Principles of Office Anesthesia: Part I. Infiltrative Anesthesia

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The use of effective analgesia is vital for any office procedure in which pain may be inflicted. The ideal anesthetic achieves 100 percent analgesia in a short period of time, works on intact or nonintact skin without systemic side effects, and invokes neither pain nor toxicity. Because no single agent meets all of these criteria, the physician must choose from the available armamentarium based on the anesthetic properties that are most desired. Infiltrative anesthetics are frequently chosen because of their proven safety record, low cost, ease of storage, widespread availability, and rapid onset of action. Allergy to local injectable anesthetics is rare, and when it occurs it is often secondary to the preservative in multidose vials. Anesthesia can be prolonged with the addition of epinephrine or the use of longer-acting agents. Buffering the local anesthetic with bicarbonate, warming the solution, and injecting slowly can minimize the pain of anesthetic injection. Complications are rare but include central nervous system and cardiovascular toxicity, or extreme vasoconstriction in an end organ, if epinephrine is used. (Am Fam Physician 2002;66:91-4. Copyright© 2002 American Academy of Family Physicians.)

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This is part I of a two-part article on office anesthesia. Part II, "Topical Anesthesia," appears on page 99 of this issue.

Since the development of lidocaine (Xylocaine) in 1943, infiltrative local anesthetics have been used for many clinical procedures. Laceration repair, skin biopsies, curettage, and digital blocks are some of the standard procedures that require local infiltrative anesthesia. Even with the recent advances in topical anesthesia, infiltrative anesthesia remains a mainstay for painful office procedures.

Contraindications to Injection Anesthetics

There are few absolute contraindications for local injection anesthetics. Allergy to amide anesthetics such as lidocaine is rare, and when it does occur, it is usually caused by the preservative methylparaben.[1] One way to circumvent a potential allergic reaction is to use preservative-free lidocaine, which is available in single-dose vials. History of an allergy to an ester anesthetic such as procaine (Novocain) is not a contraindication to the use of lidocaine,[1] because they are chemically different, and cross-reaction is rare *(Table 1)*. Another approach includes using 1 percent diphenhydramine (Benadryl), which has proved effective in randomized studies.[2]

The addition of epinephrine, a potent vasoconstrictor, is contraindicated when it may compromise blood flow in a confined space. Epinephrine should never be used in digital and penile blocks or in skin flaps with marginal viability. The use of epinephrine in the nasal tip and ear is relatively contraindicated for the same reasons, but it has been used in studies in which the treated areas are kept warm to prevent additional vasoconstriction.[3] The clinician should exercise caution when contemplating the use of vasoconstrictors in

TABLE 1
Common Injectable Anesthetics

Amides
Lidocaine (Xylocaine)
Bupivacaine (Marcaine)
Mepivacaine (Carbocaine)
Prilocaine (Citanest)
Etidocaine (Duranest)
Esters
Procaine (Novocain)
Chloroprocaine (Nesacaine)
Tetracaine (Pontocaine)

TABLE 2
Injectable Local Anesthetics: Pharmacokinetics and Maximal Dose

Anesthetic	*Equivalent concentration*	*Onset (minutes)*	*Duration (hours)*	*Maximal dose (mg per kg)*	*Maximal dose (mL per 70 kg)*
Moderate duration					
Lidocaine (Xylocaine)	1 or 2%	< 2	1.5 to 2	4 mg per kg, not to exceed 280 mg	28 mL (1%); 14 mL (2%)
Mepivacaine (Carbocaine)	1%	3 to 5	0.75 to 1.5	4 mg per kg, not to exceed 280 mg	28 mL
Prilocaine (Citanest)	1%	< 2	> 1	7 mg per kg, not to exceed 500 mg	50 mL
Long duration					
Lidocaine with epinephrine (Xylocaine Injectable)	1 or 2% lidocaine, 1:100,000 or 1:200,000 epinephrine	< 2	2 to 6	7 mg per kg, not to exceed 500 mg	Based on lidocaine 50 mL (1%); 25 mL (2%)
Bupivacaine (Marcaine)	0.25%	5	2 to 4	2.5 mg per kg, not to exceed 175 mg	50 mL
Etidocaine (Duranest)	0.5 to 1%		2 to 3	4 mg per kg, not to exceed 300 mg	50 mL (0.5%)

Information from references 3 through 5.

dirty wounds because of the increased risk of infection. In addition, certain patients with diabetes, hypertension, heart block, or cerebrovascular disease may be particularly sensitive to epinephrine.

Choosing a Local Anesthetic for Injection

Local anesthetics are divided into amide and ester classes. Historically, amide (lidocaine, bupivacaine [Marcaine]) and ester (procaine, tetracaine [Pontocaine]) anesthetics were both used, but esters lost their favor after reports of increased sensitization.[1] For most routine procedures in the office, amide anesthetics suffice *(Table 1)*.

Lidocaine is the most versatile and commonly used amide anesthetic. In 1943, lidocaine was the first drug of the amino amide type to be introduced into clinical practice, and its rapid onset and moderate duration of action ensure its widespread use today. Lidocaine is available in solutions ranging from 0.5 to 4 percent; however, no studies have compared the efficacy of the different solutions. Lidocaine at 2 percent concentration may be particularly useful when a smaller injected volume is indicated.

Bupivacaine provides an intermediate onset and a longer duration of action. It is especially useful when prolonged anesthesia is needed and epinephrine is contraindicated (i.e., for joint injections and digital nerve blocks). Other anesthetics in the amide group can be used in the office but are commonly reserved for spinal and regional anesthesia.

The addition of epinephrine at 1:100,000 to 200,000 (5 to 10 μg per mL) is useful to prolong the duration of anesthesia and provide some degree of hemostasis. When working on highly vascular tissues such as the scalp, the physician may need to wait between injection and surgery. The onset of optimal vasoconstrictive effect from epinephrine is approximately five minutes. With the vasoconstric-

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tion and resultant delay in absorption afforded by epinephrine, the maximum recommended dose of lidocaine increases from 4 to 7 mg per kg[1] (*Table 2*[3-5]).

Because of the vasoconstriction and resultant delayed absorption afforded by epinephrine, the maximum recommended dose of lidocaine increases from 4 to 7 mg per kg.

Mixtures of Anesthetic Solutions

Few randomized, double-blind trials have assessed the benefits of mixing short- and long-acting anesthetic solutions.[6,7] The studies that have evaluated the clinical advantages of mixing lidocaine and bupivacaine have been inconclusive.[1,6,7] If anesthesia is required for more than 30 to 60 minutes, lidocaine with epinephrine or bupivacaine with or without epinephrine is recommended.

Technique of Injection Anesthesia

Before injection, alcohol wipes should be used to clean the anesthetic vial and the skin. Alcohol wipes have been shown to be as effective as chlorhexidine (Peridex) or povidone-iodine (Betadine) on intact skin.[8] The physician should use a large-gauge needle to draw up the anesthetic solution and then change to a small-gauge needle before injection. The needle should be inserted into the site and the plunger withdrawn slightly to reduce the risk of injection directly into the vascular space. Finally, the anesthetic should be infused slowly into the tissue, moving slowly from treated to untreated areas to reduce the pain of reinsertion.

Methods Used to Reduce the Pain of Injection

The pain of injection is caused by insertion of the needle and infiltration of the anesthetic into the skin. Ideally, the smallest gauge needle, usually 25 to 30, should be used to inject all anesthetics. Adjunctive techniques using topical anesthetics, cryotherapy, or distraction may complement the routine use of lidocaine. Pinching the skin stimulates local sensory nerves, partially blocking the transmission of other painful stimuli. Injecting slowly and steadily can minimize the pain of the anesthetic itself. If clinically indicated, injecting into the subcutaneous tissues is less painful than infiltrating directly into the dermis to raise a wheal. Physicians should remember that ethyl chloride is flammable and should not be used with electrocautery.

Several experiments have shown that adding sodium bicarbonate to lidocaine significantly decreases any burning sensation during infusion.[9,10] Commonly, the physician will mix nine parts lidocaine (1 to 2 percent) to one part sodium bicarbonate (8.4 percent) in a syringe or anesthetic bottle just before the procedure. Raising the pH of the anesthetic solution also appears to reduce the pain of injection without affecting the efficacy of the anesthesia.[11] The only drawback appears to be the decreased shelf life of buffered anesthetics. Buffered anesthetics left on the shelf may not be effective after one week.[12] Warming lidocaine to body temperature seems to have an equally beneficial effect on the pain of injection as buffering, and both techniques are additive.[11]

Complications of Injection Anesthetics

Most local anesthetics rarely produce side effects. The most common complications occur during epidural administration or accidental intravascular administration. If large amounts of local anesthetics are absorbed rapidly, central nervous system (CNS) and cardiovascular toxicity may occur. The signs and symptoms of CNS toxicity induced by local anesthetic resemble vasovagal responses. Early symptoms, such as a metallic taste, tinnitus, lightheadedness, and confusion, are followed by tremors and shivering. Ultimately, generalized seizures and respiratory arrest may occur.[4]

Local anesthetics can also have profound

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effects on the cardiovascular system. At low doses, local anesthetics cause systemic vasoconstriction and raise blood pressure. At high doses, local anesthetics may cause negative inotropic effects on the heart as well as heart block. In addition, the high protein binding and lipid solubility of bupivacaine may explain rare reports of ventricular arrhythmias with the use of this agent.[1,4]

Toxic reactions to local anesthetics are best avoided by slow and careful injection to avoid intravascular administration. Low doses well below the toxic range should be used in patients with known peripheral vascular and cardiovascular disease *(Table 2*[3-5]). Epinephrine can also be used to slow absorption. However, epinephrine is a two-edged sword because it may cause an exaggerated vasoconstrictor response and arrhythmias in susceptible patients. Warm compresses are useful if any signs of excess vasoconstriction, such as cyanosis or decreased capillary refill, are noted. Halting the injection and administering oxygen will often suffice to treat CNS and cardiovascular toxicity. If systemic toxicity appears to be worsening, immediate referral to an emergency department is indicated.

Special Considerations

Although safety has been demonstrated with the use of both local anesthetics and epinephrine in infants and young children, the pharmacokinetics of local anesthetics are distinctly different in children and adults.[13] The increased cardiac output in children leads to a more rapid peak plasma concentration. The half-life of local anesthetics is also prolonged, secondary to a greater volume of distribution and decreased hepatic metabolism. Because of the difference in pharmacokinetics, the toxic threshold in infants and toddlers is approximately one half that in children older than five years and adults.[13] The maximal anesthetic dose in mg per kg must be adjusted accordingly.

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REFERENCES

1. Tetzlaff JE. The pharmacology of local anesthetics. Anesthesiol Clin North Am 2000;18:217-33.
2. Bartfield JM, Jandreau SW, Raccio-Robak N. Randomized trial of diphenhydramine versus benzyl alcohol with epinephrine as an alternative to lidocaine local anesthesia. Ann Emerg Med 1998; 32:650-4.
3. Arca MJ, Biermann JS, Johnson TM, Chang AE. Biopsy techniques for skin, soft-tissue, and bone neoplasms. Surg Oncol Clin North Am 1995;4:157-74.
4. Dripps RD, Eckenhoff JE, Vandam LD, Longnecker DE, Murphy FL. Dripps/Eckenhoff/Vandam introduction to anesthesia. 8th ed. Philadelphia: Saunders, 1992.
5. Drug facts and comparisons. St. Louis: Facts and Comparisons, 1999:3604.
6. Ribotsky BM, Berkowitz KD, Montague JR. Local anesthetics. Is there an advantage to mixing solutions? J Am Podiatr Med Assoc 1996;86:487-91.
7. Sweet PT, Magee DA, Holland AJ. Duration of intradermal anaesthesia with mixtures of bupivacaine and lidocaine. Can Anaesth Soc J 1982; 29:481-3.
8. Dzubow LM, Halpern AC, Leyden JJ, Grossman D, McGinley KJ. Comparison of preoperative skin preparations for the face. J Am Acad Dermatol 1988;19:737-41.
9. Colaric KB, Overton DT, Moore K. Pain reduction in lidocaine administration through buffering and warming. Am J Emerg Med 1998;16:353-6.
10. Masters JE. Randomised control trial of pH buffered lignocaine with adrenaline in outpatient operations. Br J Plast Surg 1998;51:385-7.
11. Brogan GX Jr, Giarrusso E, Hollander JE, Cassara G, Maranga MC, Thode HC. Comparison of plain, warmed, and buffered lidocaine for anesthesia of traumatic wounds. Ann Emerg Med 1995;26:121-5.
12. Bartfield JM, Homer PJ, Ford DT, Sternklar P. Buffered lidocaine as a local anesthetic: an investigation of shelf life. Ann Emerg Med 1992;21:16-9.
13. Lin YC, Krane EJ. Regional anesthesia and pain management in ambulatory pediatric patients. Anesthesiol Clin North Am 1996;14:803-16.