Local Anesthetic Agents in Dentistry

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CE Credits: 1 hour
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Online Course: *www.dentalcare.com/en-us/professional-education/ce-courses/ce646*

Conflict of Interest Disclosure Statement

- Mr. Viola reports no conflicts of interest associated with this course. He has no relevant financial relationships to disclose.

Introduction – Local Anesthetic Agents

Participants in this course will be introduced to evidence-based information related to the pharmacology of local anesthetic agents and factors to consider in selecting the most effective and least toxic local anesthetic for perioperative pain management.

Course Contents

Overview

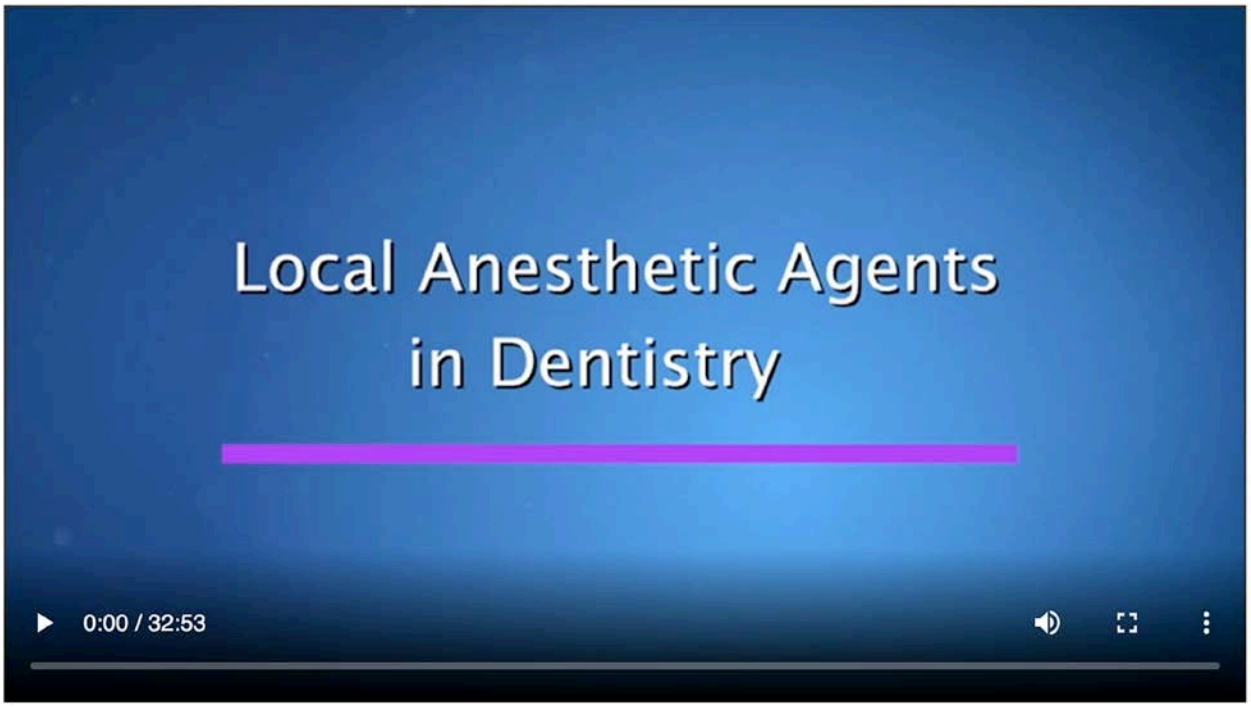
Participants in this course will be introduced to evidence-based information related to the pharmacology of local anesthetic agents (LAs); issues related to potency, onset, and duration of action of LAs as factors to be considered in selecting a LA for perioperative pain management; and precautions to consider with the use of LAs.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Discuss the pharmacology of LAs.
- Discuss the factors to consider in selecting the most effective and least toxic LA for perioperative pain management.
- Discuss precautions to consider with the use of LAs.

Video: Local Anesthetics



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Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/professional-education/ce-courses/ce646/test*

1. All the following statements related to LAs are correct EXCEPT which one?

A. LAs consist of an aromatic group connected by either an ester- or amide-linkage to an aliphatic chain, which contains a secondary or tertiary amine group.
B. Agents primarily used by dentists have an amide-linkage and lidocaine is the prototypical amide or aminoamide LA.
C. Procaine produces psychological and physical dependence, mood alteration, CNS and cardiac excitation, and intense vasoconstriction.
D. The structural components of LAs affect their pharmacological characteristics.

2. All the following statements related to homeostatic mechanisms in excitable neuronal cells are correct EXCEPT which one?

A. Excitable neuronal cells maintain a chemical gradient with low extracellular sodium and low intracellular potassium concentrations.
B. In resting state, the inside of neuronal cells is electronegative (-50 to -90 mV) and the outside is electropositive.
C. Nociceptive or painful stimuli alter the distribution of sodium and potassium ions and briefly reverse electrical polarity.
D. The energy generated by neuronal depolarization may activate voltage-gated sodium channels.

3. All the following statements related to action potential generation and LAs' interaction with its receptors are correct EXCEPT which one?

A. If the threshold energy level required for the activation of voltage-gated sodium channels is reached, sodium ions flow into the cell and an action potential is generated.
B. LAs irreversibly reduce the amplitude and conduction velocity of action potentials by interacting with their receptors located on voltage-gated sodium channels.
C. The sites of action of LAs on voltage-gated sodium channels are located on the cytosolic side of these large membrane proteins.
D. From the site of administration, to interact with their receptors, LAs must diffuse across lipophilic neuronal membranes.

4. All the following statements related to the ability of LAs to cross biological membranes are correct EXCEPT which one?

A. LAs cross neuronal membranes by passive diffusion as function of its pKa or dissociation constant and the pH of the environment at the site of drug administration.
B. LAs are weak bases, in an aqueous environment they exist as a mixture of protonated or positively charged (ionized) and deprotonated or neutral (unionized) molecules.
C. Unionized LA molecules are unable to reach their receptors or diffuse into the circulation and become trapped at the site of administration.
D. When lidocaine with a pKa of 7.9 is deposited into an infected/inflamed site with a pH less than 7.9, more than 50% of its molecules become ionized.

5. All the following statements related to LAs' absorption into and distribution from the vascular compartment are correct EXCEPT which one?

A. The rate of absorption of LAs into the systemic circulation is predicated on passive diffusion.
B. In the vascular compartment, LAs bind to albumin, α-1 acid glycoproteins, and erythrocytes.
C. The protein-binding capacity of an LA affects drug distribution from the vascular compartment to other body fluids or tissues, including LAs' ability to reach their receptors.
D. The rapid decline in drug plasma levels due to the drug's distribution to well-perfused tissues (i.e., brain, liver, heart, kidneys, and lungs) reflect the drug's distribution half-life.

6. All the following statements related to LAs' volume of distribution (V_d) and elimination half-life ($T_{1/2\beta}$) are correct EXCEPT which one?

A. The degree of LAs' tissue uptake is expressed as its V_d.
B. LAs with lower plasma protein-binding capacity have a greater V_d.
C. A LA's lipid solubility has no effect on its Vd.
D. The V_d of LAs is the primary determinant of its elimination half-life ($T_{1/2\beta}$).

7. All the following statements are correct with respect to the metabolism of LAs EXCEPT which one?

A. The metabolism of aminoamide-type LAs takes place primarily in the liver by cytochrome P450 isoenzymes CYP3A4 and CYP1A2.
B. With some exceptions, the excretion of metabolites and any unchanged LA takes place in the kidneys.
C. Prilocaine is unique in that it contains a thiophene-based nucleus and is rapidly inactivated via hydrolysis by plasma carboxylesterase.
D. As a rule, aminoamide-type LAs require 5 half-lives, i.e., $T_{1/2\beta}$ x 5, for systemic clearance.

8. All the following statements related to adjuvants in LAs are corrects EXCEPT which one?

A. Adjuvants include citric acid and edetate calcium, an antioxidant and a stabilizer, respectively.
B. The adjuvant sodium chloride produces isotonicity.
C. Sodium hydroxide and/or hydrochloric acid is/are added to increase the pH of the solution.
D. The vasoconstrictors epinephrine or levonordefrin are added to decrease LAs' rate of diffusion into excitable neuronal cells.

9. All the following statements relative to a LA's potency are correct EXCEPT which one?

A. Lipid solubility, which is a function of the aromatic group, affects the ability of LAs to pass through biological membranes.
B. As lipid solubility increases, the partition of drugs through the neuronal membrane decreases.
C. The primary determinant of a LA's potency is its partition coefficient.
D. The relative potencies of LAs are reflected by their concentrations in aqueous formulations.

10. All the following statements relative to a LAs' onset of action are correct EXCEPT which one?

A. The amine group confers hydrophilicity and in aqueous solutions LAs exist as a mixture of protonated and deprotonated forms.
B. The ration of protonated to deprotonated forms is predicated on the drug's dissociation constant (pKa) and the pH of the environment.
C. The closer is a LA's pKa to the pH at the site of its administration (physiologic pH of 7.4), greater is its ionized fraction that can translocate across neuronal membranes.
D. Since only the deprotonated form can translocate across neuronal membranes, the pKa is the primary determinant of a LAs onset of action.

11. All the following statements related to LAs' duration of action are correct EXCEPT which one?

A. The receptor site for LAs, i.e., the voltage gated sodium channel, is an integral membrane protein.
B. LAs with low protein-binding capacity bind more tightly and dissociate slowly from their receptor sites.
C. LAs' protein-binding capacity is the primary determinant of its duration of action.
D. The duration of action of LAs is also modulated by their lipid solubility, vascularity at the injection site, and the presence of a vasoconstrictor in the formulation, and dosing.

12. In general, which of the following is the LA of choice, because of its longer duration of action, when the use of a vasoconstrictor is contraindicated?

A. Lidocaine 2% plain
B. Mepivacaine 3% plain
C. Prilocaine 4% plain
D. Mepivacaine 2% with levonordefrin 1:20,000

13. A practical approach to determine the dosage of LAs in healthy adults is based on weight, e.g., milligram of drug per pound of body weight; however, if a patient's weight is ≥150 lbs. no more than the maximum recommended dose (MRD) should be administered.

A. True
B. False

14. All the following statements related to vasoconstrictors in LAs formulations are correct EXCEPT which one?

A. To minimize medication errors, it is prudent to think of dosage strengths in ratio expressions, e.g., 1:100,000, rather than mg/mL of the vasoconstrictor in the formulation.
B. The maximum recommended dose (MRD) of epinephrine in healthy adults is 0.2 mg per visit.
C. Levonordefrin, 0.05 mg, is bioequivalent to epinephrine, 0.01 mg; consequently, the MRD of levonordefrin is 1 mg.
D. In high-risk populations, a dose of 0.02 to 0.05 mg of epinephrine is recommended.

15. All the following statements related to MRDs of LAs' are correct EXCEPT which one.

A. The maximum safe dose of 2% lidocaine w/epinephrine 1:100,000 (0.01 mg/mL) is 20 mL.
B. The MRD of 2% lidocaine (500 mg) with epinephrine 1:50,000 is reached before the MRD of epinephrine (0.02 mg/mL).
C. With mepivacaine 2% w/ levonordefrin 1:20.000, the MRD of mepivacaine (400 mg) and the MRD of levonordefrin (1 mg) are both reached at 20 mL of the LA.
D. Based on the MRD of articaine 4% (500 mg) with epinephrine 1:100,000 (0.01 mg/mL) or 1:200,000 (0.005 mg/mL), the MRD of articaine is 12.5 ml.

16. All the following statements related to LAs' local toxicity are correct ECEPT which one?

A. LA-induced epithelial and vascular reactions may include edema, desquamation, and ischemic necrosis.
B. Injection into muscles may result in LA-associated myotoxicity and vasoconstrictor-associated necrosis.
C. Most cases of LA-induced neurotoxicity manifest as permanent anesthesia or paresthesia of the lip, tongue, and other oral tissues.
D. The reported incidence of permanent paresthesia following mandibular nerve block is significantly higher with 4% LA formulations.

17. All the following statements related to LAs' CNS toxicity are correct EXCEPT which one?

A. The excitatory CNS effects of LAs are characterized by lightheadedness, restlessness, anxiety, apprehension, euphoria, confusion, dizziness, tinnitus, blurred or double vision, twitching, tremors, and rarely convulsions.
B. The excitatory manifestations of LAs' CNS toxicity are prolonged.
C. CNS depressant effects of LAs include drowsiness progressing to unconsciousness, respiratory depression, and finally, respiratory arrest.
D. LAs' CNS toxicity may include nausea, vomiting, chills, and miosis.

18. With high plasma concentration of LAs, early signs of reduced cardiac output include sweating, faintness, and altered mentation; followed by bradycardia, hypotension, and progressive cerebral hypoxia leading to seizures; and, finally, may progress to ventricular arrhythmias, atrioventricular block, and cardiac arrest.

A. True
B. False

19. All the following statements related to LA-induced allergic reactions are correct EXCEPT which one?

A. A breakdown product of ester-type LAs, para-aminobenzoic acid (PABA), can sensitize lymphocytes or eliciting the formation of IgE antibodies.
B. Allergy to amide-type LAs and cross sensitivity among members of amide-type LAs is common.
C. LAs with a vasoconstrictor contain metabisulfite that may precipitate an allergic reaction in susceptible patients.
D. The prevalence of sulfite sensitivity in the general population is unknown, but sulfite sensitivity is seen more frequently in patients with asthma.

20. All the following statements related to epinephrine toxicity are correct EXCEPT which one?

A. Epinephrine has a relatively narrow therapeutic window, reaching peak plasma levels in 5-10 minutes.
B. Since epinephrine crosses the blood-brain barrier, epinephrine-associated ADRs are the result of CNS effects.
C. Signs and symptoms of epinephrine toxicity include restlessness, agitation, anxiety, tremulousness, headache, dizziness, pallor, palpitation, and tachycardia.
D. In patients with Parkinson's disease, epinephrine may increase tremor and rigidity.

21. Particularly vulnerable populations, even to the effects of therapeutic doses of epinephrine, include all the following EXCEPT which one?

A. The young and the old
B. Those with high BP and severe cardiovascular diseases
C. Patients with uncontrolled hypothyroidism
D. Patients on nonselective β-adrenoceptor antagonists, which block β_2-adrenoceptor-mediated vasodilation resulting in unopposed α-adrenoceptor-induced vasoconstriction and high BP

22. All the following statements related to the use of LAs containing a vasoconstrictor during pregnancy are correct EXCEPT which one?

A. There is general concern that the β_1-adrenergic activity of epinephrine may decrease uterine contraction and prolong labor.
B. There is general concern that epinephrine's α_1-adrenergic activity may decrease uterine blood flow and fetal circulation.
C. Investigators have found that bolus doses of epinephrine up to 0.1 mg do not prolong labor.
D. Investigators have found that the use of LAs with epinephrine in healthy pregnant women does affect placental blood flow and fetal circulation.

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Additional Resources

- No Additional Resources Available.

About the Author

Thomas Viola, RPh, CCP

With over 30 years' experience as a board-certified pharmacist, clinical educator, professional speaker and published author, Tom Viola, RPh, CCP, has earned his national and international reputation as the go-to specialist for making pharmacology practical and useful for all members of the dental team. As the founder of Pharmacology Declassified, Tom provides valuable insight on the complex interplay between pharmacology and physiology so that clinicians may be knowledgeable about not only the dental considerations of medications used to treat systemic illness but also the systemic considerations of medications used to provide dental treatment. As an educator, Tom is a member of the faculty of over 10 dental professional degree programs and has received several awards for outstanding teacher of the year. As an author, Tom is well known for his contributions to several professional journals, has served as a contributor, chapter author and peer reviewer for several pharmacology textbooks and currently serves as a consultant to the American Dental Association's Council on Scientific Affairs. As a speaker, Tom has presented over 1000 informative, humorous and engaging continuing education seminars and webinars to dental professionals internationally since 2001. Meeting planners and attendees agree that Tom is their choice to educate within this dental specialty.

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