Guideline on 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 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

This revision included a new systematic literature search of the MEDLINE/Pubmed® electronic database using the following parameters: Terms: dental anesthesia, dental local anesthesia, and topical anesthesia; Field: all fields; Limits: within the last 10 years, humans, English, and clinical trials. One thousand one hundred thirty articles matched these criteria. Papers for review were chosen from this list and from references within selected articles. 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. 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 "nonthreatening" 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, tetracaine); 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 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.[4] Epinephrine is contraindicated in patients with hyperthyroidism.[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 vasoconstrictor.[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]

Compounded topical anesthetics also are available.[14,15] Two of the more common formulations contain 20% lidocaine, 4% tetracaine, and 2% phenylephrine or 10% lidocaine, 10% prilocaine, 4% tetracaine, and 2% phenylephrine.[15] Compounded topical anesthetics have been used in orthodontic procedures for placement of mini-screw implants to aid tooth movement,[14,16] as well as in pediatric dentistry to anesthetize palatal tissues prior to injection and for extraction of loose primary teeth without the need for an injection. They contain high doses of both amide and ester agents and are at risk for side effects.[15] The US Food and Drug Administration does not regulate compounded topical anesthetics and recently issued warning about their use.[17,18]

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 the drugs in topical anesthetics must be considered when calculating the total amount of anesthetic administered.

The AAPD recommends further investigation regarding the safety and efficacy of compounded topical anesthetics and their applications for pediatric dental patients.

Selection of syringes and needles

The American Dental Association (**ADA**) has established standards for aspirating syringes for use in the administration of local anesthesia.[19,20] Needle selection should allow for profound local anesthesia and adequate aspiration. Larger gauge needles provide for less deflection as the needle passes through

Table 1. INJECTABLE LOCAL ANESTHETICS

	Duration in minutes[3,23]				Maximum dosage[23]		Maximum total dosage[23]*
	Maxillary infiltration		Mandibular block				
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			

* Total dosage should be based on child's weight and should never exceed maximum total dosage.

Table 2. DOSAGE PER DENTAL CARTRIDGE[3]

Anesthetic	mg/1.7 ml OR 1.8 ml cartridge	Vasoconstrictor/1.7 ml OR 1.8 ml cartridge
Lidocaine		
2% plain	34 OR 36	N/A
2%+1:50,000 epinephrine	34 OR 36	34 µg or 0.034 mg OR 36 µg or 0.036 mg
2%+1:100,000 epinephrine	34 OR 36	17 µg or 0.017 mg OR 18 µg or 0.018 mg
Mepivacaine		
3% plain	51 OR 54	N/A
2%+1:100,000 epinephrine	34 OR 36	17 µg or 0.017 mg OR 18 µg or 0.018 mg
2%+1:20,000 levonordefrin	34 OR 36	85 µg or 0.085 mg OR 90 µg or 0.090 mg
Articaine		
4%+1:100,000 epinephrine	68 OR 72	17 µg or 0.017 mg OR 18 µg or 0.018 mg
Prilocaine		
4% plain	68 OR 72	N/A
4%+1:200,000 epinephrine	68 OR 72	8.5 µg or 0.0085 mg OR 9 µg or 0.009 mg
Bupivacaine		
0.5%+1:200,000 epinephrine	8.5 OR 9	8.5 µg or 0.0085 mg OR 9 µg or 0.009 mg

soft tissues and for more reliable aspiration.[21] 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. Needle breakage is a rare occurrence. The primary cause of needle breakage is weakening the needle due to bending it before insertion into the soft tissues; another cause is patient movement after the needle is already inserted.[22]

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.[21] 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.[21] An extra-short, 30-gauge is appropriate for infiltration injections.[21]
3. Needles should not be bent if they are to be inserted into soft tissue to a depth of >5 mm or inserted to their hub for injections to avoid needle breakage.[21]

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.[23] 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] Local anesthetics without vasoconstrictors should be used with caution due to rapid systemic absorption which may result in overdose.[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.[23] 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.[23] Studies using articaine, lidocaine, and prilocaine, however, did not substantiate these claims.[23,24]

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] Local anesthetics that contain vasopressors help reduce toxicity by slowing the rate of absorption of the anesthetic and/or vasopressor into the cardiovascular system.[12] A vasopressor-containing local anesthetic should be used when treatment extends to 2 or more quadrants in a single visit.[12]

An end product of prilocaine metabolism can induce formation of methemoglobin, reducing the blood's oxygen-carrying capacity. In patients with subclinical methemoglobinemia[25] or with toxic doses (>6 mg/kg), prilocaine can induce methemoglobinemia symptoms[26] (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.[23]

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, especially when treatment extends to 2 or more quadrants in a single visit.
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 but should be used with caution to minimize the risk of toxicity of the anesthetic agents.
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.[27] 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. Documentation must include the type and dosage of local anesthetic. Dosage of vasoconstrictors, if any, must be noted. (For example, 34 mg lido with 0.017 mg epi or 34 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. If the local anesthetic was administered in conjunction with sedative drugs, the doses of all agents must be noted on a time-based record.
4. In patients for whom the maximum dosage of local anesthetic may be a concern, the weight should be documented preoperatively.
5. Documentation should include that post-injection instructions were reviewed with the patient and parent.

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 (eg, 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 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.[28] 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.[29] 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.[30] 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.[29] 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.[30] Most cases resolve in 8 weeks.[31]

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.[32] 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.[33]

Caregivers responsible for postoperative supervision should be given a realistic time for duration of numbness and informed of the possibility of 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.[34,35] However, there is no research demonstrating a relationship between reduction in soft tissue trauma and the use of shorter acting local anesthetics.[36]

Recommendations to reduce 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 behavioral precautions (eg, do not bite or suck on lip/cheek, do not ingest hot substances) and the possibility of soft tissue trauma while anesthesia persists. Placing a cotton roll in the mucobuccal fold may help prevent injury, and lubricating the lips with petroleum jelly helps prevent drying.[36] Practitioners who use pheytolamine mesylate injections to reduce the duration of local anesthesia still should follow these recommendations.

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.[37]

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.[38] During pulpal therapy, administering local anesthetic directly into the pulp may be indicated when other methods fail to anesthetize the tooth.[38]

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 infants, children, adolescents, and special health care needs patients, since specific teeth may be anesthetized with less residual anesthesia (ie, avoid discomfort and potential self-mutilation of block anesthesia).[38] 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.[9,33] 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.[38]

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.[39] 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.[39]

Using local anesthesia has been found to reduce the dosage of inhalation anesthetics for patients undergoing general anesthesia.[40] 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).[41] Local anesthesia also has been reported to reduce pain in the postoperative recovery period after general anesthesia.[42]

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.

References

1. Nathan JE, Venham LL, West MS, Werboff J. The effects of nitrous oxide on anxious young pediatric patients across sequential visits: A double-blind study. ASDC J Dent Child 1988;55(3):220-30.
2. Malamed SF. Basic injection technique in local anesthesia. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:159-69.
3. Haas DA. An update on local anesthetics in dentistry. J Can Dent Assoc 2002;68(9):546-51.
4. Malamed SF. Pharmacology of vasoconstrictors. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:41-54.
5. Pérusse R, Goulet JP, Turcotte JY. Contraindications to vasoconstrictors in dentistry: Part II. Hyperthyroidism, diabetes, sulfite sensitivity, cortico-dependant asthma, and pheochromocytoma. Oral Surg Oral Med Oral Pathol 1992;74(5):687-91.
6. Malamed SF. Physical and psychological evaluation. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:141-56.
7. Goulet JP, Perusse R, Turcotte JY. Contraindications to vasoconstrictors in dentistry: Part III. Pharmacologic interactions. Oral Surg Oral Med Oral Pathol 1992;74(5):692-7.
8. Gielen M, Viering W. 3-in-1 lumbar plexus block for muscle biopsy in malignant hyperthermia patients: Amide local anesthetics may be used safely. Acta Anaesthesiol Scand 1986;30(7):581-3.
9. Malamed SF. Local anesthetic considerations in dental specialties. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:269, 274-5.
10. Jeske AH, Blanton PL. Misconceptions involving dental local anesthesia. Part 2: Pharmacology. Tex Dent J 2002;119(4):310-4.
11. Rosivack RG, Koenigsberg SR, Maxwell KC. An analysis of the effectiveness of two topical anesthetics. Anesth Prog 1990;37(6):290-2.
12. Malamed SF. Systemic complications. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:311-25.
13. Malamed SF. Additional armamentarium. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:120.
14. Graham JW. Profound, needle-free anesthesia in orthodontics. Clin Ortho 2006;40(12):723-4.
15. Kravitz ND. The use of compound topical anesthetics: A review. J Am Dent Assoc 2007;138(10)1333-9.
16. Kravits ND, Kusnoto B, Tsay TP, Hohlt WF. The use of temporary anchorage devices for molar intrusion. J Am Dent Assoc 2007;138(1):56-64.
17. US Food and Drug Administration. FDA public health advisory: Life-threatening side effect with the use of skin products containing numbing ingredients for cosmetic procedures. Available at: "http://www.fda.gov/cder/drug/advisory/topical_anesthetics.htm". Accessed November 15, 2008.
18. US Dept for Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research. Guidance for FDA staff and industry: Marketed unapproved drugs–Compliance policy guide. Sec 440.100 Marketed new drugs without approved NDAs or ANDAs. Available at "http://www.fda.gov/cder/guidance/6911fnl.pdf". Accessed November 15, 2008.
19. American Dental Association Council on Dental Materials and Devices. New American National Standards Institute/American Dental Association specification no. 34 for dental aspirating syringes. J Am Dent Assoc 1978;97(2):236-8.
20. American Dental Association Council on Dental Materials, Instruments, and Equipment. Addendum to American National Standards Institute/American Dental Association specification no. 34 for dental aspirating syringes. J Am Dent Assoc 1982;104(1):69-70.
21. Malamed SF. The needle. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:99-107.
22. Malamed SF. Local complications. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:285-7.
23. Malamed SF. Clinical action of specific agents. In: Handbook of Local Anesthesia. 5th ed. St Louis, Mo: Mosby; 2004:55-81.
24. Haas DA, Harper DG, Saso MA, Young ER. Lack of differential effect by Ultracaine (articaine) and Citanest (prilocaine) in infiltration anaesthesia. J Can Dent Assoc 1991;57(3):217-23.

25. Bellamy MC, Hopkins PM, Hallsall PJ, Ellis FR. A study into the incidence of methaemoglobinaemia after "three-in-one" block with procaine. Anaesthesia 1992;47(12): 1084-5.
26. Hardwick FK, Beaudreau RW. Methemoglobinemia in renal transplant patient: Case report. Pediatr Dent 1995; 17(7):460-3.
27. American Academy of Pediatric Dentistry. Guideline on record-keeping. Pediatr Dent 2008;30(suppl):226-33.
28. Scott DB. Toxicity caused by local anesthetic drugs. Br J Anaesth 1981;53(6):553-4.
29. Haas DA. Local complications. In: Malamed SF, ed. Handbook of Local Anesthesia. 5th ed. St Louis, Mo: Mosby; 2004:288-9.
30. Haas DA, Lennon D. A 21-year retrospective study of reports of paresthesia following local anesthetic administration. J Can Dent Assoc 1995;61(4):319-20, 323-6, 329-30.
31. Nickel AA. A retrospective study of reports of paresthesia following local anesthetic administration. Anesth Prog 1990;37(1):42-5.
32. College C, Feigal R, Wandera A, Strange M. Bilateral vs unilateral mandibular block anesthesia in a pediatric population. Pediatr Dent 2000;22(6):453-7.
33. Oulis C, Vadiakas G, Vasilopoulou A, The effectiveness of mandibular infiltration compared to mandibular block anesthesia in treating primary molars in children. Pediatr Dent 1996;18(4):301-5.
34. Tavares M, Goodson MJ, Studen-Pavlovich D, et al. Reversal of soft-tissue local anesthesia with phentolamine mesylate in pediatric patients. J Am Dent Assoc 2008; 139(8):1095-104.
35. Hersh EV, Moore PA, Papas AS, et al. Reversal of soft-tissue local anesthesia with phentolamine mesylate in adolescents and adults. J Am Dent Assoc 2008;139(8): 1080-93.
36. Malamed SF. Anatomical considerations. In: Handbook of Local Anesthesia. 5th ed. St. Louis, Mo: Mosby; 2004:173-4.
37. Wilson W, Taubert KA, Gevitz P, et al. Prevention of infective endocarditis: Guidelines from the American Heart Association. Circulation e-published April 19, 2007. Available at: "http://circ.ahajournals.org/cgi/reprint/CIRCULATIONAHA.106.183095)". Accessed March 30, 2008. Correction Circulation. 2007;116:e376-e377. Available at: "htttp://circ.ahajournals.org/cgi/content/full/116/15/1736". Accessed May 23, 2008.
38. Malamed SF. Supplemental injection techniques. In: Handbook of Local Anesthesia. 5th ed. St Louis, Mo: Mosby; 2004:256-68.
39. Moore PA. Adverse drug reactions in dental practice: Interactions associated with local anesthetics, sedatives, and anxiolytics. J Am Dent Assoc 1999;130(4):541-4.
40. Barash PG, Cullen BF, Stoelting RK. Clinical Anesthesia. 2nd ed. Philadelphia, Pa: JB Lippincott Co; 1992:531.
41. Dionne RA, Phero JC, Becker DE. Management of Pain and Anxiety in the Dental Office. Philadelphia, Pa: WB Saunders; 2002:274-5.
42. Nick D, Thompson L, Anderson D, Trapp L. The use of general anesthesia to facilitate dental treatment. Gen Dent 2003;51(5):464-8.