure of local anesthesia by 26.4% of patients.[20] Intraosseous injections in adults yield success rates ranging from 41% to 96%. Studies involving evaluations during treatments using anesthetic with epinephrine have reported success rates ranging from 73% to 96%.[1,5,7-9,12,13] The lower success rates found in the present study related to extractions of primary (88%) and permanent (75%) teeth may be explained by inflammatory bone resorption associated with infections leading to lower local concentrations of anesthetic solution. The IO anesthetic injections cannot be as effective in sites affected by bone resorption as in healthy sites. The lower success rate in mandibular sessions confirms previous results in adults. Coggins et al.[1] reported that successful anesthesia was obtained with 75% of mandibular molars and 78% of mandibular laterals versus 93% of maxillary molars and 90% of maxillary laterals.

Mucosal numbing was reported by only 6.5% of the patients in the present study and involved just the lower lip. The numbing was mild and the patients could still feel their lips. There was thus no discomfort, and no self-biting occurred. The 6.5% rate was much lower than the 58% rate reported for adults by Coggins et al.[1] using the Stabident system. Because soft tissue injuries are considered to be major side effects of dental anesthesia in children, this is a major advantage of IO injections over alveolar nerve block and other infiltration techniques.

CONCLUSIONS

This study is the first to evaluate IO anesthetic injections in young patients. The IO injections had a high success rate, especially for restorative and endodontic treatments. Very few patients reported numbing of the mucosa, and no self-biting occurred. This technique, when used with a system allowing computer-controlled osseous perforation and delivery of the anesthetic solution, can be considered as a good alternative or supplement to classic infiltration techniques in children and adolescents.

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Reprint requests:

Jean-Louis Sixou
Département d'Odontologie Pédiatrique
U.F.R. d'Odontologie
2 Avenue du Professeur Léon Bernard
35043 Rennes Cedex
France
jean-louis.sixou@univ-rennes1.fr