

Use of Local Anesthesia for Pediatric Dental Patients

Latest Revision

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Abstract

This best practice presents recommendations regarding use of local anesthesia to control pain during pediatric dental procedures. Considerations in the use of topical and local anesthetics include: the patient's medical history, developmental status, age, and weight; planned procedures; risk for methemoglobinemia; formulations of injectable anesthetic agents with and without vasoconstrictor as well as contraindications for their use; and selection of syringes and needle length and gauge. Guidance for documentation of local anesthesia addresses anesthetic selection and dose administered in addition to injection type and location and postoperative instructions. Potential complications such as toxicity, paresthesia, allergy, and postoperative self-induced soft tissue injury are discussed. Recommendations also are provided for alternative delivery methods, use with sedation or general anesthesia, and use during pregnancy. Safety precautions emphasize calculating maximum dosage based on the patient's weight, adjusting local anesthetic dosage when additional analgesic or sedative agents are used, considering systemic absorption and the possibility of methemoglobinemia from topical anesthetic use, and bending of needles at the hub increases risk for breakage. Management of pain is an important component of oral health care and can result in a more positive patient experience.

This document was developed through a collaborative effort of the American Academy of Pediatric Dentistry Councils on Clinical Affairs and Scientific Affairs to offer updated information and recommendations on using local anesthetics in the management of dental pain for pediatric patients and persons with special health care needs.

KEYWORDS: ANALGESICS; ANESTHESIA, GENERAL; ANESTHESIA, LOCAL; DELIVERY OF HEALTH CARE; METHEMOGLOBINEMIA; PAIN MANAGEMENT; PEDIATRIC DENTISTRY

Purpose

The American Academy of Pediatric Dentistry (AAPD) intends this document to help practitioners make decisions when using local anesthesia to control pain in infants, children, adolescents, and individuals with special health care needs during the delivery of oral health care.

Methods

Recommendations on local anesthesia were developed by the Council on Clinical Affairs and adopted in 2005¹, and last revised in 2015.² This update is based upon a literature search of the Pubmed®/MEDLINE database using the terms: local anesthesia AND dentistry AND systematic review, topical anesthesia AND dentistry, buffered anesthesia AND dentistry. Additionally, *Handbook of Local Anesthesia, 7th edition*³ contributed significantly to this revision. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Local anesthesia is the temporary loss of sensation including pain in one part of the body produced by a topically-applied or injected agent without depressing the level of consciousness. Local anesthetics act within the neural fibers to inhibit

the rapid ionic influx of sodium necessary for neuron impulse generation.^{4,5} This helps to prevent transmission of pain sensation during procedures, which can serve to build trust and foster the relationship of the patient and dentist, allay fear and anxiety, and promote a positive dental attitude. The technique of local anesthetic administration is an important consideration in pediatric patient behavior guidance.⁶ Age-appropriate nonthreatening terminology, distraction, topical anesthetics, proper injection technique, and pharmacologic management can help the patient have a positive experience during administration of local anesthesia.^{6,7} In pediatric dentistry, the dental professional should be aware of proper dosage (based on body weight) to minimize the chance of toxicity and the prolonged duration of anesthesia, which can lead to self-inflicted tongue or soft tissue trauma.⁸ Knowledge of gross and neuroanatomy of the head and neck allows for proper placement of the anesthetic solution and helps minimize complications (e.g.,

ABBREVIATIONS

AAPD: American Academy Pediatric Dentistry. **ADA:** American Dental Association. **CNS:** Central nervous system. **CVS:** Cardiovascular system. **FDA:** U.S. Food and Drug Administration. **kg:** kilogram. **lb:** pound. **mg:** milligram. **mm:** millimeter. **mL:** milliliter. **PDL:** Periodontal ligament.

hematoma, trismus, intravascular injection).^{8,9} Familiarity with the patient's medical history is essential to decrease the risk of aggravating a medical condition while rendering dental care. Medical consultation should be obtained as needed.

Many local anesthetic agents are available to facilitate management of pain in the dental patient. There are two general types of local anesthetic chemical formulations: (1) esters (e.g., procaine, benzocaine, tetracaine); and (2) amides (e.g., lidocaine, mepivacaine, prilocaine, articaine).¹⁰

Vasoconstrictors (e.g., epinephrine, levonordefrin, norepinephrine) are added to local anesthetics to constrict blood vessels in the area of injection. This lowers the rate of absorption of the local anesthetic into the blood stream, thereby lowering the risk of toxicity and prolonging the anesthetic action in the area.¹¹ Epinephrine is a relative contraindication in patients with hyperthyroidism, and dose of local anesthetics with epinephrine should be limited.¹² Patients with significant cardiovascular disease, thyroid dysfunction, diabetes, or sulfite sensitivity and those receiving monoamine oxidase inhibitors, tricyclic antidepressants, antipsychotic drugs, norepinephrine, or phenothiazines may require a medical consultation to determine the need for a local anesthetic without vasoconstrictor.¹³ When halogenated gases are used for general anesthesia, the myocardium is sensitized to epinephrine, and such situations dictate caution with use of a local anesthetic.¹³

Amide-type local anesthetics no longer are contraindicated in patients with a family history of malignant hyperthermia,

an abnormal elevation in body temperature during general anesthesia with inhalation anesthetics or succinylcholine.¹³

If a local anesthetic is injected into an area of infection, its onset will be delayed or even prevented.^{7,8} The inflammatory process in an area of infection lowers the pH of the extracellular tissue, inhibiting anesthetic action as little of the active free base form of the anesthetic is allowed to cross into the nerve sheath to prevent conduction of nerve impulses.⁸ Additionally, endocarditis prophylaxis (antibiotics) is not recommended for routine local anesthetic injections through noninfected tissue in patients considered at risk.¹⁴

Topical anesthetics

The application of a topical anesthetic may help minimize discomfort caused during administration of local anesthesia. Single drugs often used as topical anesthetics in dentistry include 20 percent benzocaine, five percent lidocaine, and four percent tetracaine.¹⁵ Topical anesthetics are effective on surface tissues (up to two to three millimeters in depth) to reduce pain from needle penetration of the oral mucosa.^{4,15} These agents are available in gel, liquid, ointment, patch, and aerosol forms.

The United States Food and Drug Administration (FDA) has issued warnings about the use of compounded topical anesthetics¹⁶ and the risk of methemoglobinemia.¹⁷ Compounded topical anesthetics are custom-made medications that may bypass the FDA's drug approval process.¹⁶ These products may contain very high combined levels of both amide and ester agents.

Exposure to high concentrations of local anesthetics can lead to serious adverse reactions, as indicated in the FDA's warning.¹⁶ Acquired methemoglobinemia is a serious but rare condition that occurs when the ferrous iron in the hemoglobin molecule is oxidized to the ferric state. This molecule is known as methemoglobin, which is incapable of carrying oxygen.¹⁸ Risk of acquired methemoglobinemia has been associated primarily with two local anesthetics: prilocaine and benzocaine.¹³ Benzocaine is contraindicated in patients with a history of methemoglobinemia and should not be used in children younger than two years of age.¹⁷

Selection of syringes and needles

The American Dental Association (ADA) has long standing standards for aspirating syringes for use in the administration of local anesthesia.¹⁹⁻²¹ Needle selection should allow for profound local anesthesia and adequate aspiration.^{19,20} Needle gauges range from size 23 to 30, with the lower numbers having the larger inner diameter.

Table. INJECTABLE LOCAL ANESTHETICS (Adapted from Coté CJ et al.³²)

Anesthetic	Duration in minutes ^A	Maximum dose ^B		mg anesthetic/ 1.7 mL cartridge	mg vasoconstrictor/ 1.7 mL cartridge
		mg/kg	mg/lb		
<i>Lidocaine</i> ^C	90-200	4.4	2		
2%+1:50,000 epinephrine				34	0.034 mg
2%+1:100,000 epinephrine				34	0.017 mg
<i>Articaine</i>	60-230	7	3.2		
4%+1:100,000 epinephrine				68	0.017 mg
4%+1:200,000 epinephrine				68	0.0085 mg
<i>Mepivacaine</i> ^D	120-240	4.4	2		
3% plain				51	—
2%+1:20,000 levonordefrin				34	0.085 mg
<i>Bupivacaine</i> ^E	180-600	1.3	0.6		
0.5%+1:200,000 epinephrine				8.5	0.0085 mg

^A Duration of anesthesia varies greatly depending on concentration, total dose, and site of administration; use of epinephrine; and the patient's age.

^B Use lowest total dose that provides effective anesthesia. Lower doses should be used in very vascular areas. Doses should be decreased by 30 percent in infants younger than six months. For improved safety, AAPD, in conjunction with the American Academy of Pediatrics, recommends a dosing schedule for dental procedures that is more conservative than the manufacturer's recommended dose (MRD).

^C The table lists the long-established pediatric dental maximum dose of lidocaine as 4.4 mg/kg; however, the MRD is 7 mg/kg.

^D Use in pediatric patients under four years of age is not recommended.

^E The prolonged anesthesia of bupivacaine can increase risk of self-inflicted soft tissue injury.

Needles with lower number provide for less deflection as the needle passes through soft tissues and for more reliable aspiration.²⁰ The depth of insertion varies not only by injection technique but also by the age and size of the patient. Dental needles are available in three lengths: long (32 millimeters [mm]), short (20 mm), and ultrashort (10 mm). Most needle fractures occur during the administration of inferior alveolar nerve block with 30-gauge needles.²² Breakage can occur when a needle is inserted to the hub, when the needle is weakened due to bending it before insertion into the soft tissues, or by patient movement after the needle is inserted.²¹⁻²³

Injectable local anesthetic agents

Local amide anesthetics available for dental usage include lidocaine, mepivacaine, articaine, prilocaine, and bupivacaine (Table). Absolute contraindications for local anesthetics include a documented local anesthetic allergy.¹⁵ True allergy to an amide is exceedingly rare.¹⁵ Allergy to one amide does not rule out the use of another amide, but allergy to one ester rules out use of another ester.¹⁵ Potassium metabisulfate is used as a preservative in local anesthetics containing epinephrine. For patients having an allergy to bisulfates, use of a local anesthetic without a vasoconstrictor is indicated.²⁴ Local anesthetics without vasoconstrictors can undergo rapid systemic absorption which may result in overdose.²⁴

While the prolonged effect of a long-acting local anesthetic (i.e., bupivacaine) can be beneficial for post-operative pain in adults, the concomitant increased risk of self-inflicted injury infers that it is contraindicated for the child or the physically or intellectually disabled patient.¹⁵ Claims have been made that articaine can diffuse through hard and soft tissue from a buccal infiltration to provide lingual or palatal soft tissue anesthesia.¹⁵ Systematic reviews comparing articaine versus lidocaine have concluded they present the same efficacy with no differences in patient-reported pain²⁵ and that articaine is more effective in anesthetic success in mandibular first permanent molar areas²⁶ as well as superior for inferior alveolar nerve block in patient with irreversible pulpitis²⁷.

Prilocaine is contraindicated in patients with methemoglobinemia, sickle cell anemia, anemia, or symptoms of hypoxia or in patients receiving acetaminophen or phenacetin, since both medications elevate methemoglobin levels.¹⁵

The effect of adjusting the pH of local anesthetics in dentistry has become of interest because the acidic nature of local anesthetics (adjusted to approximately pH of 4.5 to prolong shelf life) may cause pain during infiltration and delayed onset. One systematic review found that local anesthesia buffered with sodium bicarbonate was 2.3 times more likely to achieve successful anesthesia than nonbuffered local anesthesia for participants with a clinical diagnosis of symptomatic irreversible pulpitis requiring endodontic treatment.²⁸ Another systematic review found that the pH adjustment was not effective in reducing pain of intraoral injections in normal or inflamed tissues or reducing the time of anesthesia onset, but it had a slight reduction on the onset time with inferior

alveolar injections for pulpitis.²⁹ This review concluded that the reduced time of onset may not be clinically relevant considering the time required to prepare the buffered agent.²⁹ Similar results were found in children ages six to 12 years old.³⁰

Documentation of local anesthesia

The patient record is an essential component of the delivery of competent and quality oral health care.³¹ Following each appointment, an entry is made in the record that accurately and objectively summarizes that visit. Appropriate documentation includes specific information relative to the administration of local anesthesia. This would include, at a minimum, the type and dosage of local anesthetic administered.³¹ Documentation also may include the type of injection(s) administered (e.g., infiltration, block, intraosseous), needle selection, and patient's reaction to the injection. For example, local anesthesia administration might be recorded as: mandibular block with 27-short; 34 milligrams (mg) two percent lidocaine with 0.017 mg epinephrine [or 1/100,000 epinephrine]; tolerated procedure well. In patients for whom the maximum dosage of local anesthetic may be a concern (e.g., young patients, those undergoing sedation), the body weight should be documented preoperatively. Because there may be enhanced sedative effects when local anesthetics are administered in conjunction with sedative drugs, recording doses of all agents on a time-based record can help ensure patient safety.³² Local anesthesia documentation also should include that post-injection instructions were reviewed with the patient and parent.

Local anesthetic complications

Toxicity (overdose)

Younger pediatric patients are at greater risk for adverse drug events.⁸ Most adverse drug reactions develop either during the injection or within five to 10 minutes.¹⁸ Local anesthetic systemic toxicity can result from high blood levels caused by a single inadvertent intravascular injection or repeated injections.⁶ Local anesthetic causes a biphasic reaction (excitation followed by depression) in the central nervous system (CNS).³³ The classic overdose reaction to local anesthetic is generalized tonic-clonic convulsion.³³ Early subjective indications of toxicity involve the CNS and include dizziness, anxiety, and confusion. This may be followed by diplopia, tinnitus, drowsiness, and circumoral numbness or tingling. Objective signs may include muscle twitching, tremors, talkativeness, slowed speech, and shivering, followed by overt seizure activity. Unconsciousness and respiratory arrest may occur.¹⁰

The cardiovascular system (CVS) response to local anesthetic toxicity also is biphasic. Initially, the CVS is subject to stimulation; heart rate and blood pressure may increase. As plasma levels of the anesthetic increase, however, vasodilatation occurs followed by depression of the myocardium with subsequent fall in blood pressure. Bradycardia and cardiac arrest may follow. The cardiodepressant effects of local anesthetics are not seen until there is a significantly elevated level in the blood.¹⁵

Local anesthetic toxicity can be prevented by careful injection technique, watchful observation of the patient, and knowledge of the maximum dosage based on body weight. It should be recognized that half the volume of a four percent local anesthetic should be used compared to a two percent solution with the same dosing recommendation. Practitioners should aspirate before agent delivery during every injection and inject slowly.¹⁵ Aspiration during injections decreases the risk of an intravascular injection, and a slow injection technique reduces tissue distortion and related discomfort. After the injection, the doctor, hygienist, or assistant should remain with the patient while the anesthetic begins to take effect. Early recognition of a toxic response is critical for effective management. When signs or symptoms of toxicity are noted, administration of the local anesthetic agent should be discontinued. Additional emergency management, including patient rescue and activation of emergency medical services, is based on the severity of the reaction.⁴

Allergy to local anesthesia

Allergic reactions are not dose related but are due to the patient's heightened capacity to react to even a small dose and can manifest in a variety of ways, some of which include urticaria, dermatitis, angioedema, fever, photosensitivity, or anaphylaxis.^{15,24} Emergency management is dependent on the rate and severity of the reaction.

Paresthesia

Paresthesia is persistent anesthesia beyond the expected duration. Trauma to the nerve can result in paresthesia and, among other etiologies, can be caused by the needle during the injection.³⁴ Patients who initially experience an electric shock sensation during injection may have persistent anesthesia.³⁴ Paresthesia has been reported to be more common with four percent solutions such as articaine and prilocaine compared to those of lower concentrations.³⁵

Postoperative soft tissue injury

Self-induced soft tissue trauma (lip and cheek biting) is an unfortunate clinical complication of local anesthetic use in the oral cavity. Most lesions of this nature are self-limiting and heal without complications, although bleeding and infection are possible.³⁴ The use of bilateral mandibular blocks does not increase the risk of soft tissue trauma when compared to unilateral mandibular blocks or ipsilateral maxillary infiltration.³⁴

Advising the patient/caregiver of a realistic duration of numbness and post-operative precautions is necessary to decrease risk of self-induced soft tissue trauma. Visual examples may help stress the importance of observation during the period of numbness. For all local anesthetics, the duration of soft tissue anesthesia is greater than dentinal or osseous anesthesia. Use of phentolamine mesylate injections in patients over age six years or at least 15 kilograms (kg) has been shown to reduce the duration of effects of local anesthetic by about 47 percent in the maxilla and 67 percent in the mandible.^{36,37}

However, there is no research demonstrating a relationship between reduction in soft tissue trauma and the use of shorter acting local anesthetics.

Alternative techniques for delivery of local anesthesia

Most local anesthesia procedures in pediatric dentistry involve traditional methods of infiltration or nerve block techniques with a dental syringe, disposable cartridges, and needles as described so far. Several alternative techniques, however, are available. These include computer-controlled local anesthetic delivery, periodontal injection techniques, needleless systems, and intraseptal or intrapulpal injection. Such techniques may improve comfort of injection by better control of the administration rate, pressure, and location of anesthetic solutions and result in more successful and controlled anesthesia.^{38,39}

The mandibular bone of a child usually is less dense than that of an adult, permitting more rapid and complete diffusion of the anesthetic.⁸ Mandibular buccal infiltration anesthesia is as effective as inferior nerve block anesthesia for some operative procedures.⁸ In patients with bleeding disorders, the periodontal ligament (PDL) injection minimizes the potential for postoperative bleeding of soft tissue vessels.¹³ The use of the PDL injection or intraosseous methods is contraindicated in the presence of inflammation or infection at the injection site.³⁸

Local anesthesia with sedation and general anesthesia

Local anesthetics and sedative agents both depress the CNS. Therefore, it is recommended that the dose of local anesthesia be adjusted downward when sedating children with opioids.⁴⁰

For patients undergoing general anesthesia, the anesthesia care provider needs to be aware of the concomitant use of a local anesthetic containing epinephrine, as epinephrine can produce dysrhythmias when used with halogenated hydrocarbons (e.g., halothane).⁴ Local anesthesia has been reported to reduce pain in the postoperative recovery period after general anesthesia.⁴¹

Local anesthesia and pregnancy

The use of local anesthesia during pregnancy is considered safe.⁴² The FDA has established a drug classification system based on their risks to pregnant women and their fetuses.⁴³ In respect to the five categories (A, B, C, D, and X) established by the FDA, lidocaine is considered in Category B, the safest of the local anesthetics.⁴⁴ Lidocaine is considered to be safe for use during breastfeeding.⁴⁵

Recommendations

1. Selection of local anesthetic agents should be based on the patient's medical history and mental/developmental status, the anticipated duration of the dental procedure, and the planned administration of other agents (e.g., nitrous oxide, sedative agents, general anesthesia).

2. Administration of local anesthetic should be based on the body weight of the patient, not to exceed AAPD recommendations in mg/kg found in Table. Use lowest total dose that provides effective anesthesia.
3. A topical anesthetic may be used prior to the injection of a local anesthetic to reduce discomfort associated with needle penetration. Systemic absorption of the drugs in topical anesthetics must be considered when calculating the total amount of anesthetic administered.
4. Benzocaine is contraindicated in patients with a history of methemoglobinemia and should not be used in children younger than two years of age.
5. Documentation of local anesthesia administration would include, at a minimum, the type and dosage of local anesthetic. If the local anesthetic was administered in conjunction with sedative drugs, the doses of all agents must be noted on a time-based record.
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Safety and risks

1. In the Table, the long-established pediatric dental maximum dose for lidocaine is 4.4 mg/kg; however, seven mg/kg maximum dose for lidocaine is the manufacturer's recommended dose.
2. Compounded topical anesthetics may contain very high combined levels of both amide and ester agents which can lead to serious adverse reactions.
3. Reduce local anesthesia dose when combined with sedative medications.
4. Half the volume should be used for four percent anesthetic solutions compared to two percent solutions with the same dosing recommendation.
5. Manufacturers do not recommend articaine use in pediatric dental patients younger than four years old.
6. Needles should not be bent or inserted to their hub to avoid breakage.
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