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Case report

Enhancing pediatric endodontic treatment: Intraosseous anesthesia with computer-controlled delivery system

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ABSTRACT

Background: *Pain control during endodontic treatment is essential but challenging, particularly in pediatric dentistry. Intraosseous anesthesia (IO) ensures adequate areas are anesthetized for endodontic treatment of the primary tooth with only a single injection site and a small amount of anesthetic solution required. Anesthesia should be delivered slowly to enhance the success rate, minimize pain and, for the IO technique, minimize risk of osteonecrosis. The IO anesthesia delivery system that meets such criteria is computer-controlled local anesthetic delivery (CCLAD).* ***Purpose:*** *To describe the enhancement of pediatric endodontic treatment with minimum risk intraosseous anesthesia using CCLAD.* ***Case:*** *An 8-year-old male patient came to the Pediatric Dentistry Clinic at Padjadjaran University Dental Hospital reporting pain on the lower right second molar deciduous teeth, indicated for vital pulpectomy.* ***Case Management:*** *The procedure of vital pulpectomy was done under local anesthesia. Patient was given intraosseous injection with CCLAD prior to opening access. The point of injection was at two mm apical from distal interdental papillae of the lower right second molar deciduous teeth. The patient remained calm throughout the local injection and vital pulpectomy procedure.* ***Conclusion:*** *Intraosseous anesthesia is beneficial when used for pain control during pediatric endodontic therapy. The use of CCLAD gives comfort to the patient while lowering the risk of necrotizing alveolar bone.*

Keywords: *CCLAD; intraosseous injection; pain control; painless pediatric endodontic*
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INTRODUCTION

The 2018 Basic Health Research shows that the prevalence of cavities in childhood is still very high at around 93 percent. This means that only seven percent of Indonesian children are free from dental caries.[1] The American Academy of Pediatric Dentistry (AAPD) states that pediatric patients may experience pain in the oral cavity as a direct result of oral conditions or a secondary result of invasive dental procedures. Inadequate pain control can have physical and psychological consequences, including changing the child's perception of pain in the future. Therefore, pain control is a crucial part of pediatric dental care, such as during pediatric dental pulp procedures. It is important for the dentist to be aware of the patient's response so that treatment can be carried out with minimum pain.[2–4]

The development of safe and effective local anesthetics is of great importance in dentistry. Dental procedures can be painful and cause anxiety, especially in children. In fact, dental injections have been identified as one of the most painful components of dental treatment. However, the use of local anesthetics can prevent further procedural pain. For endodontic treatment of pediatric teeth, adequate pain control under anesthesia is required to ensure patient management and minimize operator stress during treatment.[5,6]

However, the effectiveness of local anesthetic for endodontic treatment of vital teeth is sometimes inadequate, especially when mandibular nerve block is used in the treatment of irreversible pulpitis cases. The disadvantages of block injection, besides a low success rate, are that it is more difficult, more painful, and can cause muscle injury,

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increased duration of soft tissue anesthesia, and temporary or permanent damage to surrounding nerves and accidental injection into nearby blood vessels.[5,6]

Intraosseous injection is the only supplemental technique–with a success rate reaching 98 percent in some cases, proving to be more efficient than periodontal ligament injection. Intraosseous anesthesia can be used as the primary technique in pulp treatment.[7–9] Intraosseous anesthesia requires mechanical perforation of the thick cortical plate between the tooth roots to allow anesthetic solution to be injected directly into the cancellous bone. The anesthetic fluid quickly reaches the periapical area and enters the axonal area of the nerve, where it temporarily deactivates the sodium pump. The anesthetic effect can be achieved in less than 30 seconds, and only a small amount of anesthetic is required (0.4–0.6 ml to anesthetize one to two teeth).[8] The advantages of the intraosseous anesthetic technique compared to block anesthesia is that it is less painful, avoids lingual nerve injury or accidental injection of vessels, and is more comfortable for the patient because it does not anesthetize the lips and tongue, meaning it can be used in bilateral mandibles if anesthesia is desired on both sides.[8,10,11]

One of the methods for giving intraosseous injections is a computer-controlled anesthetic delivery system (CCLAD), which allows a less painful administration of local anesthetics. This system allows dentists to precisely manipulate needle placement with accuracy. Administration of local anesthesia is carried out by foot control, while a handpiece that is held like a pen provides a tactile sensation and better control compared to a traditional syringe. The flow rate of local anesthetic is computer controlled and thus remains consistent from one injection to the next. The CCLAD system represents a significant change in the way local anesthetic injection is administered. The operator can focus on needle position and insertion, while the motor in the device manages the anesthetic flow rate as programmed. Greater ergonomic control coupled with a consistent and controlled flow rate is what makes the injection experience with the CCLAD better than a conventional syringe. CCLAD devices are well tolerated by patients, reduce disruptive patient behavior during injection, and have been proven successful for restoration, pulp therapy, and extraction in adult and pediatric dentistry.[10–14] This manuscript describes the use of the intraosseous technique for the enhancement of pediatric endodontic treatment by using CCLAD to ensure minimum risk.

CASE

An eight-year-old patient came to the Pediatric Dentistry Clinic at Padjadjaran University Dental Hospital with a complaint of pain in the lower back teeth. The parents said that the tooth had been filled a few months ago, but it had come off. Objective examination showed that the teeth were vital with pulp exponation (Figure 1), there was no pain during the percussion or biting test, and no

Figure 1. Clinical picture of tooth 85. Pulp exponation was seen at the first visit.

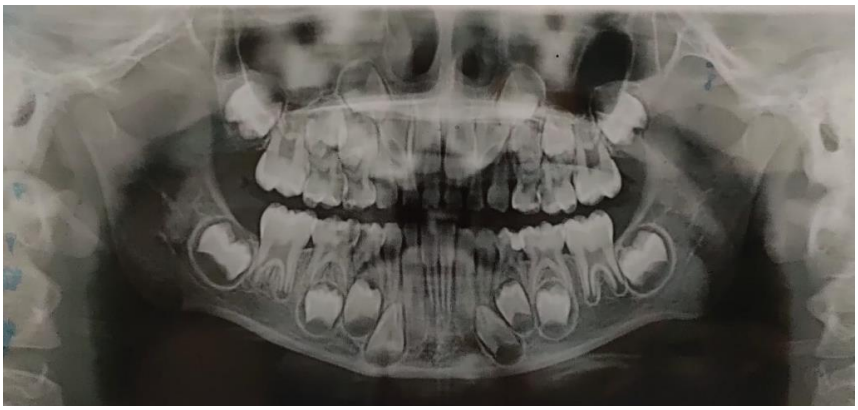

Figure 2. Panoramic radiograph of the patient.

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mobility. Radiological examination showed that tooth 85 had caries up to the pulp horn, and there was a radiolucent in the furcation (Figure 2). The diagnosis of this tooth was symptomatic irreversible pulpitis. The treatment plan was vital pulpectomy under intraosseous anesthesia using CCLAD. The patient's parents agreed and signed the consent letter for the publication of the case at the Dies Forum Padjadjaran University.

Figure 3. Picture of the CCLAD set that was used. There are two modes on the pedal, distinguished by number and color.

CASE MANAGEMENT

The selected local anesthetic technique is the intraosseous technique with CCLAD on tooth 85. The CCLAD (SleeperOne 5, Dental Hi-Tec, France) has three injection modes that are indicated by color: blue for osteocentral or intraseptal injection, pink for intraligamentary injection, and yellow for infiltration or nerve block injection. The mode can be selected by pressing the pedal. This device also has two types of depositioning selection, indicated by the number on the pedal: 1 for attached gingiva or palatine injection, 2 for any other injection (Figure 3).

The needle insertion point was at the distal tooth, two–three mm from the interdental papilla apically. Topical anesthetic gel was applied for approximately two minutes to the gingiva around the point of insertion to reduce pain during needle insertion.[10] The CCLAD handpiece was set to the intraosseous mode, displaying a blue light.

A nine mm diameter 30G needle was used and inserted at 90 degrees to the gingiva, then a few drops of four percent articaine with 1:100.000 epinephrine were injected by pressing the foot control in slow mode to anesthetize the mucosa.[15] The needle was then inserted deeper with the rotational movement technique or birotational technique (BRIT), up to six mm in length or if determined by tactile sensation to have entered the cancellous bone (Figure 4 and 5).[5,10,15] Anesthetic fluid was deposited on the cancellous

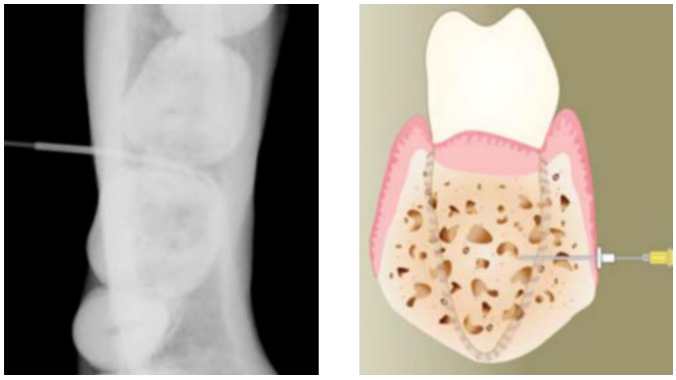

Figure 4. Illustration of the needle position.[14] The needle is thought to have entered the cancellous bone by the depth of needle or tactile sensation.

Figure 5. Intraoral photograph showing the position of the needle. The needle was inserted at 90 degrees to the gingiva, two–three mm from interdental papilla apically.

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bone, as much as 0.5 ml, with the handpiece in both blue mode (Figure 6) and fast mode. The gingiva of the injection site will appear pale or ischemic, which is called blanched-tissue positive.[10] Patient was allowed to communicate about pain when it occurred.

When examined by gently twitching the tissue, the patient showed no lip and buccal mucosa numbness. Gingival numbness was checked by the same method, and pulpal numbness was checked by inserting the same anesthetic needle into the exposed pulp and a K-file in the root canal. The patient felt no pain on the gingiva and pulp tests, indicating that the anesthetic had adequately administered. Patient did not show any change in expression or communicate verbally about pain during the needle insertion and anesthetic deposition.

Pulpectomy performed after the numbness test showed a positive result. The pulp tissue in the root canal was extirpated and the root canal was prepared up to K-file

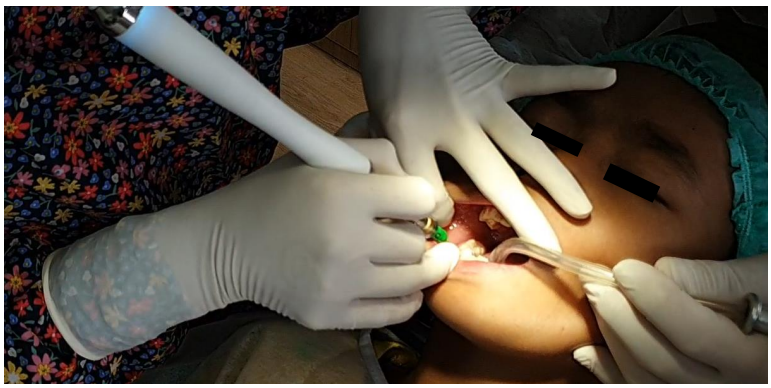

Figure 6. Delivery of the anesthetics. The handpiece was in blue mode during anesthetics delivery.

Figure 7. The pulp chamber after root canal preparation.

Figure 8. Intraosseous anesthesia before placing rubber dam. The anesthesia was done in the same manner as the first visit.

Figure 9. Preparation of the tooth before obturation.

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no.25 (Figure 7). Calcium hydroxide medicament was applied to the root canal, then the cavity was closed with a temporary filling for two weeks. Patients went through the entire vital pulpectomy procedure cooperatively without complaining of pain.

At the next visit, three weeks after the first visit, the patient did not express any complaints about tooth 85, both perioperatively and after several days postoperative. Objective examination, i.e., vitality, percussion, pressure, and mobility, showed negative results, so it was planned to fill the root canal. A rubber dam was placed under intraosseous anesthesia, which was performed in the same manner as the first visit (Figure 8). The root canals were filled with zinc oxide paste using a rubber dam (Figure 9).

DISCUSSION

The success rate of inferior alveolar nerve blocks (IANBs) when used for treatment of mandibular vital teeth diagnosed with symptomatic irreversible pulpitis is only 20 percent.[5,6] IANBs can fail due to anatomic variations, a thick mandibular cortical plate which will interfere with the diffusion of anesthetic solution into the mandible, patient anxiety, local anesthesia technique, increased acidity of the inflamed pulp, nerve growth and increased expression of sodium channels which are resistant to tetrodotoxin.[5,6]

Supplementary techniques are often used to complement a failed or partially successful block anesthesia. Supplemental intraligamentary anesthesia increases the success rate of failed IANB by about 40 percent but is not always clinically sufficient during pulp extirpation. Periodontal ligament anesthesia (PDL) is administered with high injection pressure to deliver the local anesthetic solution through the PDL into the medullary cancellous bone surrounding the tooth. The disadvantages of PDL anesthesia are that it causes pain due to high pressure when administering anesthesia, leakage of anesthetic fluid into the patient's mouth causes discomfort, and post-injection pain can persist for several days.[5,6,10] Supplemental local anesthesia also has a lower complication rate when compared to block anesthesia.

The intraosseous injection in this report demonstrated success in terms of numbness and patient comfort. This is consistent with the case report by Han, Kim, and Pol et al.[11,13] The local anesthesia onset in this case was very fast, at around 30 seconds, verified by inserting the needle into the orifice without any complaint of pain from the patient.[11,13] This may be due to deposition of the anesthetic substances directly on the cancellous bone near the apex of the tooth.[10,16] In addition, due to deposition of the anesthetic agent directly into the cancellous bone near the apex of the tooth, intraosseous injection eliminates soft tissue numbness while providing adequate dental anesthesia. Combined with the pain reduction from the computer-controlled deposition rate, intraosseous injection with CCLAD makes the patient more comfortable than conventional techniques.[12,16]

The anesthetic agent used in this case report was four percent articaine with 1:100,000 epinephrine. Variations in the pharmacology of local anesthetics can affect the success of anesthesia in endodontic patients. Bigby et al. suggested that additional intraosseous injection of four percent articaine increased the success of IANB anesthesia in mandibular posterior teeth with irreversible pulpitis.[7]

The duration of anesthesia in this report was sufficient to complete the entire vital pulpectomy procedure. The duration with intraosseous injection as the primary technique for anesthetics containing a vasoconstrictor is approximately 30 minutes.[10] Gallatin et al. found that the duration of pulpal anesthesia with intraosseous injection will gradually decrease within 60 minutes.[17] This is far from the duration of mandibular block anesthesia, which is 140 minutes. The short duration of intraosseous anesthesia is due to the vascularity of the cancellous bone at the anesthetic delivery site.[9] A duration between 30–60 minutes is considered sufficient for endodontic treatment of primary teeth.[9,18] In the clinical setting, the rapid onset and high success of intraosseous anesthesia with CCLAD allows operators to perform treatment procedures more quickly and see more patients in a day (especially beneficial for clinicians who perform endodontic procedures).[16]

The patient in this report felt no soft tissue numbness of the lips and tongue. This is consistent with the study by Sixou et al. where mucosal numbness was reported by only 6.5 percent of patients in their study and only involved the lower lip, and patients could still feel their lips, thus there was no discomfort and no soft tissue trauma due to patients biting their cheek or lip. Soft tissue injury is thought to be a major adverse effect of dental anesthesia in children. Avoiding mucosal numbness after the anesthesia is a major advantage of intraosseous injection over alveolar nerve blocks and other infiltration techniques.[15]

Intraosseous anesthesia only requires a low volume of anesthetic to achieve local anesthesia (mean value 0.80 ml), and therefore the amount of epinephrine delivered is also minimized, thereby reducing the risk of epinephrine-related damage due to local vascular constriction or intraosseous pressure.[11,15] The slow and consistent flow rate controlled by a computer further reduces the risk.[10,14] This might be why intraosseous injection with CCLAD is more comfortable and does not cause postoperative complaints.

The perceived challenge when performing intraosseous anesthesia is determining the correct orientation of the drill tip. This influences the dentist's decision to choose PDL ligament injection, which is significantly less effective, over the intraosseous method, which is more technically difficult. Administration of intraosseous anesthesia is traditionally performed with perforation of the cortical bone. Cortical bone perforations carry a risk of bone necrosis. The lack of evidence regarding its safety and accuracy can lead to possible iatrogenic complications such as inadequate perforation, breakage of the perforator tip in bone, or trauma to the periodontium or adjacent roots, although better device are available for this technique.[6] The multibeveled

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needle used in this case report can eliminate the need for cortical bone drilling. Multibeveled needles produce the most effective puncture, while eliciting the least amount of trauma. The asymmetrical bevel design allows needle insertion with less tissue displacement, thus requiring less force to penetrate mucosa.[19] The fine needle used (30G needle) can easily be deflected, meaning accurate needle insertion is often difficult, but the birotational technique aids needle insertion by minimizing needle deflection up to deposition area.[20] Anesthetic delivery in this report can be performed with a single needle insertion stage, thereby avoiding the risk of bone necrosis.[9,19]

Regarding the efficacy, patient comfort, and the low risk of intraosseous anesthesia in this case, we can conclude that intraosseous anesthesia is beneficial when used in pain control during pediatric endodontic therapy. Furthermore, the use of CCLAD gives more comfort to the patient while lowering the risk of necrotizing alveolar bone.

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