Guideline on Appropriate Use of Local Anesthesia for Pediatric Dental Patients

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

Methods
This guideline is based on a review of the current dental and medical literature related to use of local anesthesia. A MEDLINE search was conducted using the terms "anesthesia" and "local anesthesia".

Background
Local anesthesia is the temporary loss of sensation or pain in one part of the body produced by a topically applied or injected agent without depressing the level of consciousness. Prevention of pain during dental procedures can nurture the relationship of the patient and dentist, building trust, allaying fear and anxiety, and promoting a positive dental attitude. The technique of local anesthetic administration is an important consideration in the behavior guidance of a pediatric patient. Age-appropriate "non-threatening" terminology, distraction, topical anesthetics, proper injection technique, and nitrous oxide/oxygen analgesia/anxiolysis can help the patient have a positive experience during administration of local anesthesia.[1,2] In pediatric dentistry, the dental professional should be aware of proper dosage (based on weight) to minimize the chance of toxicity and the prolonged duration of anesthesia, which can lead to accidental lip or tongue trauma. Knowledge of the 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). Familiarity with the patient's medical history is essential to decrease the risk of aggravating a medical condition while rendering dental care. Appropriate medical consultation should be obtained when needed.

Many local anesthetic agents are available to facilitate management of pain in the dental patient. There are 2 general types of local anesthetic chemical formulations: (1) esters (eg, procaine, benzocaine); and (2) amides (eg, lidocaine, mepivacaine, prilocaine, articaine).[3] Local anesthetics are vasodilators; they eventually are absorbed into the circulation, where their systemic effect is related directly to their blood plasma level.[4] Vasoconstrictors are added to local anesthetics to constrict blood vessels in the area of injection. This lowers the absorption of the local anesthetic into the blood stream, thereby lowering the risk of toxicity and prolonging the anesthetic action in the area.[4] Epinephrine is contraindicated in hyperthyroid patients.[5] Its dose should be kept to a minimum in patients receiving tricylic antidepressants since dysrhythmias may occur. Levonordefrin and norepinephrine are absolutely contraindicated in these patients.[6] Patients with significant cardiovascular disease, thyroid dysfunction, diabetes, or sulfite sensitivity and those receiving monoamine oxidase inhibitors, tricyclic antidepressants, or phenothiazines may require a medical consultation to determine the need for a local anesthetic without vaso-constrictor.[6,7] When halogenated gases (eg, halothane) are used for general anesthesia, the myocardium is sensitized to epinephrine. Such situations dictate caution with use of a local anesthetic.[6] 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.[7,8]

If a local anesthetic is injected into an area of infection, its onset will be delayed or even prevented.[3] The inflammatory process in an area of infection lowers the pH of the extracellular tissue from its normal value (7.4) to 5 to 6 or lower. This low pH inhibits anesthetic action because little of the free base form of the anesthetic is allowed to cross into the nerve sheath to prevent conduction of nerve impulses.[9] Inserting a needle into an active site of infection also could lead to possible spread of the infection.

Recommendations
Topical anesthetics
The application of topical anesthetic may help minimize discomfort caused during administration of local anesthesia. Topical anesthetic is effective on surface tissues (2-3 mm in depth) to reduce painful needle penetration of the oral mucosa.[10,11] A variety of topical anesthetic agents are available in gel, liquid, ointment, patch, and aerosol forms.

The topical anesthetic benzocaine is manufactured in concentrations up to 20%; lidocaine is available as a solution or ointment up to 5% and as a spray up to a 10% concentration.[3]

Benzocaine has a rapid onset. Benzocaine toxic (overdose) reactions are virtually unknown. Localized allergic reactions, however, may occur after prolonged or repeated use.[12] Topical lidocaine has an exceptionally low incidence of allergic reactions but is absorbed systemically and can combine with an injected amide local anesthetic to increase the risk of overdose.[13]

Recommendations:

1. Topical anesthetic may be used prior to the injection of a local anesthetic to reduce discomfort associated with needle penetration.
2. The pharmacological properties of the topical agent should be understood.
3. A metered spray is suggested if an aerosol preparation is selected.
4. Systemic absorption of a lidocaine topical anesthetic must be considered when calculating the total amount of anesthetic administered.

Selection of syringes and needles

The American Dental Association (**ADA**) has established standards for aspirating syringes for use in the administration of local anesthesia.[14,15] Needle selection should allow for profound local anesthesia and adequate aspiration. Larger gauge needles provide for less deflection as the needle passes through soft tissues and for more reliable aspiration.[16] 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). Needle gauges range from size 23 to 30.

Recommendations:

1. For the administration of local dental anesthesia, dentists should select aspirating syringes that meet ADA standards.
2. Short needles may be used for any injection in which the thickness of soft tissue is less than 20 mm. A long needle may be used for a deeper injection into soft tissue.[16] Any 23- through 30-gauge needle may be used for intraoral injections, since blood can be aspirated through all of them. Aspiration can be more difficult, however, when smaller gauge needles are used.[16] An extra-short, 30-gauge is appropriate for infiltration injections.[16]
3. Needles should not be bent or inserted to their hub for injections to avoid needle breakage.[16]

Injectable local anesthetic agents

Local amide anesthetics available for dental usage include lidocaine, mepivacaine, articaine, prilocaine, and bupivacaine (Tables 1 and 2). Absolute contraindications for local anesthetics include a documented local anesthetic allergy.[17] True allergy to an amide is exceedingly rare. Allergy to one amide does not rule out the use of another amide, but allergy to one ester rules out use of another ester.[3] A bisulfate preservative is used in local anesthetics containing epinephrine. For patients having an allergy to bisulfates, use of a local anesthetic without a vasoconstrictor is indicated.[12]

A long-acting local anesthetic (ie, bupivacaine) is not recommended for the child or the physically or mentally disabled patient due to its prolonged effect, which increases the risk of soft tissue injury.[17] 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.[17] Studies using articaine, lidocaine, and prilocaine, however, did not substantiate these claims.[17,18]

Table 1. INJECTABLE LOCAL ANESTHETICS

	Duration in minutes[3,17]						
	Maxillary infiltration		Mandibular block		Maximum dosage[17]		Maximum total dosage[17]
Anesthetic	**Pulp**	**Soft tissue**	**Pulp**	**Soft tissue**	**mg/kg**	**mg/lb**	**(mg)**
Lidocaine					4.4	2.0	300
2% plain	5		5-10				
2%+1:50,000 epinephrine	60	170	85	190			
2%+1:100,000 epinephrine	60	170	85	190			
Mepivacaine					4.4	2.0	300
3% plain	25	90	40	165			
2%+1:100,000 epinephrine	60	170	85	190			
2%+1:20,000 levonordefrin	50	130	75	185			
Articaine					7.0	3.2	500
4%+1:100,000 epinephrine	60	190	90	230			
Prilocaine					6.0	2.7	400
4% plain	20	105	55	190			
4%+1:200,000 epinephrine	40	140	60	220			
Bupivacaine					1.3	0.6	90
0.5%+1:200,000 epinephrine	40	340	240	440			

Table 2. DOSAGE PER DENTAL CARTRIDGE[3]

Anesthetic	mg/1.8 ml cartridge	Vasoconstrictor/1.8 ml cartridge
Lidocaine		
2% plain	36	N/A
2%+1:50,000 epinephrine	36	36 µg or 0.036 mg
2%+1:100,000 epinephrine	36	18 µg or 0.018 mg
Mepivacaine		
3% plain	54	N/A
2%+1:100,000 epinephrine	36	18 µg or 0.018 mg
2%+1:20,000 levonordefrin	36	90 µg or 0.090 mg
Articaine		
4%+1:100,000 epinephrine	72	18 µg or 0.018 mg
Prilocaine		
4% plain	72	N/A
4%+1:200,000 epinephrine	72	9 µg or 0.009 mg
Bupivacaine		
0.5%+1:200,000 epinephrine	9	9 µg or 0.009 mg

Epinephrine decreases bleeding in the area of injection. Epinephrine concentrations of 1:50,000 may be indicated for infiltration in small doses into a surgical site to achieve hemostasis, but are not indicated in children to control pain.[12]

An end product of prilocaine metabolism can induce formation of methemoglobin, reducing the blood's oxygen-carrying capacity. In patients with subclinical methemoglobinemia[19] or with toxic doses (>6 mg/kg), prilocaine can induce methemoglobinemia symptoms[20] (eg, gray or slate blue cyanosis of the lips, mucous membranes, and nails; respiratory and circulatory distress).[6] Prilocaine may be 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.[17]

Recommendations:

1. Selection of local anesthetic agents should be based upon:
   a. the patient's medical history and mental/developmental status;
   b. the anticipated duration of the dental procedure;
   c. the need for hemorrhage control;
   d. the planned administration of other agents (eg, nitrous oxide, sedative agents, general anesthesia);
   e. the practitioner's knowledge of the anesthetic agent.
2. Use of vasoconstrictors in local anesthetics is recommended to decrease the risk of toxicity of the anesthetic agent.
3. In cases of bisulfate allergy, use of a local anesthetic without a vasoconstrictor is indicated. A local anesthetic without a vasoconstrictor also can be used for shorter treatment needs.
4. The established maximum dosage for any anesthetic should not be exceeded.

Documentation of local anesthesia

The patient record is an essential component of the delivery of competent and quality oral health care.[21] 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.

Recommendations:

1. Documentationtion must include the type and dosage of local anesthetic in milligrams. Vasoconstrictors, if any, must be noted either in milligrams or concentration (eg, 36 mg lido with 0.018 mg epi or 36 mg lido with 1:100,000 epi).[2]
2. Documentation may include the type of injection(s) given (eg, infiltration, block, intraosseous), needle selection and patient's reaction to the injection.
3. Postoperative instructions (eg, behavioral and dietary precautions) should be given to the patient and/or caregiver.
4. If the local anesthetic was administered in conjunction with sedative drugs, the doses of all agents must be noted on a time-based record.
5. In patients for whom the maximum dosage of local anesthetic may be a concern, the weight should be documented mented preoperatively.

Local anesthetic complications

Toxicity (overdose)

Most adverse drug reactions develop either during the injection or within 5 to 10 minutes.[12] Overdose of local anesthetic can result from high blood levels caused by a single inadvertent intravascular injection or repeated injections.[3] Local anesthetic causes a biphasic reaction (ie, excitation followed by depression) in the central nervous system (**CNS**). Early subjective indications of toxicity involve the CNS and include dizziness, anxiety, and confusion. This may be followed by diplopia, tinnitis, 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 possible respiratory arrest may occur.[3]

The cardiovascular system (**CVS**) response to local anesthetic toxicity also is biphasic. The CVS is more resistant to local anesthetics than the CNS.[22] Initially, during CVS 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 local anesthetic blood level.[12]

Local anesthetic toxicity can be prevented by careful injection technique, watchful observation of the patient, and knowledge of the maximum dosage based on weight. Practitioners should aspirate before every injection and inject slowly.[12] 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 is based on the severity of the reaction.[3,12]

Allergy to local anesthesia

Allergic reactions are not dose dependant but are due to the patient's heightened capacity to react to even a small dose. Allergies can manifest in a variety of ways, some of which include urticaria, dermatitis, angioedema, fever, photosensitivity, or anaphylaxis.[12] 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 produce paresthesia and, among other etiologies, trauma can be caused by the needle during the injection.[23] The patient may experience an "electric shock" in the involved nerve distribution area. Paresthesia also can be caused by hemorrhage in or around the nerve.[24] Risk of permanent paresthesia is 1:1,200,000 for 0.5%, 2%, and 3% local anesthetics and 1:500,000 for 4% local anesthetics.[23] Reports of paresthesia are more common with articaine and prilocaine than expected from their frequency of use. Paresthesia unrelated to surgery most often involves the tongue, followed by the lip, and is more common with 4% solutions of articaine or prilocaine.[24] Most cases resolve in 8 weeks.[25]

Postoperative soft tissue injury

Self-induced soft tissue trauma is an unfortunate clinical complication of local anesthetic use in the oral cavity. Most lip- and cheek-biting lesions of this nature are self-limiting and heal without complications, although bleeding and infection possibly may result. 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.[26] In fact, the frequency of soft tissue trauma was much higher than expected when only 1 side was anesthetized. Using mandibular infiltration vs blocks is not of great value in prevention of these injuries, since the duration of soft tissue anesthesia may not be reduced significantly. In addition, for some procedures, infiltration is not as effective as the mandibular block.[27]

Caregivers responsible for postoperative supervision should be given a realistic time for duration of numbness and informed of the possibility of soft tissue trauma. Placing cotton rolls has been suggested for prevention.[28] Visual examples also 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.

Recommendations for local anesthetic complications:

1. Practitioners who utilize any type of local anesthetic in a pediatric dental patient shall possess appropriate training and skills and have available the proper facilities, personnel, and equipment to manage any reasonably foreseeable emergency.
2. Care should be taken to ensure proper needle placement during the intraoral administration of local anesthetics. Practitioners should aspirate before every injection and inject slowly.
3. After the injection, the doctor, hygienist, or assistant should remain with the patient while the anesthetic begins to take effect.
4. Residual soft tissue anesthesia should be minimized in pediatric and special health care needs patients to decrease risk of self-inflicted postoperative injuries.
5. Practitioners should advise patients and their caregivers regarding appropriate behavioral precautions and the possibility of soft tissue trauma following the administration of local anesthesia.

Supplemental injections to obtain local anesthesia

The majority of 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 (ie, periodontal ligament [**PDL**], intraligamentary, and peridental injection), "needleless" systems, and intraseptal or intrapulpal injection. These techniques may improve comfort of injection by better control of the administration rate, pressure, and location of anesthetic solutions and/or result in successful and more controlled anesthesia. Endocarditis prophylaxis is recommended for intraligamentary local anesthetic injections in patients at risk.[29]

Intraseptal injection for lingual anesthesia is a variation in technique after the buccal tissue is anesthetized. The needle is inserted through the buccal tissue to anesthetize the lingual/palatal soft tissues. It can be used with the PDL injection to gain lingual anesthesia when postoperative soft tissue trauma is a concern.[29] During pulpal therapy, administering local anesthetic directly into the pulp may be indicated when other methods fail to anesthetize the tooth.[30]

As with traditional methods of obtaining oral local anesthesia, the alternative methods generally are safe if the practitioner understands the principles for their use. Some of these techniques are desirable, especially in infant, child, and adolescent patients, since specific teeth may be anesthetized with less residual anesthesia (ie, avoid discomfort and potential

self-mutilation of block anesthesia).[30] The mandibular bone of a child usually is less dense than that of an adult, permitting more rapid and complete diffusion of the anesthetic.[9] Mandibular buccal infiltration anesthesia is as effective as inferior nerve block anesthesia for some operative procedures.[9,27] In patients with bleeding disorders, the PDL injection minimizes the potential for postoperative bleeding of soft tissue vessels.[6] Intraosseus techniques may be contraindicated with primary teeth due to potential for damage to developing permanent teeth.[30] Also, the use of the PDL injection or intraosseus methods is contraindicated in the presence of inflammation or infection at the injection site.[30]

Recommendation:

Alternative techniques for the delivery of local anesthesia may be considered to minimize the dose of anesthetic used, improve patient comfort, and/or improve successful dental anesthesia.

Local anesthesia with sedation, general anesthesia, and/or nitrous oxide/oxygen analgesia/anxiolysis

Drugs that have the same mechanism of action often will have additive effects when used together. Local anesthetics and sedative agents both depress the CNS. An increase in toxic reactions of local anesthetics when combined with opioids has been demonstrated.[31] Narcotics may decrease the amount of protein binding of local anesthetics and also elevate arterial carbon dioxide, both of which will increase CNS sensitivity to convulsions. In addition, narcotics such as meperidine have convulsant properties when excessive doses are administered. It has been suggested that the dose of local anesthesia be adjusted downward when sedating children with opioids.[31]

Using local anesthesia has been found to reduce the dosage of inhalation anesthetics for patients undergoing general anesthesia.[32] 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 (eg, halothane).[33] Local anesthesia also has been reported to reduce pain in the postoperative recovery period after general anesthesia.[34]

Recommendations:

1. Particular attention should be paid to local anesthetic doses used in children. To avoid excessive doses for the patient who is going to be sedated, a maximum recommended dose based upon weight should be calculated.
2. The dosage of local anesthetic should not be altered if nitrous oxide/oxygen analgesia/anxiolysis is administered.
3. When general anesthesia is employed, local anesthesia may be used to reduce the maintenance dosage of the anesthetic drugs. The anesthesiologist should be informed of the type and dosage of the local anesthetic used. Recovery room personnel also should be informed.

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