Procedures in Primary Care

Local anesthesia

Topical application, local infiltration, and field block

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CME learning objectives

- To understand the appropriate selection of an anesthetic agent
- To recognize the potential side effects of anesthetic agents
- To appreciate the different uses of local anesthetics and the techniques of application

This page is best viewed with a browser that supports tables

Fourth in a series of articles on office procedures coordinated by David A. Driggers, MD, faculty member of the Alaska Family Practice Residency Program, Anchorage, and Roger A. Schauer, MD, director of predoctoral medical education in family medicine and associate professor of family medicine, University of North Dakota School of Medicine, Grand Forks.

Preview: Local anesthetics are warranted whenever a clinical procedure causes pain that could be eliminated by their use. Their effectiveness is influenced by many factors, particularly the choice of agent and the technique of administration. The authors discuss the clinical uses and advantages of common local anesthetics and describe three techniques used in the primary care setting: topical application, local infiltration, and field block.


Local anesthesia is useful in a wide variety of clinical situations. It increases patient comfort and facilitates patient cooperation during procedures. As a diagnostic aid, it helps localize or identify the source of pain. Use of local anesthesia in the primary care setting can be maximized by an understanding of how anesthetic agents work, the indications for their use, appropriate methods of administration, and techniques to minimize the pain of administration.

**Pharmacology and physiology**

Local anesthetics reversibly block nerve impulses by disrupting permeability to sodium during an action potential. Onset of action is largely dependent on an agent's pharmacokinetics and the dosage given (1). Potency and duration of action differ among the various agents. The more hydrophobic an agent, the greater the potency and the longer the duration of action. Molecular size influences the rate of dissociation of local anesthetics from their receptor sites; in this case, the smaller the molecule, the faster the dissociation (2).

Using epinephrine mixed with local anesthetics causes vasoconstriction, which decreases clearance of the agent, increases duration of action, and decreases the total required dosage. Vasoconstriction also aids in hemostasis during wound care. The addition of epinephrine to agents already possessing a long duration of action, such as bupivacaine (Marcaine, Sensorcaine), does little to prolong anesthesia (1).

**Indications**

Local anesthesia is warranted for any clinical procedure with a potential for pain, such as incision and drainage of abscesses, laceration repair, biopsy, wart treatment, vasectomy, and neonatal circumcision.

**Selection of an agent**

Many local anesthetics are available (table 1). The more widely used agents include procaine (Novocain), lidocaine, and bupivacaine (2). Local anesthetics are most commonly used for analgesia during wound care. Techniques for their administration in the primary care setting include topical application, local infiltration, field block, and peripheral nerve block (the last technique will not be discussed here).

**Table 1. Common agents used for local anesthesia**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Concentration</th>
<th>Relative potency</th>
<th>Onset of action with infiltration</th>
<th>Onset of action with nerve block</th>
<th>Duration of action with block</th>
<th>Maximum one-time dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>1%</td>
<td>2</td>
<td>Fast</td>
<td>4-10 min</td>
<td>60-120 min</td>
<td>4.5 mg/kg (30 mL in average)</td>
</tr>
</tbody>
</table>
Lidocaine is the most commonly used local anesthetic. It is inexpensive and is available in a variety of concentrations and volumes. The common mixture of 1% lidocaine with epinephrine in a ratio of 1:100,000 produces optimal skin vasoconstriction and adequate duration of effect for many procedures (3). However, use of epinephrine mixtures should be avoided in areas with limited vascular supply (ie, fingers, toes, penis, nose, and ears).

Bupivacaine has a longer duration of action than lidocaine and thus may be more appropriate for very complex wounds requiring long repair times. In settings where wound care is likely to be interrupted, use of bupivacaine may avoid the need for reanesthetization before wound repair is completed. Bupivacaine also provides better relief in the postrepair period. For these reasons, many emergency department physicians choose bupivacaine over lidocaine (4). A mixture of the two agents is often preferred because it utilizes the rapid onset of lidocaine and the longer duration of bupivacaine; however, its value is unproved.

Adverse effects

True allergic reactions to local anesthetics are rare and usually involve an ester agent (eg, procaine, cocaine, tetracaine [Pontocaine], benzocaine). Allergic reactions are very seldom caused by amide anesthetic agents (eg, lidocaine, bupivacaine, mepivacaine [Carbocaine, Polocaine], prilocaine [Citanest]). There is no cross-reactivity between the amide and ester agents (1,2,5). An easy way to determine whether an agent is an amide or an ester is to look at the spelling of the generic name. Any “-caine” anesthetic containing the letter / (as in amide) in the prefix is an amide agent (eg, prilocaine). The ester agents do not contain an / in the prefix.

If a patient is allergic to a particular agent from one class, an agent from the other class can be substituted. In the event of true hypersensitivity to both esters and amides, the use of diphenhydramine (Benadryl, Hyrexin-50) is recommended. A 1-mL dose of diphenhydramine 50 mg/mL is diluted with 9 mL of sterile saline solution to make a

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Concentration</th>
<th>Onset</th>
<th>Duration</th>
<th>Maximum Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mepivacaine (Carbocaine, Polocaine)</td>
<td>1%</td>
<td>Fast</td>
<td>6-10 min</td>
<td>7 mg/kg (30 mL in average [70-kg] adult)</td>
</tr>
<tr>
<td>Bupivacaine (Marcaine, Sensorcaine)</td>
<td>0.25%</td>
<td>Moderate</td>
<td>8-12 min</td>
<td>2 mg/kg (50 mL in average [70-kg] adult)</td>
</tr>
</tbody>
</table>

Data from Norris (1) and Trott (14).
0.5% solution for local infiltration (6,7). However, compared with a local anesthetic, such as lidocaine, this mixture causes more pain on infiltration, is less efficacious, and carries an increased risk of tissue necrosis (4).

It is important to keep track of the total anesthetic dose given, because toxic effects are dose-related (table 1). Adverse reactions are related to the central nervous system (CNS) and, to a lesser degree, the cardiovascular system. Initial symptoms of CNS toxicity include light-headedness, dizziness, nystagmus, sensory disturbances, restlessness, disorientation, and psychosis. Slurred speech, muscle twitching, and tremors often precede seizures. Symptoms of cardiac toxicity include hypotension, bradycardia, and cardiac arrest. Treatment of toxic effects is largely supportive (1).

**Topical anesthesia**

Several agents have been developed to replace or augment local infiltration anesthesia. Topical anesthesia is used to reduce the pain of local infiltration, the pain of superficial laceration repair, and the pain associated with vascular cannulation or to reduce patient apprehension.

**Thermal anesthesia**

Ice can be used to provide short-acting superficial anesthesia for procedures such as skin tag clipping, venipuncture, and injections. For adequate anesthesia, the ice must be in direct contact with the skin surface for at least 10 seconds. Alternatively, the vapo-coolant ethyl chloride may be sprayed on the skin for 1 to 2 seconds; the effect lasts for only a few seconds. Caution is needed to avoid blistering with use of thermal anesthesia (8).

**EMLA cream**

Achieving local anesthesia without inflicting pain has been a goal for years, particularly in children with lacerations. In the past, this was attempted with use of anesthetic creams consisting of local anesthetics in an oil base. Skin penetration was poor, and because high concentrations of anesthetic were necessary, toxic effects and local irritation occurred.

When it was discovered that crystalline bases of lidocaine and prilocaine could be combined to produce a liquid at room temperature, the possibility of producing a topical local anesthetic seemed promising. A mixture of two substances that has a melting point lower than that of either substance by itself is called a eutectic mixture. Thus the term “eutectic mixture of local anesthetics” (EMLA) was born. This combination has excellent penetration, and because the total amount of anesthetic used is decreased, local irritation and toxic effects are reduced (9,10).

Efficacy of EMLA varies by site. In highly vascular sites, such as the face or damaged skin, onset is prompt (15 minutes). For all other sites, an anesthetic depth of 3 mm is achieved after 60 minutes. The depth increases 1 mm per 30 minutes up to 5 mm at 120 minutes. Supplemental lidocaine infiltration is required for undermining and closure of deep wounds (10).

Proven useful applications of EMLA include cutaneous
lesion curettage, lumbar puncture, otitis externa debridement, circumcision, vasectomy, and situations requiring reduced apprehension in pediatric patients. Proposed uses include facilitation of venous and arterial cannulation, routine injections, and laceration repair, although its value in these procedures is unproved.

The use of EMLA cream for laceration repair has not been studied. No benefit has been seen with pediatric procedures, possibly because cooperation by children has more to do with apprehension than with actual pain. Use of EMLA in venous cannulation has decreased patients' perception of pain, and it does not distort laboratory values of venous blood samples. EMLA's use in arterial cannulation has met with conflicting results and conclusions (11). Because of the lack of proven benefit and the length of time (45 minutes) necessary for EMLA to produce anesthesia, many physicians feel that lidocaine infiltration is preferable for arterial cannulations (4,9,10).

EMLA has been widely used for procedures such as superficial skin surgery, external otitis debridement, circumcision, and lumbar puncture (8,12,13). It has been shown to be at least as effective as lidocaine with epinephrine, and it avoids the pain of infiltration. The decision of whether to use EMLA is a matter of practicality rather than efficacy. EMLA certainly provides anesthesia, but factors such as planning, cost, and patient instruction should be evaluated.

Adverse effects of EMLA are minimal. Local vascular responses include erythema, pallor, edema, pruritus, and altered sensation to temperature. Vasoconstriction occurs in the first 30 to 90 minutes after application. Vasodilatation follows at about 180 minutes (10,14). Prilocaine may cause methemoglobinemia, which is of special concern in children because of their low levels of methemoglobin reductase.

EMLA cream is supplied with occlusive adhesive dressing (eg, Tegaderm). One to 2 g of EMLA per 10 cm2 of skin is applied, and the dressing is laid over it and kept in place for at least 1 hour. If an adequate amount was applied, the cream is still visible when the dressing is removed; if the cream is no longer visible at removal, the amount applied was insufficient. A new product is the EMLA Anesthetic Disc, which consists of an adhesive disc impregnated with 1 g of EMLA cream; the back of the disc is peeled off and the disc is applied over the site of injection. A 1-g EMLA disc can anesthetize 10 cm2 of skin (11).

**Tetracaine, adrenaline, and cocaine**
The combination of tetracaine, adrenaline, and cocaine (TAC) has most commonly been used for repair of lacerations in the face and scalp of children. Use on other areas has been less efficacious. The epinephrine and cocaine in the TAC cause vasoconstriction. A nearly bloodless, anesthetized field is helpful in wound repair, but care must be taken to avoid ischemia in damaged skin near wounds. Because of its vasoconstrictive effect, TAC should not be used in the nose or on the penis, fingers, toes, or ears. Application consists simply of filling the wound with 2 to 4 mL of TAC solution and letting it sit for 3 minutes. Patients should be monitored for signs of adverse effects, such as drowsiness or excitation, seizure,
arrhythmia, vomiting, flushing, or urticaria. Use of TAC on mucous membranes is not recommended. Overall, use of TAC does not increase risk of infection (8,15).

**Local infiltration**

Anesthesia can be induced by direct wound infiltration or field block.

**Direct wound infiltration**

This technique consists of injection of a solution of local anesthetic directly into the wound tissue. Effectively communicating with patients, especially children, about the procedure is as important as selecting the proper agent. Attempts should be made to alleviate the patient's apprehensions before administering local anesthetics. This can be accomplished by:

- Demonstrating the procedure on an uninjured extremity first
- Keeping the needle hidden when possible
- Pretreating the area with topical anesthetics
- Using a countdown technique for the duration of infiltration
- Applying skin pressure or pinching near the site of injection while injecting the anesthetic

The pain of injection may be reduced by dripping the anesthetic agent into the wound. The surrounding tissue may then be injected painlessly through the wound, rather than through the surrounding skin. This technique carries a small risk of infection if bacteria are inadvertently introduced into the surrounding tissue. Mucosal surfaces may be anesthetized simply by applying lidocaine topically.

The depth and speed of injection, as well as the temperature and buffering of the agent, are all considerations in the attempt to make infiltration as painless as possible. Shallow, rapid injections that produce skin wheals in the superficial dermis are more painful than deep, slow injections placed intradermally. Slow injection over 10 seconds is less painful than injection of the same volume over 2 seconds. Lidocaine at body temperature is optimal; the cooler the lidocaine, the more painful the injection. Buffering the slightly acidic lidocaine with sodium bicarbonate in a 10:1 ratio (10 mL of 1% lidocaine to 1 mEq/mL of sodium bicarbonate) also reduces pain (4,14,16).

The technique of infiltration is quite variable. However, use of the smallest-diameter needle available (eg, 25 gauge or smaller) and injection through the margins of a wound rather than through the skin surrounding it greatly reduce the pain associated with infiltration (figure 1: not shown). Use of long needles reduces the number of puncture sites. To prevent inadvertent breakage within the tissue, no more than two thirds of the needle should be inserted at once (2).

The smallest-volume syringe that can provide the desired amount of anesthetic should be used. For example, if 5 mL of anesthetic is the estimated need, a 5- or 6-cc syringe should be used, rather than a 10-cc syringe. Use of the smallest appropriate syringe allows for greater control over the volume and rate of injection. The least painful
method of lidocaine infiltration is deep dermal infiltration of a warm, buffered solution over 10 seconds with a 30-gauge needle.

**Field block**
When infiltration through the margins of a wound is not appropriate, parallel margin infiltration may be indicated. This method is useful for wounds that are contaminated or that require manipulation prior to closure. An advantage of this technique is no tissue distortion in the operative field. Use of longer needles allows for fewer needle sticks.

The needle is inserted directly through the skin at one end of the laceration, then advanced to about the depth where the dermis and subcutaneous tissues meet (figure 2: not shown). The needle is then advanced parallel through this plane toward the other end of the laceration. Aspiration should be performed to avoid intravascular injection. If intravascular injection does occur, the needle should be advanced or retracted and again aspirated.

Next, a track of anesthetic is slowly injected as the needle is withdrawn. Without complete withdrawal of the needle from the initial insertion site, the needle is redirected and another track is made on the other side of the wound. Insertion, injection, and redirection are repeated on all sides of the wound until complete anesthesia is achieved (17). Five to 10 minutes is usually needed to achieve full anesthetic effect.

Field blocks are also appropriate when infiltration would distort a specific lesion or body part and make repair difficult. The same technique described for a parallel margin block may be used (figure 3: not shown).

**Conclusion**
Local anesthetic techniques are a crucial skill needed in the primary care setting. Patient compliance is greatly enhanced if the clinician has a knowledgeable and compassionate approach to anesthetic delivery.

**References**

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