THIRD EDITION

Successful Local Anesthesia

for Restorative Dentistry and Endodontics

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QUINTESSENCE PUBLISHING

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Preface

Why do patients avoid going to the dentist? According to a survey by the American Dental Association,[1] fear of pain is the greatest factor that prevents patients from visiting their dentist. Additional surveys[2,3] have found that 90% of dentists have some anesthesia difficulties during restorative dentistry procedures. Because adequate pulpal anesthesia is a clinical problem, we and other authors have performed a number of research studies on local anesthesia over the last 37 years. This third edition of our book offers new and valuable information regarding local anesthesia for restorative dentistry. It also provides additional important information on managing postoperative endodontic pain and covers pulp capping, outcomes of incision and drainage procedures, and the use of preemptive medications for success of the inferior alveolar nerve block (IANB) in the treatment of irreversible pulpitis.

Profound pulpal anesthesia is the cornerstone to the delivery of dental care, and the administration of local anesthesia is one of the most common procedures in clinical practice. It is invariably the first procedure we perform, and it affects almost everything we do during the appointment. If a patient planned for extensive restorative work is not adequately anesthetized, difficulties arise. This book explains why problems occur and offers clinical solutions to help clinicians stay on schedule.

Fortunately, local anesthesia has evolved tremendously over the last 30 years, just as the materials and techniques have evolved in restorative dentistry and endodontics. The current technology and drug formulations used for local anesthesia have made it so much easier to treat patients successfully. We now have the ability to anesthetize patients initially, provide anesthesia for the full appointment, and reverse some of the effects of soft tissue anesthesia if desired. Priceless!

This book covers the research-based rationale, advantages, and limitations of the various anesthetic agents and routes of administration. A special emphasis is placed on supplemental anesthetic techniques that are vital to the practice of dentistry. However, this book does not cover the basic techniques used for the delivery of local anesthetics because that information is readily available elsewhere in textbooks and other publications.

In addition, this book emphasizes information for the restorative dentist and endodontist because the requirements for pulpal anesthesia are different than for oral surgery, implant dentistry, periodontics, and pediatric dentistry. Approximately 85% of local anesthesia teaching in dental school is done by oral and maxillofacial surgery departments,[4] and while they do an excellent job, it is sometimes difficult for oral surgeons to appreciate the requirements for pulpal anesthesia in restorative dentistry and endodontic therapy.

Throughout the book, the information is divided into specific topics to make it understandable and easy to reference. When indicated, summary information has been provided. References to published literature are included in the chapters because clinicians within the specialty of endodontics (of which we are members) communicate with each other by citing authors and studies. We think it's important to credit the authors for their contributions to the literature on local anesthesia.

This book is a clinical adjunct to help you successfully anesthetize patients using the newest technology and drugs available, with pulpal anesthesia emphasized throughout. Pulpal anesthesia is required in order for restorative dentists and endodontists to perform painless treatment. We think that is a worthy goal for the dental profession.

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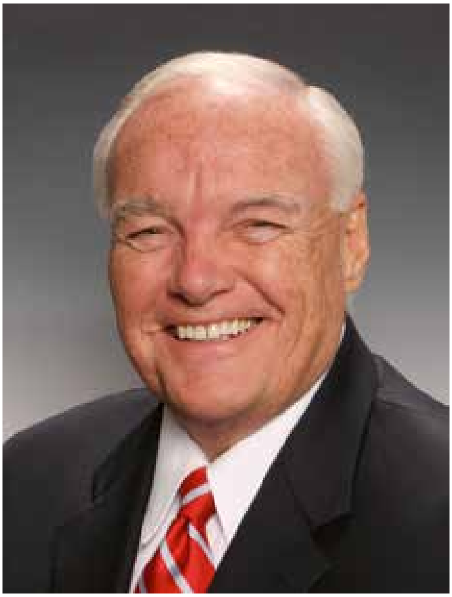
Acknowledgments

Senior author Al Reader would like to thank his coauthors for all their help: "My associates and I always compromise. I admit I'm wrong, and they agree with me."

All royalties from the sale of this book will be donated to the American Association of Endodontists' Foundation to support further research on anesthesia and pain control.

About the Authors



Dr Al Reader received his DDS from The Ohio State University College of Dentistry in 1971 and completed his endodontic training at The Ohio State University in 1975, earning his certificate in endodontics and an MS for research involving pulpal nerve innervation. Dr Reader is a Diplomate of the American Board of Endodontics and has served as its director. He is currently Professor Emeritus and was past program director for the Advanced Endodontic Program in the Division of Endodontics. He has advised or was a committee member for 168 master theses and has authored more than 175 scientific articles and 14 chapters in leading endodontic texts. Dr Reader has received recognition from the American Association of Endodontics in the form of the Louis I. Grossman Award for contributions to the endodontic literature and the I.B. Bender Lifetime Educator Award. His focus of research is local anesthesia and pain control.

Dr John Nusstein received his DDS from the University of Illinois at Chicago College of Dentistry in 1987. He served 12 years in the US Air Force and completed his endodontic training at The Ohio State University in 1995, earning a certificate in endodontics and an MS for research involving intraosseous anesthesia. Dr Nusstein has been a Diplomate of the American Board of Endodontics since 1999. He became a full-time educator at The Ohio State University College of Dentistry in 2000 and is now a tenured professor, was appointed Chair of the Division of Endodontics in 2006, and holds the William J. Meyers Endowed Chair in Endodontics. He has authored/coauthored over 100 scientific articles and 9 chapters in leading endodontic textbooks. His focus of research is local anesthesia and pain control and ultrasonic irrigation.

Dr Melissa Drum received her DDS from the University of Minnesota and her endodontic certificate and MS from The Ohio State University. She teaches at the dental student and resident levels and is the Advanced Endodontic Program Director and former Predoctoral Endodontic/Emergency Clinic Director. Dr Drum is active in service at the college, state, and national levels and is a full tenured professor. She has published more than 80 articles and multiple book chapters. Dr Drum became a Diplomate of the American Board of Endodontics in 2008 and has served as its director and president. She was named holder of the Al Reader Endowed Professorship in 2013. Dr Drum received the 2014 Edward M. Osetek Award from the American Association of Endodontists as well as numerous local teaching and research awards over the years.

Dr Sara Fowler is a member of the 2006 inaugural class of the University of Nevada Las Vegas School of Dental Medicine. She completed the General Practice Residency program at The Ohio State University and then served as the Endodontic Division's Postgraduate Fellow before going on to advanced endodontic training at Ohio State, where she earned her certificate in endodontics and MS in 2010. She began her career as a full-time educator in 2011 and is currently an associate professor and Director of Predoctoral Endodontics and the Emergency Dental Clinic at The Ohio State University College of Dentistry. She has authored over 35 scientific articles. Her research focus is local anesthesia and pain control.

Dedication

This book is dedicated to the current and former endodontic graduate students who shared our goal of profound pulpal anesthesia.

1 Clinical Factors Related to Local Anesthesia

After reading this chapter, the practitioner should be able to:

- Discuss the clinical factors related to local anesthesia
- Provide ways of confirming clinical anesthesia
- Describe issues related to local anesthesia
- Explain the effects anxiety has on local anesthesia
- Discuss the use of vasoconstrictors
- Characterize injection pain
- Evaluate the use of topical anesthetics
- Discuss alternative modes of reducing pain during injections

Clinical pulpal anesthesia is dependent on the interaction of three major factors: *(1)* the dentist, *(2)* the patient, and *(3)* local anesthesia (Fig 1-1). The dentist is dependent on the local anesthetic agents, as well as their technique. In addition, the dentist is dependent on the interaction with the patient (rapport/confidence). How the patient interacts with the administration of local anesthesia is determined by a number of clinical factors.

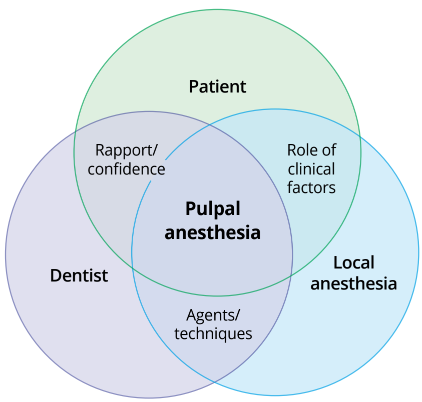


Fig 1-1 The relationship of pulpal anesthesia to the patient, dentist, and local anesthesia.

Confirming Pulpal Anesthesia in Nonpainful Vital Teeth

Lip numbness

A traditional method to confirm anesthesia usually involves asking the patient if their lip is numb. In 1884, Dr Halsted injected cocaine into the mandible of a dentist. The dentist stated that within 6 minutes there was complete anesthesia of the left half of

Fig 1-2 Lip numbness does not guarantee pulpal anesthesia.

Fig 1-3 A lack of patient response to mucosal or gingival "sticks" is a poor indicator of pulpal anesthesia.

the lower lip. A pin thrust completely through the lip caused no sensation whatsoever, and hard blows upon the teeth with the back of a knife caused no sensation. Hence, the concept of lip numbness representing complete pulpal anesthesia was born. Although lip numbness can be obtained 100% of the time, pulpal anesthesia may fail in the mandibular first molar in 23% of patients.[1–16] Therefore, lip numbness does not always indicate pulpal anesthesia (Fig 1-2). However, lack of lip numbness for an inferior alveolar nerve block (IANB) does indicate that the injection was "missed," and pulpal anesthesia will not be present.

In conclusion, lip numbness does not always indicate pulpal anesthesia.

Soft tissue testing

Using a sharp explorer to "stick" the soft tissue (gingiva, mucosa, lip, tongue) in the area of nerve distribution (Fig 1-3) has a 90% to 100% incidence of success.[2–5] Regardless, pulpal anesthesia may still not be present for the mandibular first molar in 23% of patients.[1–16] Negative mucosal sticks usually indicate that the mucosal tissue is anesthetized.

In conclusion, the lack of patient response to sharp explorer sticks is a poor indicator of pulpal anesthesia.

Commencing with treatment

The problem with commencing treatment without confirming anesthesia is that there is no way to know if the patient is numb until we start to drill on the tooth. This may create anxiety for both the patient and the dentist. A typical scenario involving a crown preparation on a mandibular molar can become problematic if the patient feels pain when the mesiobuccal dentin is reached with the bur. If the patient reacts to the pain, the dentist may say, "Oh, did you feel that?" and then may try to continue with treatment. If the patient reacts again when the mesiobuccal dentin is touched with the bur,

Fig 1-4 A cold refrigerant may be used to test for pulpal anesthesia before the start of a clinical procedure. (Courtesy of Coltène/Whaledent.)

Fig 1-5 The cold refrigerant is sprayed on a large cotton pellet.

the dentist may try to work around the pain the patient is feeling by saying, "I'll be done in a minute." Such a situation would not make a good day for the dentist or the patient.

In conclusion, *commencing with treatment without confirming anesthesia may add apprehension for the dentist and patient because neither one knows if the tooth is anesthetized.*

Cold refrigerant or electric pulp testing

A more objective measurement of anesthesia in nonpainful vital teeth is obtained with an application of a cold refrigerant of 1,1,1,2-tetrafluoroethane or by using an electric pulp tester (EPT). Cold refrigerant or the EPT can be used to test for pulpal anesthesia prior to beginning a clinical procedure.[17–20] A dental assistant can test the tooth to determine when pulpal anesthesia is obtained and then inform the dentist that treatment can be started.

In a very anxious patient, the use of pulp testing may cause a very painful reaction. Apprehensive patients can become sufficiently keyed up to react to even minimal stimulation. They may say, "Of course I jumped; it hurts!" or "It's only normal to jump when you know it's going to hurt."

In conclusion, *pulp testing with a cold refrigerant or an EPT will indicate if the patient has pulpal anesthesia. For anxious patients, pulp testing may need to be postponed until the patient can be conditioned to accept noninvasive diagnostic procedures.*

Cold testing

A cold refrigerant tetrafluoroethylene (Hygenic Endo-Ice, Coltène/Whaledent) (Fig 1-4) can be used to test for pulpal anesthesia before commencing drilling on the tooth. The technique for cold testing is quick and easy; it takes only seconds to complete and does not require special equipment. Once the patient is experiencing profound lip numbness, the cold refrigerant is sprayed on a large cotton pellet held with cotton tweezers[21] (Fig 1-5). The cold pellet is then placed on the tooth (Fig 1-6). If clinical

Fig 1-6 The pellet with the cold refrigerant is applied to the surface of the tooth.

anesthesia has been successful, applications of cold refrigerant should not be felt. If the patient feels pain with application of the cold, supplemental injections should be given. If no pain is felt with the cold, it is likely that pulpal anesthesia has been obtained. Testing with a cold refrigerant is more convenient than with an EPT and gives a good indication of clinical anesthesia.

Pulp testing with a cold refrigerant can be performed effectively on gold crowns and porcelain-fused-to-metal crowns. In fact, pulp testing is fairly easy to use in these situations because the metal conducts the cold very nicely. Miller and coauthors[21] also showed that pulp testing with a cold refrigerant is effective for all-ceramic crowns.

In conclusion, *pulp testing with a cold refrigerant is a reliable way to confirm clinical pulpal anesthesia, even in teeth with gold, porcelain-fused-to-metal, or all-ceramic crowns.*

Electric pulp testing

In order to use an EPT (Kerr Vitality Scanner, SybronEndo) (Fig 1-7), the tooth should be dried with a gauze pad or cotton roll. Toothpaste is applied to the probe tip of the EPT before placing the tip on the middle of the labial surface (for anterior teeth) or buccal surface (for posterior teeth) of the tooth to be anesthetized (Fig 1-8). The Kerr EPT automatically starts on contact with the tooth and continues to apply current until the maximum output reading of 80 is reached. On removal from the tooth, the EPT

Fig 1-7 An EPT may also be used to test for pulpal anesthesia but is not as convenient as cold testing. (Courtesy of SybronEndo.)

Fig 1-8 The EPT probe is placed on the surface of the tooth.

automatically resets to 0. Contemporary EPTs are easy to use and no longer rely on the dentist to increase the current rate manually via a dial or to reset the unit manually.

Kitamura and coauthors[22] reported that the EPT was 99% accurate when testing teeth determined to be vital. Dreven and colleagues[17] and Certosimo and Archer[18] showed that a lack of patient response to an 80 reading with the EPT was an assurance of pulpal anesthesia in nonpainful vital teeth. That is, there was no pain during the clinical restorative procedure if an 80/80 (maximum reading) was achieved before the procedure.

Certosimo and Archer[18] demonstrated that patients who responded to EPT readings of less than 80 experienced pain during operative procedures in normal teeth. Therefore, using the EPT prior to beginning dental procedures on nonpainful vital teeth will provide the clinician with a reliable indicator of pulpal anesthesia. We have used the EPT experimentally in many of the studies outlined in this book because it is easier to use for constant pulp testing over a period of 60 minutes.

In conclusion, *the EPT is very reliable in determining pulpal anesthesia in nonpainful vital teeth. Patient response to EPT readings less than the maximum output reading (80) indicate a lack of pulpal anesthesia.*

A note on experimental EPT testing

We and other authors have performed many studies using an EPT to confirm anesthesia. In many of the studies outlined in this book, we used an EPT experimentally because it makes it easier to perform constant pulp testing over a period of 60 minutes. Early studies were performed with animals, but we didn't want to hurt man's best friend (Fig 1-9), so we chose to use dental students as subjects. They had minimal restorations, a full complement of teeth, and no periodontal disease. They learned a great deal about dental anesthesia and were grateful to participate. Remember, there are six phases of any research project:

Fig 1-9 Man's best friend.

1. Exultation
2. Disenchantment
3. Confusion
4. Search for the guilty
5. Punishment of the innocent
6. Distinction for the uninvolved

Just kidding.

These early research studies provided the foundation for additional studies using patients with painful pulpal conditions and were important for our understanding of basic dental anesthesia. It can be hard to accept new information because our clinical biases are often based on strong convictions but limited research. Please try to think through the findings in this book. It will help you a great deal in clinical practice!

Clinical testing of pulp vitality before restorative procedures

Cold testing is more convenient than using an EPT for testing pulpal vitality before beginning restorative procedures, particularly in teeth with extensive restorations or a history of symptoms. We have probably all had a patient who has had a crown preparation and subsequently develops a painful tooth with swelling. In these patients, the pulp died previously, and the crown preparation has caused an endodontic flare-up. A simple application of cold to this tooth would have revealed a necrotic pulp.

__In conclusion__, pulp testing a tooth with cold before a restorative procedure may reveal whether it is vital or necrotic.

EPT and cold testing in clinical practice

Almost all of the studies outlined in this book can be duplicated in your office. That is, by pulp testing teeth after giving different local anesthetic formulations and techniques, you can perform the same tests in your office to evaluate pulpal anesthesia.

Some may say that a negative response to pulp testing is not needed to perform restorative dentistry. This is true if you don't mind the patient often experiencing pain during treatment.[18] However, our goal is to have the patient experience no pulpal pain. While patients may tolerate being hurt during dental procedures, we think this is unnecessary in today's modern dental practice.

__In conclusion__, pulp testing is a very valuable tool to determine pulpal anesthesia in clinical practice.

Clinical Local Anesthesia–Related Issues

Patient considerations

Pain versus pressure during treatment

The senior author remembers that when extracting painful teeth, he used to explain to patients that they were only feeling pressure during treatment—not pain. The explanation was that, although the local anesthetic was very effective at inhibiting the nerve fibers that transmit pain sensations, it did not have much of an effect on the nerves that transmit pressure sensations. While this theory may have some merit, it has never been proven, and the reason patients feel pain during treatment is much more complicated (see chapters 2 and 4). For example, voltage-gated sodium channels (VGSCs) exist on nerve membranes and differ in their roles in mediating peripheral pain.[23–25] They are divided into channels that are blocked by the toxin tetrodotoxin (TTX) and the channels that are resistant to the toxin (TTX-R).[26] A number of TTX-R channels are found on pain receptors $Na_V1.8$ and $Na_V1.9$,[26] and these channels are somewhat resistant to local anesthetics.[27]

In conclusion, pressure transmission is an incomplete explanation of why patients react to pain during dental treatment, and TTX-R channels are involved in resistance to local anesthetic action on nerves.

Patient reaction to local anesthetic injection

Brand and coauthors[28] found that feeling tense (42%), clenching fists (14%), and moaning (13%) were the most common reactions to an IANB. Vika and coauthors[29] reported that about 17% of patients indicated high fear to an injection during their last dental appointment, which may lead to avoidance of necessary treatment in the future.

In conclusion, some patients react negatively to receiving an IANB.

Patients who report previous difficulty with local anesthesia

In addition, patients who report having had difficulty with local anesthesia in the past are more likely to experience unsuccessful anesthesia.[30] These patients will generally identify themselves with comments such as, "Novocaine doesn't work on me" or "a lot of shots are needed to get my teeth numb." A good clinical practice is to ask the patient if they have had previous difficulty achieving clinical anesthesia. If so, supplemental injections should be considered.

In conclusion, patients who report previous difficulty with anesthesia are more likely to experience unsuccessful anesthesia.

Dentist considerations

Dentist reaction to local anesthetic injection

Simon and coauthors[31] found that 19% of dentists reported that the administration of local anesthetic injections caused enough distress that they had at some point reconsidered dentistry as a career. And 6% considered it a serious problem. This study indicates that the administration of local anesthetic injections might contribute to overall professional stress for some dentists.

Patients may not be the only ones anxious about local anesthetic injections. Dower and coauthors[32] found that two-thirds of dentists described anxious patients as the main source of their anxiety, and 16% identified children as the main source of anxiety.

In conclusion, some dentists are stressed by giving a local anesthetic injection, and anxious patients and children can be sources of anxiety for the dentist.

Compassion fatigue

Moreover, a type of emotional burnout called *compassion fatigue* may affect many health care workers.[33,34] Although we become doctors because we want to help people, controlling pain on a daily basis and performing treatment at a very high level of precision may take its toll. In fact, if patients feel pain during restorative treatment, we sometimes internalize the feeling as failure.

As dentists and professionals, we provide an extraordinary service to our patients. Our ability to provide exceptional treatment with a caring attitude is a most rewarding art. However, we also have the ability to not accept failure because we have the means

TABLE 1-1

Local anesthetics available in the United States[a]

Anesthetic	Vasoconstrictor	Dental cartridge color code[b]	MAD[c]	TMD[c]
2% lidocaine	1:100,000 epinephrine	Red	13	8
2% lidocaine	1:50,000 epinephrine	Green	13	8
2% lidocaine plain	No vasoconstrictor	Light blue	8	8
2% mepivacaine	1:20,000 levonordefrin	Brown	11	8
3% mepivacaine plain	No vasoconstrictor	Tan	7	5½
4% prilocaine	1:200,000 epinephrine	Yellow	5½	5½
4% prilocaine plain	No vasoconstrictor	Black	5½	5½
0.5% bupivacaine	1:200,000 epinephrine	Blue	10	10
4% articaine	1:100,000 epinephrine	Gold	7	7
4% articaine	1:200,000 epinephrine	Silver	7	7

[a]The dosages were adapted from Malamed.[35]
[b]Uniform dental cartridge color codes.
[c]This table provides the maximum dosage in two formats. The maximum allowable dose (MAD) generally is approached only with complex oral and maxillofacial surgical procedures. The typical maximum dose (TMD) is the usual upper limit of drug dosage for most restorative and endodontic dental procedures. Both columns show the number of cartridges that would be required for an adult weighing 150 pounds (67.5 kg).

to prevent it. Dentists have been maligned for many years because of pain. Unfortunately, some of the information that we have today that allows us to prevent patient pain was not available in the past. This is particularly true with the IANB; this injection fails often enough to present meaningful clinical problems. This book will outline the steps you need to take to overcome failure with this block.

***In conclusion**, we should not accept clinical failure of pulpal anesthesia when we have the means to prevent it from happening.*

Anesthetic agents and dosages

Table 1-1 outlines the local anesthetic formulations available in the United States. The American Dental Association has specified a uniform color code to prevent confusion among brands. The maximum allowable dose applies to complex oral and maxillofacial surgery procedures. The typical maximum dose is for adults (weighing 150 pounds) who are undergoing typical restorative and endodontic procedures. Local anesthetic agents, common names, and milligrams per cartridge are presented in Table 1-2.

Gray/black rubber stoppers

Most rubber stoppers of cartridges are colored gray or black (Fig 1-10). These rubber stoppers are not color coded and are not indicative of the drug the cartridge contains.

TABLE 1-2

Local anesthetics, common names, and milligrams per cartridge

Local anesthetic agent	Common name(s)	Cartridge (mg)
2% lidocaine with 1:100,000 epinephrine	Xylocaine (Dentsply) Lidocaine	36
2% lidocaine with 1:50,000 epinephrine	Xylocaine Lidocaine	36
2% mepivacaine with 1:20,000 levonordefrin	Carbocaine (Cook-Waite) Polocaine (Dentsply)	36
3% mepivacaine plain (no vasoconstrictor)	Carbocaine Polocaine	54
4% prilocaine with 1:200,000 epinephrine	Citanest Forte (Dentsply)	72
4% prilocaine plain (no vasoconstrictor)	Citanest Plain (Dentsply)	72
0.5% bupivacaine with 1:200,000 epinephrine	Marcaine (Cook-Waite)	9
4% articaine with 1:100,000 epinephrine	Septocaine (Septodont) Zorcaine (Cook-Waite) Articadent (Dentsply)	72
4% articaine with 1:200,000 epinephrine	Septocaine	72

Orabloc articaine formulation

Orabloc (Pierrel) is an articaine local anesthetic containing a vasoconstrictor and is available in two epinephrine formulations—1:200,000 and 1:100,000. Supposedly, it is a "purer" form of articaine that has a 24-month shelf life at room temperature and very low manufacture-related degradation products, including articaine acid and epinephrine sulfonic acid, and it is sodium edetate free, methylparaben free, and latex free. As far as we are aware, no research has been performed on Orabloc in comparison with other commercially available products.

Fig 1-10 Gray anesthetic cartridge stoppers.

In conclusion, *the articaine formulation of Orabloc needs to be evaluated for clinical efficacy.*

Media hype: "Local anesthetics cause tooth cell death"

Zhuang and coauthors,[36] using pig teeth and young permanent tooth pulp cells, found that prolonged exposure to high doses of local anesthetics interfered with the

Fig 1-11 Articaine cartridge showing 1.7 mL of anesthetic solution.

Fig 1-12 Lidocaine cartridge showing 1.8 mL of anesthetic solution.

mitochondria of tooth cells and led to cell death. The researchers noted that further clinical studies are required before there is enough data to change clinical guidelines. They also urged parents not to be alarmed or withdraw their children from treatment if they need it.

__In conclusion,__ exposing pig teeth and pulp cells to high doses of local anesthetics does not prove a correlation with clinical outcomes.

Cartridge volume—1.7 mL versus 1.8 mL

Robertson and coauthors[37] measured the amount of anesthetic solution delivered with a standard aspirating syringe and a standard 27-gauge needle. Fifty articaine cartridges and 50 lidocaine cartridges were emptied into a graduated syringe with 0.01-mm increment divisions. Even though the articaine cartridge was marked externally as containing 1.7 mL (Fig 1-11), on average the anesthetic solution expressed was 1.76 mL. For the lidocaine cartridge, the amount was marked as 1.8 mL (Fig 1-12), but on average the anesthetic solution expressed was 1.76 mL. In general, a small amount of anesthetic solution remained in both cartridges after delivery of the solution with an aspirating syringe. The amount of anesthetic solution expressed was basically the same for both articaine and lidocaine. Some manufacturers are now labeling cartridges as 1.7 mL even though the anesthetic solution expressed is 1.76 mL.

__In conclusion,__ cartridges marked 1.7 mL and 1.8 mL express the same amount of anesthetic solution.

Classification of local anesthetics and clinical implications

Generally, local anesthetic agents are classified as short, intermediate, or long-acting based on their pKa, lipid solubility, and protein binding.[35] Short-duration drugs include 3% mepivacaine and 4% prilocaine. A long-acting drug is 0.5% bupivacaine with 1:200,000 epinephrine. Lidocaine, articaine, mepivacaine, and prilocaine, all with vasoconstrictors, are considered intermediate in action. However, Pateromichelakis and Prokopiou[38] found that studies on isolated nerves can be poor guides to the clinical comparisons of local anesthetics. For example, clinical studies indicate that the duration of these drugs is different when used in nerve blocks versus infiltration or intraosseous injections. A good example is anesthetic agents like bupivacaine and etidocaine. While classified as long-acting agents, this duration only holds true for nerve blocks—not for maxillary infiltration, intraligamentary, or intraosseous anesthesia.[11,39–41] Short-duration drugs like 3% mepivacaine and 4% prilocaine are effective for IANBs of at least 50 minutes[4] but have a short duration for infiltration anesthesia in the maxilla.[42,43]

In conclusion, *the overall classification of local anesthetics does not always correlate with clinical effectiveness.*

Factors influencing local anesthetic effectiveness

Genetics

Some patients may not respond adequately to local anesthetic administration. Various studies[44–47] have related pain or ineffectiveness of local anesthetic to genetic factors. Perhaps, one day in the future, we may be able to use genomic testing to improve the efficacy of local anesthetics by selecting drugs that offer the most appropriate pharmacologic usefulness. However, the problem with the gene pool is that there is no lifeguard.

In conclusion, *genetics may play a role in anesthetic failure.*

Red hair phenotype

Natural red hair color results from distinct mutations of the melanocortin-1 receptor (MC1R), which may modulate pain pathways.[48–50] Red hair color is the phenotype for *MC1R* gene, which is associated with red hair, fair skin, and freckles in humans (Fig 1-13). Women with red hair have been reported to be more sensitive to some types of pain and may be resistant to subcutaneous lidocaine.[48] Liem and coauthors[49] reported that the anesthetic requirement for desflurane was increased in redheads. In a follow-up study, Binkley and coauthors[50] found that genetic variations associated with red hair color were also associated with fear of dental pain and anxiety. However, Myles and coauthors[51] found no evidence that patient hair color affects requirements or recovery characteristics in a broad range of surgical procedures.

Droll and coauthors[52] investigated a possible link between certain variant alleles of *MC1R* or its phenotypic expression (red hair) and anesthetic efficacy of the IANB in women. They found that neither red hair nor *MC1R* was significantly linked to success rates of the IANB in women with healthy pulps (Fig 1-14). Importantly, women with red hair and women with two red hair color alleles reported significantly higher levels of

Fig 1-13 Will this woman with red hair be more difficult to anesthetize?

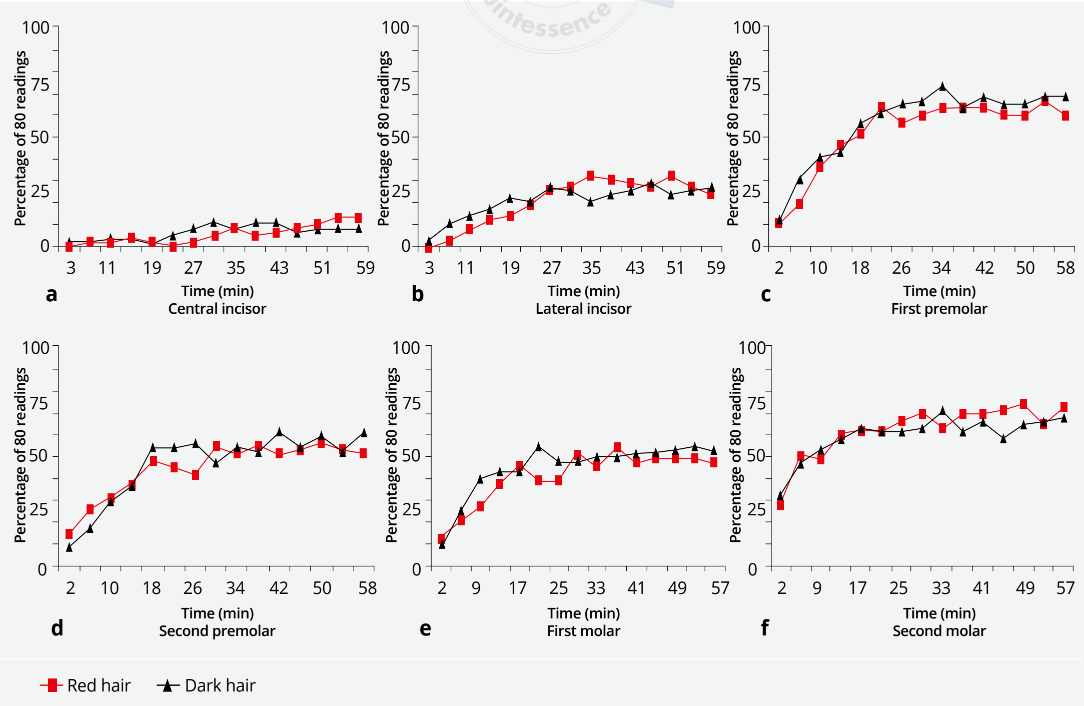


Fig 1-14 Incidence of pulpal anesthesia following an IANB for the central incisor *(a)*, lateral incisor *(b)*, first premolar *(c)*, second premolar *(d)*, first molar *(e)*, and second molar *(f)* as determined by lack of response to an EPT at maximum reading (80 reading), at each postinjection time interval, for red-haired and dark-haired women. There were no significant differences in anesthetic success for any of the teeth. Red hair was significantly linked to higher levels of dental anxiety but was unrelated to success rates of the IANB in women with healthy pulps. (Reprinted from Droll et al[52] with permission.)

dental anxiety compared with women with dark hair or women with no red hair color alleles. Women with red hair also reported greater pain on needle insertion during the injection. It may be that the clinical impression of failed anesthesia in red-haired individuals is owed to the higher anxiety levels perceived in this population. During dental treatment, this population may be more likely to report nonpainful sensations (pressure, vibration, etc) as painful.

In conclusion, *red-haired women do not have more failure with the IANB. However, red-haired women report significantly higher dental anxiety.*

Gender differences

Authors have found that women try to avoid pain more than men, accept it less, and fear it more.[53–55] Morin and coauthors[56] found that women find postsurgical pain more intense than men, but men are more disturbed than women by low levels of pain that last several days. Anxiety may also modulate differences in pain response between men and women.[54] Thus, we should be aware that women and men might react differently to pain. Tofoli and coauthors[57] found that injection discomfort and effectiveness of local anesthetics were not related to phases of the menstrual cycle or use of oral contraceptives. However, Loyd and coauthors[58] reported that a sexually dimorphic peripheral mechanism may modulate trigeminal pain processing and may be related to the luteal phase of the menstrual cycle.

In conclusion, *women try to avoid pain more than men, accept it less, and fear it more.*

Catastrophizing

Some patients may have an exaggerated negative mental set that occurs during an actual or anticipated painful experience.[59] This is called *catastrophizing*. That is, these patients are already predisposed to have a painful experience during dental treatment.

In conclusion, *clinicians may need to inquire about patients' pain experiences and help them reappraise threats.*

Pathways of dental fear

Five pathways related to dental fear have been recognized[60]: *(1)* The conditioning pathway occurs as a result of direct traumatic experiences. *(2)* The parental pathway relates to dental fear learned from parents or guardians. *(3)* The informative pathway is related to fearful experiences learned or heard about from others. *(4)* The verbal threat pathway comes from parents using the dental environment as punishment for bad behavior in children. *(5)* The visual vicarious pathway is caused by fear-inducing dental situations seen in the media. Carter and coauthors[60] found that older patients showed less fear, men were more likely than women to cancel dental appointments because of fear, and people adopted different pathways of fear based on ethnic background.

In conclusion, *there are different pathways of dental fear, and each has an influence on fear of dentistry.*

Pregnancy and breastfeeding

For pregnant patients, elective treatment should be deferred, particularly in the first trimester. However, if treatment involving a painful procedure is required, many of the commonly available local anesthetic agents are safe to use.[61] The US Food and Drug Administration classifies articaine, mepivacaine, and bupivacaine as category C drugs.[35] A category C classification means that "Either animal-reproduction studies have revealed adverse effects and there are no controlled studies in women or studies in women and animals are not available. Drugs should be given only if the potential benefit justifies the potential risk to the fetus."[35,61] Lidocaine and prilocaine are classified as category B drugs. A category B classification means that "Either animal-reproduction studies have not demonstrated a fetal risk but there are no controlled studies in pregnant women or animal-reproduction studies have shown an adverse effect that was not confirmed in controlled studies in women in the first trimester (and there is no evidence of a risk in later trimesters)."[35]

The manufacturer drug monographs that accompany local anesthetic agents place warning statements that these agents should not be used during pregnancy. These statements are placed for medicolegal reasons because the anesthetics have not been tested during pregnancy. To put things in perspective, congenital anomalies occur in 3% of the general population, yet the causes can be determined in less than 50% of these cases.[61] Hagai and coauthors[62] evaluated the rate of major anomalies after exposure to local anesthetics as part of dental care during pregnancy. They found that the use of local anesthetics, as well as dental treatment during pregnancy, did not present a major risk for anomalies.

In patients who are lactating, drugs do pass into the breast milk in very small quantities.[63] If there is concern, the patient may elect to use a breast pump, discard the milk, and provide the infant with formula or previously expressed milk for a day. If the practitioner is unsure about the safety of a drug, they could consult the National Institutes of Health LactMed database. This resource provides information on drug transference to breast milk, drug safety, and safe alternative drugs. Ather and coauthors[64] have also reviewed the current evidence on the safety of the drugs used in endodontic therapy for pregnant patients.

The most important aspect of care in the pregnant patient in pain is elimination of the source of pain by performing the indicated treatment. This approach will reduce the need for systemic medications.[61]

In conclusion, *defer elective treatment for pregnant patients, particularly in the first trimester. However, if treatment involving a painful procedure is required for the pregnant or lactating patient, many of the commonly available local anesthetic agents are safe to use.*

Elderly patients

Nordenram and Danielsson[65] found that elderly patients had significantly shorter onset times of anesthesia when compared with younger patients. In general, older patients may also be more tolerant of pain than younger patients.[66,67]

In conclusion, *older patients may tolerate pain better than younger patients.*

Alcohol addiction

Patients with alcoholism have been found to be more sensitive to painful stimulation, and those with a history of depression/unhappiness may also have shallower pulpal anesthesia.[68,69] In contrast, patients in recovery for alcohol addiction may not be at increased risk for inadequate pain control with local anesthesia.[70]

In conclusion, *patients with alcoholism who are not in recovery may be more difficult to anesthetize.*

Allergies and local anesthetics

Generally, amide local anesthetics have a very low chance of inducing allergic reactions.[70] Batinac and coauthors[71] found that the most common symptoms related to administration of local anesthetics were cardiovascular reactions (18%). True allergic reactions were rare (less than 1%). In patients who have reported adverse reactions to local anesthetics, none had hypersensitivity reactions to the intradermal injection of local anesthetics.[70] However, there have been case reports of hypersensitivity reactions to local anesthetics.[70–79] Patients who have had anaphylactic reactions or serious idiosyncratic reactions to the administration of local anesthetics should be referred to a dental anesthesiologist or oral surgeon for deep sedation or general anesthesia prior to restorative procedures. If allergy testing is being performed, make sure to include cartridge samples of both plain and epinephrine-containing solutions.

In conclusion, *patients who have had serious reactions to local anesthetics should be treated in conjunction with a dental anesthesiologist or oral surgeon.*

Latex in dental cartridges

Shojaei and Haas[77] performed a literature review on latex allergies. They concluded that the medical literature provides some evidence that the latex allergen can be released into solutions by direct contact with natural latex stoppers within the cartridges. However, they stated that there are no documented cases of allergy to dental local anesthetics. Recently, some manufacturers have introduced latex-free dental cartridges for all of their product lines.

In conclusion, *dental cartridges present little risk in patients with latex allergy.*

Sulfites

Sulfites are common additives to many food products and are present in small amounts in local anesthetic cartridges. The sulfites prevent the oxidation of the vasoconstrictor in dental formulations. Smolinske[78] felt that anaphylactic or asthmatic reactions caused by parenteral administration of sulfite agents were different than reactions caused by foods. The reactions were rapid and had no predilection for steroid-dependent asthmatics. As stated by Naftalin and Yagiela,[79] the best way to avoid a reaction in a patient with a true sulfite allergy is to use a local anesthetic without a vasoconstrictor.

In conclusion, *if a patient has a severe sulfite allergy, use an anesthetic solution without a vasoconstrictor.*

Reversing soft tissue numbness

The duration of soft tissue anesthesia is longer than pulpal anesthesia and is often associated with difficulty eating, drinking, and speaking.[80–82] Patients may feel that residual soft tissue numbness interferes with their normal daily activities in three specific areas—perceptual (perception of altered physical appearance), sensory (lack of sensation), and functional (diminished ability to speak, smile, drink, and control drooling). Patients may complain that they are unable to eat a meal or talk normally after their dental visit. And patients often do not want to have lip and tongue numbness for hours after the appointment. Phentolamine mesylate (0.4 mg in a 1.7-mL cartridge; OraVerse, Septodont) is an agent that shortens the duration of soft tissue anesthesia (Fig 1-15). OraVerse has the greatest value in dental procedures in which postoperative pain is not of concern. Clinical trials have evaluated the use of phentolamine in patients

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Fear of pain is the number one reason people give for not making regular visits to the dentist, and unfortunately, a majority of dentists report anesthesia-related problems during restorative dental procedures. The administration of local anesthesia is the first procedure dentists perform at an appointment, and it inevitably affects every aspect of treatment that comes afterward. If dentists can improve their ability to administer successful local anesthesia, patient compliance and satisfaction will improve.

This third edition of *Successful Local Anesthesia* is grounded in all the latest research to bring you up to date on the best, evidence-based ways to successfully anesthetize your patients using the newest technology and drugs available. It presents the rationale, advantages, and limitations of various anesthetic agents and routes of administration, with special attention given to pulpal anesthesia and the supplemental anesthetic techniques that are essential to the practice of dentistry.

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