CHAPTER 21

Local Anesthesia

Daniel J. Derksen

John L. Pfenninger

Local anesthetics are extremely useful in a wide variety of clinical settings. From simple laceration repair to abscess incision and drainage, local anesthetics are critical to patient comfort and physician ability to perform the necessary procedure. Local anesthetics prevent the generation and conduction of nerve impulses by several mechanisms: they increase the electrical excitation threshold, slow the propagation of nerve impulses, and disrupt the action potential and sodium permeability of nerve fibers. For the practicing physician, it is important to know that the progression and the duration of a local anesthetic is related to many factors, including the size of the area to be anesthetized; the nerve fiber diameter, myelination, and conduction velocity; the presence of infection; the blood supply in the area; the presence of chronic disease (e.g., diabetes); and the patient's pain threshold and anxiety level.

INDICATIONS

Any clinical procedure causing pain that could be eliminated by the use of a local anesthetic is sufficient to warrant the use of a local anesthetic (Tables 21-1 and

TABLE 21-1.

Commonly Used Local Anesthetics in the Office Setting (Also see Table 23-1)

Local Anesthetic	Onset(min)	Duration(hr)	Equivalent Conc.(%)
Lidocaine (Xylocaine)	1	0.5-1	1
Lidocaine w/epinephrine	1	2-6	1
Mepivacaine (Carbocaine)	3-5	0.75-1.5	1
Dibucaine (Nupercaine)	15	3-4	0.25
Dibucaine w/epinephrine	15	6	0.25
Bupivacaine (Marcaine)	5	2-4	0.25
Bupivacaine w/epinephrine	5	3-7	0.25
Etidocaine (Duranest)	3-5	3-7	0.5

Modified from Olin BR, editor: *Drug facts and comparisons,* St Louis, 1993, Mosby. Used with permission.

PROCEDURES FOR PRIMARY CARE PHYSICIANS
Pfenninger, J., & Fowler, G.
Mosby 1994. pp 135-154

TABLE 21-2.
Maximum Dosages of Commonly Used Local Anesthetics (Also See Table 20-1)

Anesthetic	Concentration	Maximum Dose
Lidocaine (Xylocaine)	1%	4.5 mg/kg not to exceed 300 mg (30 cc in adult)
Lidocaine (Xylocaine) w/epinephrine	1%	7 mg/kg not to exceed 500 mg (50 cc in adult)
Bupivacaine (Marcaine)	0.25%	3 mg/kg not to exceed 175 mg (50 cc per average adult)
Bupivacaine (Marcaine) w/epinephrine	0.25%	3 mg/kg not to exceed 225 mg

21-2). Some of the outpatient procedures in which local anesthetics are used include incision and drainage of an abscess, laceration repair, biopsy (diagnostic or excisional), digital block for treatment of paronychia, aggressive treatment of warts (such as electrodiathermy or freezing), paracervical or submucosal block of the cervix, endometrial biopsy or curettage, and others. See Box 21-1 for selection criteria for local anesthetics.

CONTRAINDICATIONS

Local anesthetics should not be used in patients with a *known sensitivity*. However, this is very uncommon with amide anesthetics (lidocaine [Xylocaine], mepivacaine [Carbocaine], and bupivacaine [Marcaine]). The older anesthetics were esters (procaine [Novocaine] and tetracaine) and caused more allergic reactions. The two

BOX 21-1. SELECTION OF LOCAL ANESTHETICS/EFFECTS

Lidocaine (Xylocaine) without epinephrine
Can cause vasodilatation
0.5 to 1 hour duration depending on site/vascularity
Use in contaminated wounds
Use in fingers, nose, penis, toes, earlobes
Use if vascular disease is present or if patient is immunocompromised
Use if there are cerebrovascular or cardiovascular risks
Use for nerve blocks

Lidocaine (Xylocaine) with epinephrine
Causes vasoconstriction
Has longer duration
Use in highly vascular areas to improve visualization of field
Use in clean wounds
In general, do not use on fingers, nose, penis, toes, and earlobes

Bupivacaine (Marcaine)
For longer duration
For nerve blocks

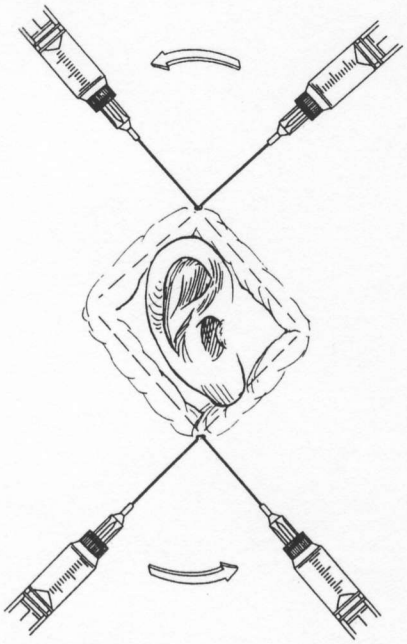

FIG. 23-8.
Technique to achieve field anesthesia of the ear. (From Trott A: *Wounds and lacerations: emergency care and closure,* ed 2, St Louis, 1991, Mosby. Used with permission.)

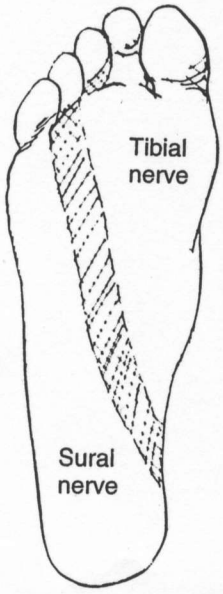

FIG. 23-9.
Distribution of sensory innervation to the foot. (From Trott A: *Wounds and lacerations: emergency care and closure,* ed 2, St Louis, 1991, Mosby. Used with permission.)

TABLE 23-1.
Local Anesthetic Agents (Also see Tables 21-1 and 21-2)

Type	Name	Equivalent Concentration	Onset	Duration (minutes)	Maximum Dose
Amino esters					
	Procaine (Novocaine)	2%	Slow	15-30 min plain 30-90 min w/epi	600 mg
	Tetracaine (Pontocaine)	0.25%	Slow	120-240 min plain 240-480 min w/epi	100 mg plain 200 mg w/epi
	Chlorprocaine (Nesacaine)	2%	Fast	15-30 min plain 30-90 min w/epi	800 mg plain 1000 mg w/epi
Amino amides					
	Lidocaine (Xylocaine)	0.5-1%-2%	Fast	30-120 min plain 60-400 min w/epi	300 mg plain 500 mg w/epi
	Etidocaine (Duranest)	0.5%	Fast	120-240 plain	300 mg plain 400 mg w/epi
	Mepivacaine (Carbocaine)	1%	Moderate	30-120 min plain 60-400 min w/epi	300 mg plain 500 mg w/epi
	Bupivacaine (Marcaine)	0.25%	Slow	120-240 min plain 240-480 min w/epi	175 mg plain 225 mg w/epi

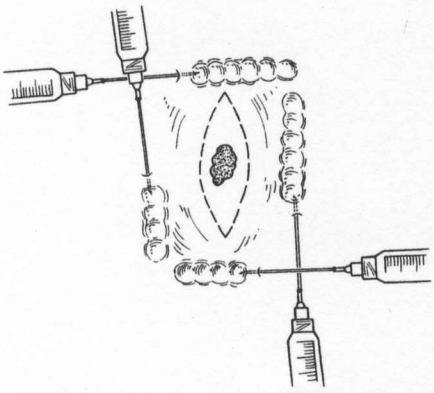

FIG. 23-1.
Field block technique.

Nerve Block

1. Before beginning any peripheral nerve block, perform a neurological examination of the area to be anesthetized and document this in the medical record. If any neurologic defect is present, include a description of it in the document of informed consent for the procedure, and have the patient sign a statement agreeing that the defect was present before the administration of the anesthetic.
2. Identify the appropriate nerve(s) and site to block.
3. Obtain informed consent.
4. Carefully clean and prepare the skin over the injection site in a sterile fashion.
5. Draw up the anesthetic. Usually a 25- to 30-gauge needle can be used to inject the anesthetic. The amount of anesthetic used will vary based on the location of the nerve.
6. Insert the needle into the site, withdrawing the plunger to avoid intravascular injection. If paresthesia is noted by the patient, withdraw the needle 2 mm and then inject the anesthetic. The goal is to inject perineurally, not into the nerve itself. If no paresthesia is noted at the expected site, confirm that there is no potential for intravascular injection and slowly inject the anesthetic. If the proper site has been identified, often as little as 1 or 2 cc will provide an excellent anesthetic field.
7. Allow 5 to 15 minutes for the block to take effect. Confirm anesthesia to pinprick before making an incision.

Common Nerve Blocks (Also See Chapter 27, Oral/Facial Anesthesia)

1. **Digital block of finger or toe.** Use 4 cc of 1% to 2% lidocaine *without* epinephrine for each finger, and 6 cc of the same for toes. Insert the 25-gauge ½-inch needle into the skin at the base of the finger or toe in the web space. Inject 1 cc into each lateral aspect of the finger, then 1 cc across the dorsal and the ventral surface of the finger in the subcutaneous space. For the toe, use 2 cc into each web space and 1 cc across the dorsal and the ventral surface of the toe. The dorsal digital nerves in both instances lie very close to bone. As the bone is touched with the needle tip, withdraw 1 or 2 mm and inject the solution (Fig. 23-2).
2. **Median nerve block.** The median nerve supplies sensation to the palmar aspect of the thumb, index, and middle fingers. In addition, the radial half of the palm is supplied by the median nerve. A nerve block may be indicated for extensive lacerations and incisions in these areas. The median nerve lies between the flexor carpi radialis and the palmaris longus. With flexion of the wrist, the palmaris longus stands out. The injection should be made at the flexor crease of the wrist just radial to the palmaris longus. Use 3 to 5 cc of 1% lidocaine *without* epinephrine (Figs. 23-3 and 23-6).
3. **Ulnar nerve block.** The ulnar nerve innervates the dorsal and palmar aspects on the ulnar side of the hand (fifth finger and ulnar side of the fourth finger). There are actually two branches of the ulnar nerve, which divides 4 to

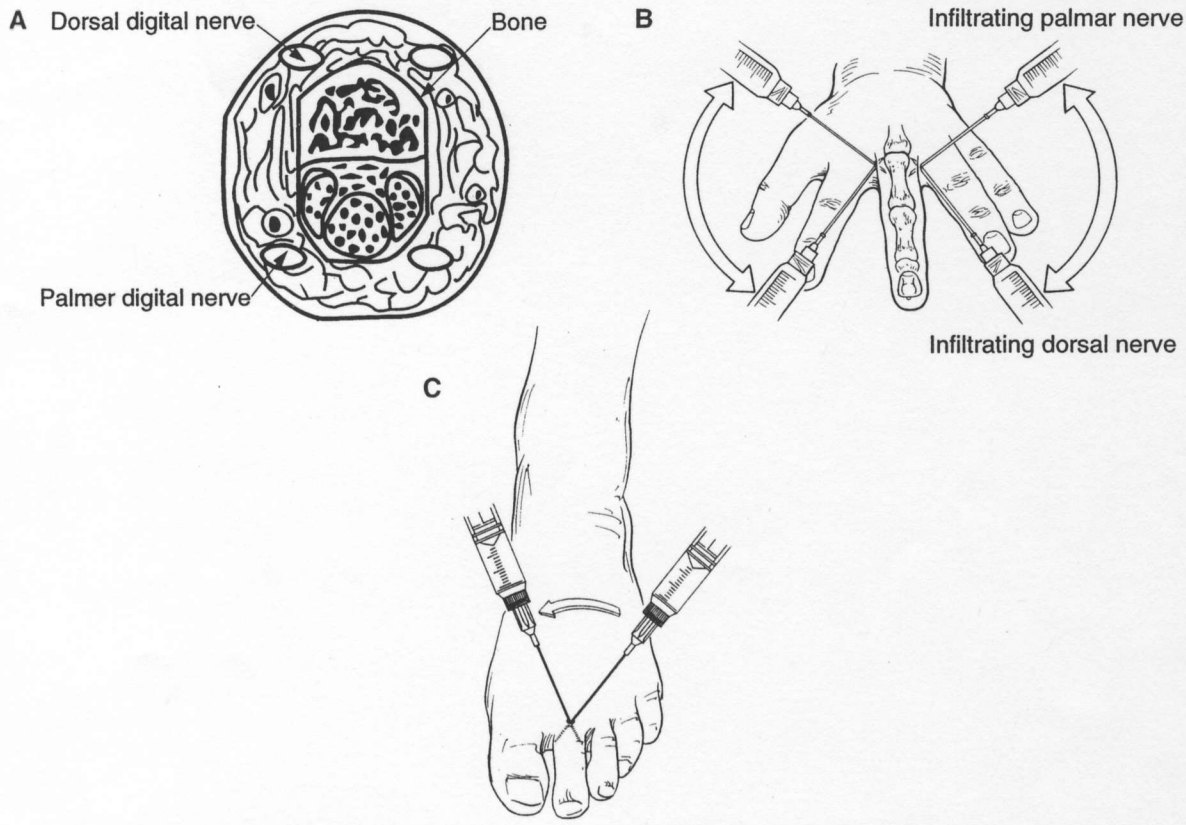

FIG. 23-2.
Anatomy and injection technique for digital nerve block. **A,** Four digital nerves of the finger. The bone is used as a landmark to find the proper plane of the dorsal digital nerve. **B,** Digital nerve block of the finger. The sites of the nerves are injected bilaterally. To obtain optimal effect, after blocking the nerves, place a "ring" of anesthetic entirely around the digit close to the bone. Inject superiorly over the bone and inferiorly under the bone in the subcutaneous plane. **C,** Digital nerve block of the toe showing an alternative method of injection. (**B** and **C** from Trott A: *Wounds and lacerations: emergency care and closure,* ed 2, St Louis, 1991, Mosby. Used with permission.)

5 cm proximal to the wrist. Therefore, the easiest way to obtain an ulnar block is to inject the ulnar nerve at the elbow where the nerve lies only 0.5 cm below the skin, between the medial epicondyle and the olecranon (Figs. 23-4 and 23-6). For all nerve blocks, it is best not to inject directly into the nerve, but around it; 2 to 3 cc of 1% lidocaine should be sufficient here.

4. **Radial nerve block.** The radial nerve innervates the dorsum of the thumb, index, and middle fingers, and the radial portion of the dorsum of the hand. Because of multiple divisions of the radial nerve, 10 cc of anesthetic is often required to obtain good results. Inject 3 cc of solution along the lateral border of the radial artery two finger breadths above the wrist. Then lay a superficial ring of solution from this point extending dorsally over the border of the wrist

groups do not cross-react, so a patient reporting an allergy to procaine can successfully use lidocaine. However, multidose vials also include paraben preservatives, which are chemically similar to ester anesthetics, and which may induce an allergic response in sensitive patients. Single-dose vials do not contain preservatives and may be indicated for the patient reporting allergy.

The employment of vasoconstrictors (i.e., epinephrine) along with local anesthetics is useful to decrease bleeding, reduce systemic absorption, and prolong the duration of action, but is contraindicated in several circumstances. Local anesthetics with vasoconstrictors should be used only with extreme caution where vasoconstriction could result in permanent destruction of tissue. In general, vasoconstrictors should not be used on the extremities—the nose, ear, penis, or ends of digits (fingers and toes). In addition, patients with known peripheral vascular disease may have an exaggerated vasoconstrictor response. Extreme care should be used if local anesthetics with vasoconstrictors are used in patients with diabetes, hypertension, arteriosclerosis, thyrotoxicosis, heart block, or cerebral vascular disease. If a skin flap has marginal viability or blood flow to a flap is compromised, do not use epinephrine.

APPROACHES FOR THE ALLERGIC PATIENT

- Use a cooling agent (ice cube, ethyl chloride, etc.).
- For small lesions, use no anesthetic.
- Use single-dose vials instead of multidose vials.
- Injecting normal saline can often provide enough relief to permit minor surgeries or suturing.
- Substitute an amide for an ester (if offending agent can be identified).
- Use diphenhydramine (Benadryl). Inject 10 to 50 mg in the usual fashion (50 mg per 1 cc diphenhydramine mixed with 4 cc of normal saline).

EQUIPMENT

- Sodium bicarbonate (Neutra-caine) 7.5% 5 ml vials
- 18-gauge needle to draw up solution
- 27- to 30-gauge needle for injection (various lengths)
- Alcohol swabs
- Various size syringes
- Anesthetic of choice

SUPPLIER

Sodium bicarbonate (Neutra-caine) 7.5% 5 ml vials
MD, Inc.
Suite 43, 408 State of Franklin Rd.
Johnson City, TN 37604
615-461-6185
800-35-MDINC

TECHNIQUE

1. Using an alcohol swab, wipe the top of the vial of local anesthetic. Draw up the anesthetic with a large-bore needle (e.g., 18 gauge) into an appropriately sized syringe (most office procedures require less than 10 cc of local anesthetic). For most shave or biopsy excisions, 1 cc is sufficient. Discard the large-bore needle in an appropriate container (avoid recapping any needle, even if "sterile").
2. Depending on the tissue to be infiltrated, choose an appropriately sized needle. For most skin biopsies, a 1-inch, 27- to 30-gauge needle provides the necessary rigidity and causes minimal discomfort.
3. Inject either intradermally or subcutaneously, depending on the lesion and surgery intended. (Subcutaneous injection will take longer to take effect.) Before infiltration, draw back the syringe plunger. If there is blood return, do not

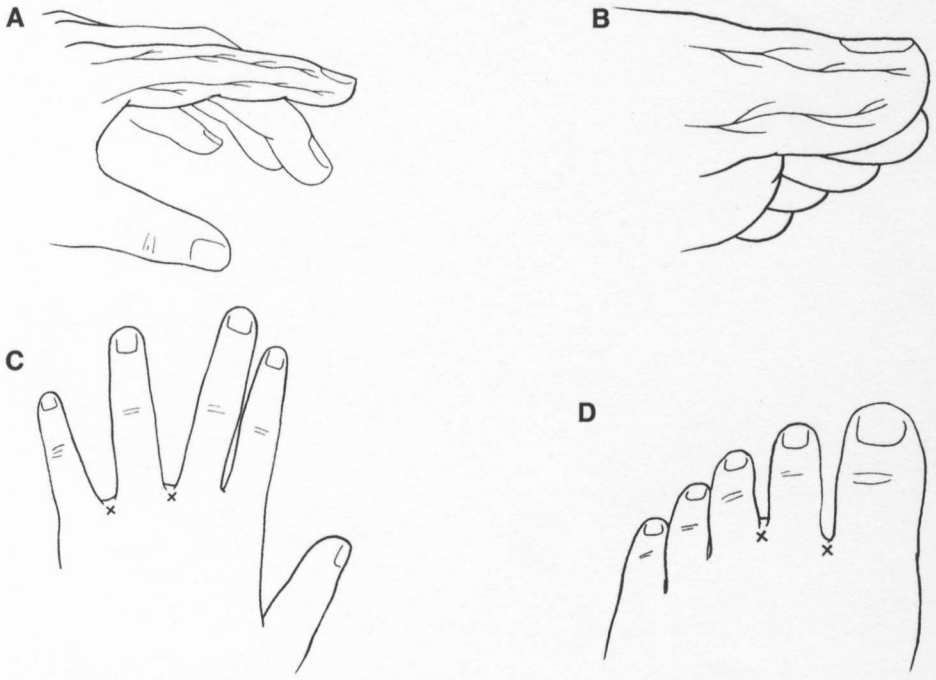

FIG. 21-1.
The anatomy of a digital block. In the finger (**A**) and toe (**B**) there are four nerves to block in order to obtain successful digital block. An anterior and posterior branch on each side of the digit needs to be blocked. If the proper site of infiltration is chosen, the four nerves of the finger (**C**) or toe (**D**) should be well anesthetized. The web space between each digit can be used to accomplish this. The needle should be moved to ensure that the anterior and posterior branch of the nerve on each side of the digit is blocked, infiltrating as the needle is withdrawn. A digital block may take several minutes to take effect. In the case of a severely inflammed paronychia, where the nail must be partially or entirely removed, additional local anesthetic may be necessary at the site of inflammation to eliminate pain and allow the removal to be done. It is best to avoid vasoconstrictor agents for local anesthetics for digital blocks. In addition, care should be taken to avoid systemic injection.

POSTPR

REDUCI

TOPICAL

infiltrate; this will prevent systemic injection. Reposition the needle and draw the plunger back. If there is no blood return, infiltrate as the needle is withdrawn. Never infiltrate as the needle is advanced. This will help to prevent systemic injection. Before any digital or other block, a review of the related anatomy is recommended. In the case of digital blocks, it is important to remember the location and number of nerves supplying each digit (Fig. 21-1). *Inability to obtain adequate pain elimination is usually due to a failure to wait the necessary time for the local anesthetic to work.*

POSTPROCEDURE PATIENT EDUCATION

Instruct patients to watch for signs of infection or local reaction to the local anesthetic. Redness, pus, increased pain, red streaks up the extremity, or other problems should prompt a phone call or return visit to the physician.

REDUCING PAIN OF INJECTION

Injection of local anesthetics causes pain because of the needle and because of the acidity of the solution (pH 4.05 to 6.49), which causes a significant burning sensation. This short-lived pain can be eliminated by adding 1 ml of sodium bicarbonate 1 mg/ml solution to 10 cc of a 1% concentration of anesthetic. Patients, especially children, will note remarkable improvement in comfort. Infiltration with unbuffered solution has been found to be 2.8 to 5.7 times more painful than infiltration with buffered counterparts. There has been no significant difference detected in the time of onset or duration of anesthesia or in the surface area of skin anesthetized. Occasionally, the addition of bicarbonate can make the solution cloudy, but there are no known adverse effects from this.

Previously, it was recommended that the buffered solution be discarded after 24 hours. Bartfield, however, concluded that buffered lidocaine was stable for 1 week at room temperature. Refrigeration may nearly double that time.

TOPICAL ANESTHETICS

Certain clinical situations favor the use of a topical anesthetic. Examples include a combative child too large for the papoose board and too small to reason with, and patients with nosebleeds, eye injuries, corneal abrasions, or lesions on mucous membranes that need to be treated with painful modalities, such as liquid nitrogen or electrodiathermy. Mucous membranes (nose, mouth, throat, esophagus, and genitourinary tract) can be successfully anesthetized with many of the local anesthetics by direct topical application. It is best to use lidocaine (2% to 4%), cocaine (4% to 10%), or tetracaine (1% to 2%). Procaine and mepivacaine do not penetrate mucous membranes enough to be effective as topical anesthetics. Topical cocaine has the added advantage of vasoconstriction. However, many clinicians are

hesitant to have cocaine preparations available in their clinic for security and other reasons. Vasoconstriction can also be obtained by using a low concentration of phenylephrine (0.005%) for topical anesthesia. Epinephrine does not penetrate mucous membranes well and is not useful in this setting. Topical application of cocaine or lidocaine has a peak effect within 2 to 5 minutes, while tetracaine requires 5 to 8 minutes. The effect lasts 30 to 45 minutes. Systemic effects are possible, especially in children. Consider using EMLA, a new topical anesthetic approach. For corneal abrasions or foreign body in the eye, the examination should be preceded by the administration of tetracaine 0.5%, 1 or 2 drops (see Chapter 22, Topical Anesthesia).

COMPLICATIONS

When a local anesthetic is used properly, complications are rare. Allergic reactions may occur (see Chapter 135, Anaphylaxis). Other complications are related to systemic absorption of the local anesthetic or to the effect of vasoconstriction when local anesthetics with epinephrine are used. If systemic absorption occurs, monitor cardiac and respiratory status carefully for the appropriate time, based on the half-life of the agent used. Anxiety, incoherent speech, lightheadedness, metallic taste, blurred vision, or drowsiness may be early signs of central nervous system toxicity and are difficult to differentiate from vasovagal effects. The use of epinephrine may cause arrhythmias or other cardiovascular or cerebrovascular changes, but this is very rare. Warm compresses to increase peripheral circulation can be used when excess vasoconstriction is observed (such as cyanosis, decreased pulse, or decreased capillary refill).

BIBLIOGRAPHY

Adriani J, Naraghi M: Local anesthetics: who should give them? *So Med Journal* 78(10): 1219, 1985.

Bartfield JM et al: Buffered lidocaine as a local anesthetic: an investigation of shelf life, *Ann Am Int Med* 21:16, 1992.

Doyle DJ: A closer look at local anesthetics, *Emerg Med* 23:147, April 1991.

Holmes HS: Options for painless local anesthesia, *Postgrad Med J* 89:71, 1991.

McKay W, Morris R, Mushlin P: Sodium bicarbonate alleviates pain on skin infiltration with lidocaine, with or without epinephrine, *Anesth Analg* 66:572, 1987.

Olin BR, editor: *Drug facts and comparisons,* St Louis, 1993, Mosby.

Trott A: Infiltration and nerve block anesthesia. In *Wounds and lacerations: emergency care and closure,* St Louis, 1991, Mosby.

CHAP

Topic

William L

TABLE 22-1.
Topical Anesthetic

Anesthetic

Benzocaine

Cocaine
Dibucaine

Cyclonine
Lidocaine

Tetracaine

From Covino BG, Vass
permission.