Review of Local Anesthetics With a Discussion of Prilocaine 4%

A Peer-Reviewed Publication
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This course was written for dentists, dental hygienists, and assistants.
Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. Be knowledgeable concerning the available local anesthetics and their chemical components
2. Understand the considerations involved in selecting a local anesthetic
3. Be knowledgeable about the recommended doses of local anesthesia for adults and children
4. Be knowledgeable about complications that can arise from use of local anesthesia

Abstract
Many studies show that prilocaine is as effective as any amide local anesthetic in the marketplace for adults and children. The choice of which local anesthetic to use might be decided upon by considering the duration of pulpal anesthesia required. Prilocaine can produce maximum pulpal anesthesia with minimal vasoconstrictor use, or it can provide short duration pulpal anesthesia with no vasoconstrictor use. As well, there are advantages to limiting or even completely eliminating vasoconstrictor from the local anesthetic solution. The patient’s medical history, acidification of tissues and pulpal insult are some of the factors to consider. Prilocaine is an effective drug to add to your local anesthesia armamentarium.

Introduction
When it comes to the use of local anesthetics, there are a variety of choices available to the practitioner. Historically, this was not the case. The first local anesthetic used in medicine was cocaine. This occurred in 1884 when Dr. Karl Koller used it for ophthalmic surgery. In that same year, Dr. William Halstead, a dentist from Baltimore mixed cocaine with boiling water and injected it in an effort to block the hemimandible. Due to the addictive and inebriating nature of cocaine use, the need to find a product that had the anesthetizing capabilities of cocaine without the other physical side effects became apparent. Thus in 1900, Alfred Einhorn was able to describe the molecular structure of cocaine. This in 1905 led to the synthesis of procaine (Novacaine) by Braun. Both cocaine and procaine are ester local anesthetics, which although wonder drugs in the early 1900’s, have some undesirable properties. These include long onset of action, short duration of action and relatively high allergenicity. To counter these disadvantages, Löfgren discovered lidocaine in 1943 and thus, the first amide local anesthetic became available with vastly improved properties over the ester products.

Today, there are a variety of amide injectable local anesthetics available. Factors that influence the choice of anesthetic may include whether or not a vasoconstrictor is desired, the anesthetic concentration, and the specific properties desired. Specific clinical factors such as bony and neuroanatomy, vascularity, pH, duration of anesthesia required, and the patient’s medical history, might also influence the choice of anesthetic. This paper will focus on the local anesthetic prilocaine. The pharmacology, advantages, disadvantages and other characteristics of this drug will be explored.

Availability
Local anesthetics for dentistry are classified as either amides or esters. Today, all injectable local anesthetics for dental use are amides, including prilocaine. It should be noted however that prilocaine can also be used as a topical anesthetic. Prilocaine was first prepared by Löfgren and Tegner in 1953 and was introduced into the United States dental marketplace in 1971 by Astra Pharmaceutical. Today, this drug remains one of the main choices utilized by dental practitioners. A study conducted in Ontario, Canada in 1995 surveyed dentists asking which type of local anesthetic they utilized. This study showed that prilocaine accounted for approximately 20% of all dental injections in Ontario (Figure 1). The chemical structure of prilocaine can be seen in Figure 2. This drug is chemically designated as propanamide, N-(2-methyl-phenyl)-2-(propylamino)-, monohydrochloride.

Figure 1. Local Anesthetic Use in Ontario, 1995

Figure 2. Chemical Structure of Prilocaine

Prilocaine is a white, odourless crystalline powder that is soluble in water and alcohol. In the United States, prilocaine is marketed as a 4% solution. It can be obtained as either a solution without a vasoconstrictor (Citanest® Plain DENTAL) or with a vasoconstrictor (Citanest® Forte DENTAL [with epinephrine 1:200,000]) both from DENTSPLY Pharmaceutical (York, Pennsylvania). The concentration of the vasoconstrictor is 1:200,000. Therefore in one cartridge, there is 0.009 mg of epinephrine.
One cartridge of Citanest DENTAL contains 1.8 ml of solution. Citanest Forte DENTAL (also 1.8 ml) contains these additional ingredients: 0.009 mg of epinephrine (1:200,000), sodium metabisulfite (an antioxidant for the vasoconstrictor) at 0.5 mg/ml, and citric acid (0.2 mg/ml). The pH of this solution is 3.3–5.5. Figure 3 shows the contents of these cartridges. Both Citanest DENTAL products are packaged in boxes of 100 cartridges, with 10 cartridges per sleeve.

**Figure 3. Cartridge Contents**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>CITANEST no epi</th>
<th>CITANEST with epi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prilocaine</td>
<td>Anesthesia 40mg/ml</td>
<td>40mg/ml</td>
</tr>
<tr>
<td>Epi bitartrate</td>
<td>Vasoconstrictor 0.005mg/ml</td>
<td></td>
</tr>
<tr>
<td>Citric acid</td>
<td>Buffer 0.2mg/ml</td>
<td></td>
</tr>
<tr>
<td>Sodium Metabisulphite</td>
<td>Antioxidant 0.5mg/ml</td>
<td></td>
</tr>
<tr>
<td>Sodium hydroxide and/or Hydrochloric acid</td>
<td>pH 6.0–7.0</td>
<td>3.3–5.5</td>
</tr>
<tr>
<td>Water for injection</td>
<td>Volume To 1.8 ml</td>
<td>To 1.8 ml</td>
</tr>
</tbody>
</table>

**Pharmacology**

Prilocaine is moderately lipophilic, similar to lidocaine but less lipophilic than bupivacaine. The lipophilic nature of a local anesthetic is important so that it is able to diffuse through the lipid membrane layer of the nerve sheath.

The product monograph for Citanest Plain DENTAL and Citanest Forte DENTAL (with epinephrine) list the following characteristics: The onset of action for infiltration anesthesia in the maxilla with Citanest Forte DENTAL (with epinephrine) is approximately 2 minutes with a duration for soft tissue anesthesia lasting around 2 hours and pulpal anesthesia approximately 45 minutes. Donaldson et al. tested the onset time of pulpal anesthesia following maxillary infiltrations with Citanest with epinephrine in adults. They reported an onset time of 97.5 seconds, close to the product monograph. Citanest Plain DENTAL (no vasoconstrictor) has a 2–3 minute onset of action for maxillary infiltrations, with soft tissue anesthesia lasting approximately 1–1.5 hours and pulpal anesthesia lasting approximately 15 minutes (Figure 4).

For inferior alveolar nerve blocks, Citanest Forte DENTAL (with epinephrine) has an approximate onset of 2–4 minutes and an average duration for soft tissue anesthesia of around 3 hours and pulpal anesthesia for approximately 1.5 hours. In Donaldson’s study, Citanest with epinephrine when used for inferior alveolar nerve blocks had an onset time of 131.25 seconds, again close to the product monograph. Citanest Plain DENTAL (no epinephrine) has an onset of action of greater than 5 minutes for inferior alveolar nerve blocks with duration of soft tissue anesthesia lasting 2.5 hours. The duration of pulpal anesthesia is 1–1.5 hours (Figure 5). Amide local anesthetics are metabolized in the liver. Prilocaine is an exception as it is metabolized primarily in the liver but also in the kidneys and lungs. Metabolic studies have shown that prilocaine is broken down in the liver more quickly than with lidocaine and following an intravenous injection, serum concentrations decrease more quickly than with lidocaine. The main mechanism for breakdown of the prilocaine molecule is hydrolysis of the amide bond. This results in the by-product o-toluidine (which can induce methemoglobinemia discussed below) and n-propylalanine. O-toluidine is broken down into 4-hydroxy-o-toluidine and 6-hydroxy-o-toluidine (Figure 6). Excretion of prilocaine is through the kidney. Prilocaine is removed from the circulatory system for renal clearance faster than compared to the other amides. This metabolic process is very effective as less than 5% of the drug is excreted through the urine unchanged.

**Dosages**

As with any local anesthetic, the lowest effective dose should always be utilized. As well, when maximum doses are printed, they relate to the average, healthy 70 kg (154 lb)
adult. There are three aspects to consider here. First even if the patient is heavier than 70 kg (154 lb) the maximum dose allowable must be adhered to. Second, there are people who are more sensitive to the effects of any drug, including local anesthetics. These people may not be able to tolerate higher doses without exhibiting signs and symptoms of toxicity. Finally, the maximum values are suggested for healthy individuals. Patients with compromised liver and or cardiac function may not be able to tolerate normal doses of any local anesthetic.

Prilocaine is one of the least toxic amide local anesthetics. A healthy adult maximum dose, as recommended by the manufacture, is 6 mg/kg. Some sources have suggested a maximum dose for healthy adults as 8 mg/kg with a maximum amount for one appointment being 500 mg. When one considers that the maximum amount for one visit is 500 mg for the healthy adult, the discrepancy between 6 vs. 8 mg/kg becomes less important for adults. However this author recommends staying within the 6 mg/kg dose range, with the 500 mg maximum allowed for larger individuals, as this will allow for a wider margin of safety for lighter adults and those who have a lower tolerance for the toxic effects of local anesthetics. It will also help to avoid methemoglobinemia in susceptible individuals. For children, the American Academy of Pediatric Dentistry suggests that no more than 4 mg/kg of any amide local anesthetic should be given to children patients. To translate these values into numbers of cartridges, see Figures 7 and 8. Figure 8 illustrates that for a child weighing 44 lbs (approximately 20 kg), only 1.11 cartridges of prilocaine can be injected before reaching the 4 mg/kg maximum. This highlights the disadvantage of using 4% solutions on small children. Doses add up very quickly and because of this, 2% lidocaine may be the safest drug in small children, especially when more than one cartridge is required. For this same 44 lb child, the practitioner could use 2.22 cartridges of lidocaine before reaching the 4 mg/kg threshold toxic levels with this 2% solution.

As well, it is thought that local anesthetics with vasoconstrictor allow for the widest margin of safety since the vasoconstrictor will decrease the local anesthetic’s ability to enter the vasculature. This is an interesting point with prilocaine since most references do not differ in the suggested maximum recommended doses for prilocaine with a vasoconstrictor as compared to prilocaine without a vasoconstrictor. One possible reason for this is that prilocaine is not a potent vasodilator. This allows prilocaine to be available as a plain solution and still have some effectiveness. Lidocaine and articaine are more potent vasodilators and as such, must be used with a vasoconstrictor to prevent quick uptake by the vasculature.

**Indications**

Prilocaine is an effective local anesthetic and is indicated for most if not all dental procedures. There are of course specific indications where this drug can be used most advantageously and there are situations when this drug may not be the formulation of choice.

Citanest Forte DENTAL with epinephrine is considered an intermediate acting anesthetic and as such can be used for any dental procedure. Citanest Plain DENTAL without vasoconstrictor has a short duration of pulpal anesthesia when given via infiltration (15 minutes) and therefore should only be used for procedures where pulpal insult can be completed before anesthesia degradation occurs. For block anesthesia in the mandible, there are only slight differences between Citanest DENTAL with and without a vasoconstrictor. The interesting message here is that a practitioner can achieve an inferior alveolar nerve block of significant duration (1–1.5 hours) without the need to use epinephrine. This could be extremely advantageous for those patients who require minimal amounts of vasoconstrictor. Patients with high blood pressure, by-pass surgery, prior myocardial infarction, angina, uncontrolled diabetes, uncontrolled thyroid disorders and those taking non-cardioselective beta blockers, tricyclic antidepressants and cocaine are examples of patients who would benefit from the use of a solution without a vasoconstrictor. It must be stressed however that profound pulpal anesthesia is paramount, especially in those with cardiovascular concerns since the creation of pain during procedures will result in the patient releasing large amounts of endogenous epinephrine. This could result in a medical emergency. The practitioner must be cognizant of the durations of action in both the maxilla and mandible when using solutions without vasoconstrictor.

Citanest Forte DENTAL with epinephrine has the advantage of containing the minimal amount of vasoconstrictor at 1:200,000 (half the amount of 1:100,000). If a practitioner utilizes less epinephrine at the site of surgery the result will be more bleeding. However when one con-
siders both the profundness of anesthesia and duration of anesthesia, there is no advantage in having epinephrine at a concentration greater than 1:200,000.8

Another interesting indication for using a plain solution is to minimize the discomfort created during the injection process. In one study, patients reported injection pain from either prilocaine without vasoconstrictor, mepivacaine with levonordrelin or lidocaine with epinephrine. The results indicated that patients perceived significantly less pain following injection with prilocaine as compared to mepivacaine or lidocaine. There was no difference between mepivacaine and lidocaine.9 In a second study, prilocaine plain was compared to bupivacaine, which contains 1:200,000 epinephrine. It was shown that the injection of prilocaine plain elicited significantly less perceived pain than did bupivacaine.10 These results were consistent for injections in the palate, for inferior alveolar nerve blocks and for posterior maxillary buccal infiltrations. The most likely reason for these experimental results revolve around the pH of the solutions. Prilocaine plain has a pH of 6.0–7.0, bupivacaine with 1:200,000 epinephrine has a pH of 3.3–5.5, lidocaine with 1:100,000 epinephrine has a pH of around 4.5 and mepivacaine with 1:20,000 levonordrelin has a pH of approximately 3. These studies suggest that the more acidic the solution is, the more discomfort will occur upon injection. Some practitioners have reported the technique of injecting prilocaine plain first to elicit as little discomfort as possible and then soon after, injecting an acidic vasoconstrictor-containing solution which now cannot create discomfort due to the anesthetized state of the tissue.

There are three final reasons to consider the advantage of using plain solutions or even solutions with minimal vasoconstrictor-concentration (i.e. 1:200,000). Firstly, using epinephrine for infiltrations can decrease the flow of blood to the pulp. This theoretically can increase the chance for pulpitis, especially following traumatic dental procedures. The use of plain solutions or those with a vasoconstrictor concentration of 1:200,000 (as opposed to 1:100,000 or 1:100,000) will minimize this possibility. Secondly, as mentioned above, vasoconstrictor containing solutions are more acidic. The more concentrated the vasoconstrictor is, the more acidic the local anesthetic solution will be. This is primarily due to the anti-oxidant preservative for the vasoconstrictor, sodium metabisulphite. In areas of infection, both periodontal and peri- apical, the pH of the infected tissue is acidic. Injecting acidic local anesthetic into this environment will favour the charged local anesthetic molecule over the neutral molecule (both of which exist in solution). It is the neutral molecule that is required to pass through the nerve sheath membrane. If there are not enough of these neutral molecules, as would be the case in this scenario, complete anesthesia may be difficult to achieve. Solutions without vasoconstrictor may avoid this problem, as they are more neutral in pH. When injected into this acidic environment, more neutral molecules are available to cross the nerve membrane and inhibit nerve conduction. This same phenomenon can occur by injecting too much local anesthetic with vasoconstrictor into the same area. In this scenario, imagine giving an inferior alveolar nerve block using a local anesthetic with vasoconstrictor concentration of 1:100,000 (the pH will be less than 5). If the block fails, the operator may decide to re-inject using the same formulation. If there is still a lack of complete anesthesia, injecting more of this solution may not lead to successful anesthesia because of the acidification of the area. The neutral molecules required to pass through the nerve membrane may not exist. The answer in this situation is to use a plain solution or one with 1:200,000 epinephrine after the first failed block to minimize the acidity created following injection.

The final reason to consider the limitation of vasoconstrictor is for those patients who are sensitive to the injection of epinephrine. There are some people who exhibit palpitations after a local anesthetic injection. This feeling can lead to anxiety and syncope. For these patients, it is prudent to limit the amount of vasoconstrictor used by choosing a plain solution or one with minimal vasoconstrictor concentration.

**Contraindications and Precautions**

There are few absolute contraindications for local anesthetics. Most are relative contraindications indicating that doses should be limited. One absolute contraindication for the use of prilocaine is allergy. Although allergies to amide local anesthetics are very rare, it is possible. It is more likely that the patient is allergic to the bisulphite anti-oxidant required for the vasoconstrictor. Patients with sulphite allergies will usually report this in their medical history. These people tend to have a higher incidence of asthma. If a sulphite allergy is present, prilocaine without vasoconstrictor may be used. If the patient reports an allergy to a local anesthetic, it is important to determine if the reaction was psychogenic or truly allergic. If allergy is suspected, testing by an allergist is warranted. The dentist should request testing two or three different amide local anesthetics and sodium metabisulphite as well.

Local anesthetics should also be used with caution in patients with epilepsy since these drugs lower the seizure threshold. This is especially a concern in children during sedation with an antihistamine and narcotic combination. As well, caution should be exercised in those with liver disease such as hepatitis or alcohol-induced cirrhosis. These patients may not be able to effectively metabolize amide local anesthetics.

Another precautionary measure to consider is that local anesthetic solutions that are supplied as a 4% con-
centration may have a higher risk of neurotoxicity. A retrospective study done by Haas et al. suggested that both articaine and prilocaine have a higher incidence of inducing permanent lip and/or tongue paresthesia following inferior alveolar nerve block injections after non-surgical dental visits. From 1973 to 1993, there were 143 cases of non-surgically induced paresthesia. In 1993 there were 14 cases of paresthesia. Articaine was used in 10 cases and in 4 of the cases, prilocaine was used. It was estimated from this study that during the year 1993, there was a 1.7 in one million chance that prilocaine would cause a permanent lip or tongue paresthesia. There was a 2.27 in one million chance for articaine. In a second study, Pogrel et al. reported 12 people who presented to a university dental setting over a 4-year period. These people complained of paresthesia following non-surgical dental appointments. Eight of these patients received lidocaine with epinephrine and 3 of them received prilocaine.

Pogrel et al. reported 12 people who presented to a university dental setting over a 4-year period. These people complained of paresthesia following non-surgical dental appointments. Eight of these patients received lidocaine with epinephrine and 3 of them received prilocaine. This study took place before articaine was released into the American marketplace and it must be realized that lidocaine was used much more frequently than articaine. An industry estimate during this time (mid 1990’s) suggested that lidocaine had 60% of the marketplace, mepivacaine 30% and prilocaine 10%. If 4% solutions had a greater risk of causing paresthesia, one would expect that lidocaine would not have had a greater incidence as it did in this second study. The majority of paresthesias that occur in these studies resolve within 8 weeks, however some are permanent. More research is clearly required in this area.

A final precaution with respect to prilocaine is methemoglobinemia. This is a rare syndrome that can occur due to inborn errors of metabolism or due to the administration of drugs that cause an increase in methemoglobin. Methemoglobin is a form of hemoglobin that is unable to carry oxygen. O-toluidine, a direct metabolite of prilocaine, stimulates the formation of methemoglobin. Typically, this manifests as the patient appearing cyanotic, usually in the nail beds and lips, a few hours after the causative drug is administered. There are no cardiac or respiratory abnormalities. Supplemental oxygen does not abolish the cyanosis because the hemoglobin cannot pick up the oxygen. If severe, this can lead to hypoxia and death. Treatment is the intravenous administration of methylene blue in a hospital. This reverses the problem quite readily. Doses of greater than 400 mg of prilocaine have been shown to be very rarely cause methemoglobinemia. In patients with congenital methemoglobinemia, prilocaine, articaine and benzocaine should be avoided. To avoid causing drug-induced methemoglobinemia, practitioners should not administer levels of prilocaine above the recommended maximum dose. Extra vigilance should occur for very small children where toxic levels can be achieved with just over one cartridge (Figure 9).

### Pregnancy and Nursing

The safe use of prilocaine in pregnant women has not been established. However, prilocaine and lidocaine carry the best rating for safety in pregnant patients as suggested by the Food And Drug Administration. The dentist should weigh the safety of giving a local anesthetic to pregnant individuals with the potential risks of long-term infection and pain resulting in the use of antibiotics and analgesics for prolonged periods. As well, consideration should be given to minimizing the total dose of local anesthetic. Since prilocaine is a 4% solution and lidocaine is a 2% solution, lidocaine might be preferred. Careful aspiration should also be paramount.

In nursing mothers, prilocaine might be secreted in the breast milk in very small amounts. This generally should not affect the nursing baby.

### Summary

Many studies show that prilocaine is as effective as any amide local anesthetic in the marketplace for adults and children. The choice of which local anesthetic to use can be confusing. This author has encountered many practitioners who only stock one type of local anesthetic in their practice. As all amide local anesthetics can produce effective pulpal anesthesia, and because they are all safe to use in the vast majority of patients, there is some justification for only using one type of local anesthetic. However, the choice of which product to use might be decided upon by considering the duration of pulpal anesthesia required. This is where prilocaine may be of advantage. It can produce maximum pulpal anesthesia with minimal vasoconstrictor use, or it can provide short duration pulpal anesthesia with no vasoconstrictor use. As well, there are advantages as mentioned above, to limiting or even completely eliminating vasoconstrictor from the local anesthetic solution. The patient’s medical history, acidification of tissues and pulpal insult are some of the factors to consider. Prilocaine is an effective drug to add to ones local anesthesia armamentarium.

### References:


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Questions

1. What was the first local anesthetic used in medicine?
   a. Ether
   b. Prilocaine
   c. Epinephrine
   d. Cocaine

2. The first use of a local anesthetic took place in what year?
   a. 1883
   b. 1884
   c. 1885
   d. 1894

3. Dr. William Halstead, a dentist, used what formulation of local anesthetic in an effort to block the hemimandible?
   a. Cocaine & HCl
   b. Cocaine & Sodium
   c. Cocaine & Citric Acid
   d. Cocaine & boiling water

4. What were the reasons a substitute for cocaine was needed?
   a. Addiction
   b. Inebriation
   c. Cost
   d. & a & b

5. In what year was procaine (Novacaine) synthesized?
   a. 1901
   b. 1903
   c. 1904
   d. 1905

6. Both cocaine and procaine have what undesirable properties?
   a. Long onset of action
   b. Short duration of action
   c. Relatively high allergenicity
   d. All of the above

7. What was the first amide-based local anesthetic?
   a. Lidocaine
   b. Marcaine
   c. Carbocaine
   d. None of the above

8. What are the two classifications of injectable local dental anesthetics?
   a. Amides and esters
   b. Bromides and esters
   c. Esters and sulphites
   d. Amides and sulphites

9. Prilocaine can be used as a topical anesthetic.
   a. True
   b. False

10. Why is the lipophilic nature of local anesthetic important?
    a. So that it is able to diffuse through the lipid membrane layer of the nerve sheath
    b. So that it lessens the stinging sensation at the injection site
    c. So that it increases the duration of the anesthetic
    d. None of the above

11. In the US prilocaine is marketed as what percent solution?
    a. 1%
    b. 2%
    c. 3%
    d. 4%

12. What is the concentration of epinephrine in Citanest Forte?
    a. 1:150,000
    b. 1:200,000
    c. 1:250,000
    d. 1:300,000

13. What is the pH of Citanest without epinephrine?
    a. 3.0–4.0
    b. 4.0–5.0
    c. 5.0–6.0
    d. 6.0–7.0

14. What is the pH of Citanest with epinephrine?
    a. 1.5–2.5
    b. 2.5–3.5
    c. 3.5–5.5
    d. 5.5–7.5

15. What is the onset of action for infiltration anesthesia in the maxilla with Citanest Dental (with epinephrine)?
    a. 1 minute
    b. 2 minute
    c. 3 minute
    d. None of the above

16. What is the duration for soft tissue anesthesia with Citanest Dental (epinephrine)?
    a. 2 hours
    b. 3 hours
    c. 4 hours
    d. None of the above

17. What is the duration of pulpal anesthesia with Citanest Dental (no vasoconstrictor)?
    a. 5 minutes
    b. 10 minutes
    c. 15 minutes
    d. 20 minutes

18. Amide local anesthetics are metabolized in the kidney.
    a. True
    b. False

19. Which body part does not metabolize prilocaine?
    a. Liver
    b. Kidneys
    c. Pancreas
    d. Lungs

20. The excretion of prilocaine is through the kidney.
    a. True
    b. False

21. At what rate is prilocaine removed from the circulatory system for renal clearance compared to other amides?
    a. About the same
    b. Slower
    c. Faster
    d. None of the above

22. When maximum doses are printed, they are done so for the average, healthy adult weighing ____________.
    a. 70 kg
    b. 75 kg
    c. 80 kg
    d. 85 kg

23. What is the maximum dose of prilocaine for one appointment for a healthy average 70kg adult?
    a. 200 mg
    b. 300 mg
    c. 400 mg
    d. 500 mg

24. The American Academy of Pediatric Dentistry suggests what dosage of amide local anesthetic be given to pediatric patients?
    a. No more than 3 mg/kg
    b. No more than 4 mg/kg
    c. No more than 5 mg/kg
    d. No more than 6 mg/kg

25. What is the maximum number of cartridges of Citanest, with or without epinephrine, for an adult (70kg)?
    a. 6.9
    b. 5.9
    c. 4.9
    d. 7.9

26. According to the author, what advantage does Citanest Dental with epinephrine have over other amide anesthetics with vasoconstrictor?
    a. It contains more epinephrine than other amides
    b. It contains half the epinephrine of other amides
    c. It has the same amount of epinephrine
    d. None of the above

27. Why are vasoconstrictor-containing solutions more acidic?
    a. The vasoconstrictor contains sodium metabisulphite
    b. The vasoconstrictor contains sodium chloride
    c. The vasoconstrictor contains both a & b
    d. None of the above

28. What is the one absolute contraindication for the use of prilocaine?
    a. Periodontitis
    b. Anemia
    c. Allergy
    d. Asthma

29. Why should local anesthetics be used with caution in patients with epilepsy?
    a. They lower the seizure threshold
    b. They raise the seizure threshold
    c. They neutralize the seizure threshold
    d. They increase the frequency of seizures

30. What is one of the symptoms of methemoglobinemia?
    a. Hyperactivity
    b. Anxiety
    c. Cyanotic appearance, usually in the nail beds and lips
    d. Depression
Review of Local Anesthetics With a Discussion of Prilocaine 4%

Evaluational Objectives

1. Be knowledgeable concerning the available local anesthetics and their chemical components.

2. Understand the considerations involved in selecting a local anesthetic.

3. Be knowledgeable about the recommended doses of local anesthesia for adults and children.

4. Be knowledgeable about complications that can arise from use of local anesthesia.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?  Objective #1: Yes No Objective #2: Yes No Objective #3: Yes No Objective #4: Yes No

2. To what extent were the course objectives accomplished overall? 5 4 3 2 1 0

3. Please rate your personal mastery of the course objectives. 5 4 3 2 1 0

4. How would you rate the objectives and educational methods? 5 4 3 2 1 0

5. How do you rate the author's grasp of the topic? 5 4 3 2 1 0

6. Please rate the instructor's effectiveness. 5 4 3 2 1 0

7. Was the overall administration of the course effective? 5 4 3 2 1 0

8. Do you feel that the references were adequate? Yes No

9. Would you participate in a similar program on a different topic? Yes No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

11. Was there any subject matter you found confusing? Please describe.

12. What additional continuing dental education topics would you like to see?

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