Use of Local Anesthesia for Pediatric Dental Patients

Latest Revision

2023

How to Cite: American Academy of Pediatric Dentistry. Use of local anesthesia for pediatric dental patients. *The Reference Manual of Pediatric Dentistry*. American Academy of Pediatric Dentistry; 2026:431-438.

Abstract

This best practice presents recommendations regarding use of local anesthesia to control pain for pediatric dental patients. Considerations in the use of topical and local anesthetics include: the patient's medical history, developmental status, age, and weight; planned procedures; needle selection; and safety concerns such as risk for methemoglobinemia and systemic effects of anesthetic agents. Guidance is offered on the documentation of local anesthesia administration including anesthetic selection, dose administered, injection type and location, and postoperative instructions. Potential complications such as toxicity, paresthesia, allergy, and postoperative self-induced soft tissue injury are discussed. Additional recommendations address alternative methods of local anesthesia delivery, concurrent use with sedation or general anesthesia, and use during pregnancy. Pain management is an important component of oral health care and can result in a more positive patient experience during pediatric dental procedures

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 regarding use of 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 use of local anesthesia were developed by the Council on Clinical Affairs, adopted in 2005[1], and last revised in 2020.[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*. Two hundred forty-eight articles matched these criteria. 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 in one part of the body produced by a topically-applied or injected agent. Local anesthetics act within neural fibers to inhibit the rapid ionic influx of sodium necessary for neuron impulse generation and propagation.[4,5] This helps prevent sensation of pain during procedures, which can foster a trusting relationship between the patient and dentist, allay fear and anxiety, and promote a positive dental attitude. Inadequate pain control during dental procedures has the potential for significant physical and psychological consequences.[6] Many local anesthetic agents are available to facilitate management of pain in the dental patient. The 2 general types of local anesthetic chemical formulations are: (1) esters (eg, procaine, benzocaine, tetracaine) and (2) amides (eg, lidocaine, mepivicaine, prilocaine, articaine).[7]

The technique of local anesthetic administration is an important consideration in pediatric patient behavior guidance.[8,9] 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 anesthetics.[8,10(p184)] In pediatric dentistry, appropriate dosage (based on body weight) will minimize the chance of toxicity.[11(p294)] Knowledge of gross and neuroanatomy of the head and neck allows for proper placement of the anesthetic solution and helps minimize complications (eg, hematoma, trismus, intravascular injection).[12(p308)] A comprehensive understanding of the patient's medical history will decrease the risk of aggravating a medical

ABBREVIATIONS

AAPD: American Academy of Pediatric Dentistry. **ADA:** American Dental Association. **CNS:** Central nervous system. **FDA:** US Food and Drug Administration. **LAST:** Local anesthetic systemic toxicity. **MRD:** Manufacturer's recommended dose. **PDL:** Periodontal ligament.

condition while rendering dental care. A medical consultation may be indicated to obtain needed information.

Topical anesthetics

The application of a topical anesthetic may help minimize discomfort caused during administration of local anesthesia. Single drugs which are often used as topical anesthetics in dentistry include 20% benzocaine, 5% lidocaine, and 4% tetracaine.[13(p79)] Topical anesthetics are effective on surface tissues (up to 2 mm to 3 mm in depth) to reduce pain from needle penetration of the oral mucosa.[13(p76)] These agents are available in gel, liquid, ointment, patch, and aerosol forms. The concentration of local anesthetics typically is higher in topical formulations than in injectable solutions, and judicious application will reduce potential for toxicity.[13(p76)] Benzocaine and prilocaine both have been associated with a risk of acquired methemoglobinemia, and their use is contraindicated in patients with a history of methemoglobinemia.[13(p69),14,15(p169)] 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 and results in a decreased availability of oxygen to the tissues.[14] Prilocaine is also relatively contraindicated in patients at risk for methemoglobinemia (eg, patients with glucose-6-phosphate dehydrogenase deficiency, sickle cell anemia, anemia; very young patients) or patients with symptoms of hypoxia.[13(p71),16] Highly significant clinical concerns have been reported in patients receiving the combination of prilocaine-containing topical agents and methemoglobin-inducing agents (eg, sulfonamides, acetaminophen, phenytoin).[16] Additionally, the US Food and Drug Administration (**FDA**) warns against use of topical anesthetics (including over-the-counter teething products) containing benzocaine for children younger than 2 years.[17]

The FDA also has issued warnings about the potential toxicity of compounded topical anesthetics due to the high concentration of individual anesthetic components.[18] Compounded topical anesthetics are custom-made medications that may bypass the FDA's drug approval process. Use of compounded topical anesthetics with unknown concentrations of local anesthetics carries a risk of complications associated with overdose, including seizures, arrhythmias, and death.[18]

Selection of syringes and needles

The American Dental Association (**ADA**) has standards for aspirating syringes for use in the administration of local anesthesia.[19,20] Needle gauges range from size 23 to 30, with the lower numbers having the larger inner diameter. Needles with lower gauge number (larger diameter) provide for less deflection as the needle passes through soft tissues and for more reliable aspiration.[21(p101)] 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 3 lengths: long (32 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[21(p100)], when the needle is weakened due to bending before insertion into the soft tissues, or by patient movement after the needle is inserted.[12(p309),22,23]

Injectable local anesthetic agents (Table)

Amide local anesthetics available for dental usage include lidocaine, mepivacaine, articaine, prilocaine, and bupivacaine. Agents that include epinephrine are formulated to an approximate pH of 4.5 in order to prolong the shelf life of the vasoconstrictor, but this may activate acid-sensing nociceptors and lead to increased pain.[26] The higher acidity of local anesthetics with vasoconstrictor also may slow the onset of the anesthetic while it transforms from its ionized to non-ionized

Table. INJECTABLE LOCAL ANESTHETICS (Adapted from Coté CJ et al.[24])

Anesthetic	Duration in minutes[A]	Maximum dose[B]		mg anesthetic/ 1.7 mL cartridge	mg vasoconstrictor/ 1.7 mL cartridge
		mg/kg	mg/lb		
Lidocaine[C]	90-200	4.4	2		
2%+1:50,000 epinephrine				34	0.034 mg
2%+1:100,000 epinephrine				34	0.017 mg
Articaine[D]	60-230	7	3.2		
4%+1:100,000 epinephrine				68	0.017 mg
4%+1:200,000 epinephrine				68	0.0085 mg
Mepivacaine	120-240	4.4	2		
3% plain				51	—
2%+1:20,000 levonordefrin				34	0.085 mg
Bupivacaine[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 or when providing local anesthesia without vasoconstrictor. Doses of amides should be decreased by 30% in infants younger than 6 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 4 years of age is not recommended.

[E] Use in patients under 12 years of age is not recommended.[25]

form in order to penetrate the lipid membrane of the nerve sheath.[26] In dentistry, the effect of adjusting the pH of local anesthetics with epinephrine is of interest as a way to reduce pain and time to onset of anesthesia. One systematic review found that local anesthetic with epinephrine buffered with sodium bicarbonate was 2.3 times more likely to achieve anesthesia than nonbuffered agents for participants with a clinical diagnosis of symptomatic irreversible pulpitis requiring endodontic treatment.[27] Another systematic review found that the pH adjustment was not effective in reducing pain of intraoral injections, but buffering did reduce the time to onset of anesthesia when performing inferior alveolar nerve blocks or injecting into inflamed tissues.[26] This review concluded that the reduced time may not be clinically relevant considering the time required to prepare the buffered agent.[26] Similar results were found in children ages 6 to 12 years old.[28] Additional research is needed regarding the effect of buffered local anesthetic on pain reduction in children.[28,29]

Vasoconstrictors (eg, 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.[30] For patients with hyperthyroidism, cautious use of epinephrine as a vasoconstrictor in local anesthetics is warranted to decrease risk of tachycardia or hypertension.[15(p148)] Patients with significant cardiovascular disease[15(p144)], thyroid dysfunction[15(p148)], diabetes[15(p148)], or sulfite sensitivity[31(p349)] and those receiving monoamine oxidase inhibitors[15(p166)], tricyclic antidepressants[15(p164)], antipsychotic drugs[15(p165)], norepinephrine, or phenothiazines[15(pp165,166)] may require a medical consultation to determine the need for a local anesthetic without vasoconstrictor.[15(p149)] The Malignant Hyperthermia Association of the United States indicates that all local anesthetics, including those with vasoconstrictor, are safe for use in patients susceptible to malignant hyperthermia.[32,33] When halogenated gases are used for general anesthesia, however, the myocardium is sensitized to epinephrine, and such situations dictate caution with use of a local anesthetic.[15(p165)] As with the topical form, injectable prilocaine is relatively contraindicated in patients with susceptibility to methemoglobinemia.[13(p71)] While the prolonged effect of a long-acting local anesthetic (ie, bupivacaine) can be beneficial for postoperative pain in adults, the concomitant increased risk of self-inflicted injury infers that it is contraindicated for children or intellectually disabled patients.[11(p298)]

The mandibular cortical bone of a child is less dense than that of an adult, permitting more rapid and complete diffusion of the injected anesthetic.[11(p297)] Because of this increased permeability, mandibular buccal supraperiosteal infiltration with local anesthetic may be as effective as an inferior alveolar nerve block for dental procedures (eg, intracoronal restorations) on mandibular primary teeth.[11(p298)] Multiple systematic reviews have compared inferior alveolar nerve blocks with lidocaine to infiltration with articaine for restorative treatment, pulp therapy, and extractions of both primary and permanent molars in individuals under 18 years of age[34-39]; the evidence regarding superiority is inconclusive. The ability of articaine to diffuse through hard and soft tissue from a buccal infiltration to provide lingual or palatal soft tissue anesthesia has been reported as a potential advantage over lidocaine.[13(p73),40]

If a local anesthetic is injected into an area of infection, its time to onset may be prolonged or anesthesia may be ineffective.[11(p289)] Infection lowers the pH of the extracellular tissue, inhibiting diffusion of the active free base form of the anesthetic across the neural membrane, thereby stopping nerve impulse conduction.[11(p289)] Endocarditis prophylaxis (antibiotics) is not recommended for routine local anesthetic injections through noninfected tissue in patients considered at risk.[41]

Documentation of local anesthesia

The patient record is an essential component of the delivery of competent and quality oral health care.[42] 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 anesthetics. This would include, at a minimum, the type and dosage of local anesthetic administered.[42] Documentation also may include the type of injection(s) administered (eg, infiltration, block, intraosseous), needle selection, and patient's reaction to the injection. For example, local anesthetic administration might be recorded as: mandibular block with 27-short; 34 mg 2% lidocaine with 0.017 mg epinephrine (or 1/100,000 epinephrine); tolerated procedure well. With patients for whom the maximum dosage of local anesthetic may be a concern (eg, young patients, those undergoing sedation), documenting the body weight and calculating the maximum recommended total dose preoperatively can help prevent overdosage. 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.[24] Local anesthesia documentation also includes a statement that post-injection instructions were reviewed with the patient and parent.

Local anesthetic complications

Critical to the safety of all patients during the administration of local anesthetics are the practitioner's awareness of the risks for complications and efforts to prevent them, recognition of the signs and symptoms of an adverse event, and the ability to provide time-critical interventions in case of a medical emergency.

Local anesthetic systemic toxicity (overdose)

Younger pediatric patients are at greater risk for adverse drug events.[31(p332)] Most adverse drug reactions develop either during the injection or within 5 to 10 minutes.[43] Local anesthetic systemic toxicity (**LAST**) can result from high blood levels caused by a single inadvertent intravascular injection or repeated injections.[31(p334)] Local anesthetic causes a biphasic reaction (excitation followed by depression) in the central

nervous system (**CNS**).[44(p32)] The classic overdose reaction to local anesthetic is generalized tonic-clinic convulsion.[44(p33)] 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. Loss of consciousness and respiratory arrest may occur.[7]

The cardiovascular system response to local anesthetic toxicity also is biphasic. Initially, heart rate and blood pressure may increase due to the injected epinephrine. As plasma levels of the anesthetic increase, however, vasodilatation occurs followed by depression of the myocardium and a subsequent fall in blood pressure. Local anesthetics block voltage-gated sodium channels that are responsible for the generation of cardiac arrhythmias, and overdose may cause bradycardia and subsequent cardiac arrest. The cardiodepressant effects of local anesthetics are not seen until there is a significantly elevated level in the blood.[31(p342)]

LAST can be prevented by careful injection technique, watchful observation of the patient, and knowledge of the maximum dosage based on body weight. This would include aspirating after needle placement before agent delivery during every injection and injecting slowly.[10(p181)] Aspiration decreases the risk of an intravascular injection, and a slow injection technique reduces tissue distortion and related discomfort. After the injection, the clinical observation of the patient will enable early recognition of a toxic response. When signs or symptoms of toxicity are noted, administration of the local anesthetic agent is discontinued and additional emergency management, including patient rescue and activation of emergency medical services, is based on the severity of the reaction.[5] Early treatment with intravenous lipid emulsion therapy is a priority in potentially serious cases of LAST.[45]

Allergy to local anesthetics

Allergy to a local anesthetic, a rare finding, is an absolute contraindication for its use.[13(p81)] Allergy to one amide does not rule out the use of another amide, but allergy to one ester rules out use of another ester.[31(p347)] Patients may report an allergy to local anesthetic agents even though they experienced a reaction to the vasoconstrictor, a sensitivity to a preservative (metabisulfite) in agents containing epinephrine, administration of a toxic dose, or an intravascular injection. Documentation of the previous event and/or allergy testing can help the practitioner proceed with procedural pain management. For patients having an allergy to bisulfites, use of a local anesthetic without vasoconstrictor is indicated.[31(p349)] 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.[31(p354)] 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.[12(p310)] Patients who initially experience an electric shock sensation during injection may have persistent anesthesia.[12(p312)] Paresthesia has been reported to be more common with 4% solutions such as articaine and prilocaine compared to those of lower concentrations.[46,47]

Postoperative soft tissue injury

Self-induced soft tissue trauma (eg, 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.[12(p320)] The use of bilateral mandibular blocks may increase the risk of soft tissue trauma when compared to unilateral mandibular blocks or ipsilateral maxillary infiltration.[48]

Advising the patient/caregiver of a realistic duration of numbness and postoperative precautions is necessary to decrease the 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 6 years or at least 15 kg has been shown to reduce the duration of effects of local anesthetic by about 47% in the maxilla and 67% in the mandible.[49,50] Phentolamine mesylate reverses the vasoconstrictor via its antagonistic effect at the α_1 receptor, allowing for vasodilation and rapid metabolism of local anesthetic.[50] A relationship between reduction in soft tissue trauma and the use of shorter acting local anesthetics has not been demonstrated.[11(p296)] Use of phentolamine mesylate is not recommended for patients who are younger than 3 years of age or weigh less than 15 kg (33 pounds).[51]

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, including computer-controlled local anesthetic delivery, periodontal injection techniques, needleless systems, and intraseptal or intrapulpal injection, are available. 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.[52]

In patients with bleeding disorders, the periodontal ligament (**PDL**) injection minimizes the potential for postoperative bleeding of soft tissue vessels.[15(p142)] The use of the PDL injection or intraosseous methods is contraindicated in the presence of inflammation or infection at the injection site.[53]

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 anesthetic be adjusted downward when sedating children with opioids.[54]

Reasons to use local anesthesia for dental procedures under general anesthesia include concerns for increased future pain sensitivity due to CNS priming[55] and reduction in postoperative pain. In patients undergoing general anesthesia for dental treatment including restorations and extractions, however, the evidence for administration of local anesthesia intraoperatively to reduce postoperative pain is equivocal.[56,57] Furthermore, intraoperative use of local anesthesia may increase risk of postoperative soft tissue trauma while the patient is numb.[58]

Local anesthesia and pregnancy

Pregnancy causes many physiologic changes, including effects on cardiovascular function and metabolism.[59] Consideration should be given to the risks and benefits of dental treatment to the pregnant patient and fetus when choosing therapeutics.[60] Local anesthetics, including lidocaine, mepivacaine, and bupivacaine, are safe for pregnant patients when the appropriate dosage is used.[61] Because local anesthetics can pass through the placental barrier, additional caution is indicated when the fetus has known medical complications.[59] Epinephrine may cause contraction of uterine blood vessels and limit blood flow to the placenta.[59] Therefore, caution is indicated in the use of local anesthetics with vasoconstrictor for pregnant women, particularly those with hypertensive conditions (eg, preeclampsia).[59] The second trimester of pregnancy, when organogenesis of the fetus is complete and comfortable positioning in the dental chair may still be possible, may be the optimal time to complete non-urgent dental treatment.[60] Lidocaine is considered safe for use during breastfeeding.[62,63]

Recommendations

Local anesthesia is an important consideration in behavior guidance of pediatric dental patients. Inadequate pain control during dental procedures has the potential for significant physical and psychological consequences, including altering future pain experiences for these children.[6] Agents used for prevention of pediatric procedural pain have the potential for toxicity and adverse reactions. Practitioners should adhere to the following recommendations for use of local anesthetics for pediatric dental patients.

- 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 (eg, nitrous oxide, sedative agents, general anesthesia).
- 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. Practitioners should use the lowest total dose that provides effective anesthesia.
- 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.
- Documentation of local anesthetic administration should include, at a minimum, the type and dosage of agent. If the local anesthetic was administered in conjunction with sedative drugs, the doses of all agents must be noted on a time-based record.
- The calculated maximum total dose for local anesthetics should be reduced when administered in conjunction with other medications that depress the CNS.
- The calculated maximum total dose of amide local anesthetics should be reduced by 30% in infants younger than 6 months.[24]
- Postoperative instructions should include guidance regarding the duration of local anesthesia and strategies to reduce the risk of biting the lip, cheek, or tongue.
- Providers should have protocols for emergency management of patients exhibiting signs of LAST or an allergic reaction.

Additional safety considerations

Careful selection, dosage, and technique are critical to the safe administration of local anesthestics for pediatric patients. Important considerations to include following.

- In the Table, the long-established maximum safe dose for use of lidocaine with pediatric dental patients is 4.4 mg/kg; however, 7 mg/kg is the manufacturer's recommended maximum dose. The maximum dose for articaine as recommended by the manufacturer is 7 mg/kg. The lowest total dose that provides effective anesthesia should be used, and lower total doses should be used for injections into vascular areas. 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.
- Manufacturers do not recommend articaine use in pediatric dental patients younger than 4 years. The use of bupivacaine is not recommended in patients younger than 12 years.
- Compounded topical anesthetics may contain very high combined levels of both amide and ester agents which can lead to serious adverse reactions.
- Use of benzocaine is contraindicated in patients with a history of methemoglobinemia and in children younger than 2 years of age. Prilocaine is also contraindicated in patients with a history of methemoglobinemia and relatively contraindicated in those who are susceptible to methemoglobinemia due to medical history or concurrent use of other medications.

- Needles are prone to breakage if bent prior to injection or inserted to their hub.
- Aspiration prior to injection and slow injection technique reduce the risk of adverse events related to systemic administration of the local anesthetic.

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