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Articaine: A New Alternative in Dental Hygiene Pain Control

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Purpose. Local anesthesia administration is integral to pain control in dental hygiene. As of 2006, 40 licensing jurisdictions in the United States include local anesthesia administration in the scope of dental hygiene practice. While the risks associated with use of intraoral local anesthesia are not great, careful attention to recommended practices helps foster patient safety. As new products are introduced, it is important to study their advantages and limitations to see where they fit into dental hygiene practice. An amide local anesthetic agent, articaine, that has been available in Europe for over 20 years, was approved for US distribution in 2000.

Methods. The purpose of this article is to review the current peer reviewed literature on the characteristics of articaine so it can be incorporated into dental hygiene practice when indicated.

Results. Rather than simply using one agent for all procedures, patient care is enhanced when local anesthetics are selected based on the unique needs of the procedure, the patient and with safety and effectiveness in mind.

Keywords: Local anesthetics, analgesia and anesthesia, dental hygiene car, pain control

Introduction

The first edition of what came to be a classic textbook in dental hygiene, *Clinical Practice of the Dental Hygienist*,[1] was published in 1959. Esther Wilkins, RDH, DMD, and Patricia McCullough, RDH, devoted one page to the topic of pain control during scaling procedures. The authors noted that, under the dentist's direct supervision, topical anesthetic could be used for patients with a low pain threshold, patients who were nervous, or to gain cooperation of apprehensive patients. For isolated patients who experienced "supersensitive" gingiva, injection of a local anesthetic by the dentist prior to scaling was the only answer.

The most recent edition of Clinical Practice of the Dental Hygienist, the ninth, was published in 2005 [2] A whole chapter is dedicated to the topic of pain and anxiety control, with the understanding that pain management is an integral part of dental hygiene practice. In the past 5 years, 13 licensing jurisdictions (Connecticut, District of Columbia, Kentucky, Massachusetts, Michigan, North Dakota, New Hampshire, New York, Ohio, Rhode Island, Tennessee, Virginia, and West Virginia) have added the administration of local anesthesia to the practice of dental hygiene.[3] Currently, 38 licensing jurisdictions (37 states and DC) include the administration of block and infiltration anesthesia for the dental hygienist. Only New York and South Carolina limit dental hygiene local anesthesia administration to infiltration injections. Continued resistance by the remaining 11 states could be due to perceptions that procedures completed by dental hygienists do not warrant pain control, or that the risk of local anesthesia administration is high. However, it is clear that the trend is to include local anesthesia into the scope of dental hygiene practice.

Local anesthetics are the drugs most widely used in provision of oral health care. Malamed estimates that over 300 million local anesthetic injections are administered on an annual basis in the United States.[4] With nearly 6 million injections each week in the United States, there are few reports of adverse events as a result of intraoral local anesthesia use by dentists or dental hygienists. Scofield and colleagues surveyed 26 state dental boards to determine the extent of disciplinary actions against dental hygienists and dentists related to the use of local anesthetics.[5] States were included if they had included local anesthesia administration by the dental hygienists for at least one year. Of the 18 state boards that responded, none reported a disciplinary action against a dental hygienist related to the administration of local anesthesia. This confirms a previous finding by Sisty-LePeau that no adverse patient reactions of formal complaints were recorded against dental hygienists using local anesthesia.[6]

While local anesthesia administration by dental hygienists has grown to be an integral component of dental hygiene practice, and has shown few, if any, adverse reactions, the administration of local anesthetic is not totally free from risk. Careful attention to the patient's health status and adherence to recommended techniques help keep the risks as low as possible. Researchers and manufacturers are continually working to enhance existing products and techniques for intraoral pain control. Over the past years, new anesthetic agents and techniques have been introduced to improve patient safety and success rates in local anesthesia. This article will review safety and effectiveness of articaine, an anesthetic agent recently introduced in the United States for consideration as part of their pain control armamentarium.

Articaine: a new local anesthetic agent

Since the introduction of procaine (Novacain) in 1904, the search for an ideal local anesthetic agent has been ongoing. The ideal agent would take effect immediately, produce profound anesthesia, pose no risk of local or systemic toxicity, and be non-allergenic. Early anesthetic agents belonged to the ester group, and while they were acceptable, they were not ideal. Amide agents were introduced in 1948. They had quicker onset, longer duration, but allergenicity was the factor that gave amides an advantage over ester agents. Amide agents were far less allergenic than ester agents. Lidocaine, the first amide agent to be marketed, quickly replaced procaine as the dental local anesthetic agent of choice.[7] As of 1996, the last remaining ester local anesthetic product in a dental cartridge, a combination of procaine and propoxycaine, was removed from the US market.[4] There are currently 5 injectable amide agents available to US dental hygienists when pain control needs require local anesthetic administration: lidocaine, prilocaine, mepivacine, bupivacine, and the relative newcomer, articaine.

Articaine has been available in Europe for over 20 years, but was approved for use in the United States only in 2000.[8] Articaine is marketed as Septocaine (Septodont, Inc, New Castle, DE; www.septodontusa.com) and Zorcaine (Cooke-Waite-Eastman Kokak, Rochester, NY) in the United States.[8] Although articaine is grouped as an amide agent, it has unique properties that distinguish it from the other amides. In addition to its amide linkage, articaine also has a thiophene or sulfur-containing ring and an ester side chain.[9] The thiophene ring gives articaine a higher lipid solubility, which can impart better diffusion through tissues and enhanced ability to cross lipid membranes.[10] The ester side chain contributes to the rapid breakdown of articaine once it is injected.[11] Amide local anesthetic agents are generally metabolized by microsomal enzymes in the liver; articaine, with its ester side chain, is hydrolyzed primarily by plasma esterases. Plasma hydolysis is much quicker, resulting in a shorter half life for articaine. The clinical advantage of a short half life is that there is less articaine accumulated and circulating in the blood. A shorter half life can reduce systemic toxicity if additional doses are administered over time as might occur in a full mouth disinfection situation. In articaine, the theoretical advantage of shorter half life with less toxicity compared to other amide agents may be offset by the fact that articaine is marketed as a 4% solution.[11] The maximum recommended dose of articaine for a healthy adult patient is 7 cartridges compared to 8 cartridges for lidocaine.[4,8]

For all dental local anesthetics, toxicity is reduced by slow injection (giving the body time to metabolize the agent), aspiration prior to injection (reducing the risk of intravascular injection and higher systemic levels of the drug), careful review of history (identifying patients who may require lower doses or different agents), and dosage control. Malamed

notes that administration of too large a dose of local anesthetic in relation to patient age and weight is **the most important cause** of serious local anesthetic reactions in dentistry.[4] As dental hygiene clinicians consider treatment plans that include full mouth disinfection, the risk of overdose reactions can be lowered by administering anesthesia to one quadrant and treating that area before administering anesthesia to the next quadrant regardless of the agent selected.

One final unique aspect of articaine is that, in spite of its ester linkage, it is not linked to higher rates of allergy like the ester anesthetic agents. Unlike ester anesthetic agents, articaine is not metabolized to PABA, the agent responsible for ester anesthetic agent allergic reactions. Yagiela notes that early information related to articaine suggested that it should not be used with patients who have an allergy to "sulfa," possibly due to the sulfur atom in the chemical structure.[11] This is **not** the case; there is no relationship between allergy to sulfonamide-related drugs and allergy to articaine.[11] Therefore, articaine has an allergy profile that is similar to those of other amides. Allergic reactions to amide agents are extremely rare.[4] Malamed notes that follow-up evaluations of reported cases of amide allergy usually find the case describing overdose, idiosyncrasy, or psychogenic reactions. Further, allergy to one amide local anesthetic does not preclude use of other amide agents.[4] So, allergy to lidocaine will not preclude use of articaine, or any of the other amide agents. This makes it essential that clinicians have more than one injectable local anesthetic agent available in practice. Table I details the characteristics of the currently available injectable dental local anesthetics.[4]

Table I Summary Characteristics of Injectable Dental Anesthetics

Anesthetic Agent*	Onset Minutes	Duration (nerve block)	MRD** # cartridges	Patient Considerations
Articaine 4%	~1 to 3	Intermediate 60-75 min.	500 mg 7 cartridges	
Bupivacaine 0.5%	~ varies, but often 6-10	Long 90-180 min.	90 mg 10 cartridges	For lengthy procedures or to manage significant postoperative pain
Lidocaine 2%	~2 to 3	Intermediate 60 min.	300 mg 8 cartridges	Pregnancy Class B; elective treatment should be deferred; if anesthetic is indicated during pregnancy, use smallest dose possible; ideally in 2nd or 3rd trimester.[7]
Mepivacaine 3% (no vasoconstrictor)	~1 to 2	Short 20-40 min.	300 mg 5.5 cartridges	Least vasodilating; provides longer duration when a vasoconstrictor is contraindicated.
Prilocaine 4% (no vasoconstrictor)	~2 to 4	Intermediate-40-60 min.	400 mg 5.5 cartridges	Duration of plain solution varies by injection type; Relatively contraindicated in patients with decreased oxygen carrying capacity.***
Prilocaine 4%	~2 to 4	Intermediate 60-90 min.	400 mg 5.5 Cartridges	Relatively contraindicated in patients with decreased oxygen carrying capacity.***

Source: Malamed SF. *Handbook of Local Anesthesia.* 5th ed. St. Louis, MO: Elsevier Mosby; 2004.

* Unless otherwise noted, details are for cartridges containing local anesthetic agent AND vasoconstrictor; use of vasoconstrictor is recommended unless contraindicated since it reduces systemic levels of anesthetic agent.

** Maximum recommended dose (MRD) for healthy adult patient; pediatric dose should be calculated using mg/kg or mg/lb.

*** Congenital or idiopathic methemoglobinemia, hemoglobinopathies, anemia, cardiac or respiratory failure evidenced by hypoxia

Research on articaine

Given its unique characteristics, potential advantages of articaine include profundity of anesthesia, longer duration, faster onset, and less toxicity. Ninety-four dentists participated in a practice-based study of articaine after its introduction into the US.[12] The study reported perceptions of practicing clinicians using articaine in 13 000 procedures classified as simple or complex. Eighty-four percent reported that articaine produced anesthesia more profound than other routinely used anesthetics. (Lidocaine was the agent the majority of practitioners reported as their "usual" anesthetic agent.) Seventy-four percent reported faster onset with articaine; 54% reported greater success with patients who were difficult to anesthetize; and 45% reported that infiltration provided excellent anesthesia on both the mandible and the maxilla, including excellent for root planing. A smaller percentage (23%) reported a reduced number of missed blocks using articaine. Higher cost

was the one disadvantage reported by practitioners. Adverse reactions reported by the practitioners included 2 cases of paresthesia and one case of tissue sloughing. Ninety seven percent of the evaluators rated articaine as excellent or good, and 71% said it would replace the products they currently use. Clinical Research Associates (CRA) concluded that articaine had fast onset, very profound anesthesia, and infiltration properties that often allowed restorative procedures without the need for a block.

It is important to obtain perspectives of practitioners in evaluating new products, but it is also essential that new products are tested in controlled trials, which have the benefit of reducing bias. A search of PubMed with limits to randomized trials in the past 10 years yielded 10 published reports comparing articaine to one of the available amide agents. Four papers reported superior results with some aspect of articaine-longer duration, longer analgesic effect, or more episodes of no response to pulp tester in studies ranging in size from 20 to 62 patients.[13,14,15,16] Six randomized, double-blind studies that ranged from small (20 patients) to large (1324 patients) found articaine comparable to other commercially available intraoral local anesthetics.[10, 17-21] The largest studies were those by Malamed et al.[10, 20, 21] He reported on 3, identical single-dose, randomized, double-blind, parallel-group, active-controlled multicenter studies involving 1324 patients conducted to test the safety and efficacy of articaine. The authors concluded that articaine was well tolerated, produced clinically effective pain control during most procedures, and had onset and duration comparable to lidocaine. In short, controlled clinical trials have failed to demonstrate a superiority of articaine, but have shown that it is comparable to available dental local anesthetics.

While reported clinical trials have concluded that articaine is a safe effective addition to the dental armamentarium, there have been reports suggesting that articaine use is associated with higher rates of paresthesia (persistent anesthesia). The practitioner based study reported by CRA noted 2 cases of paresthesia after use on 13 000 patients.[12] One patient had placement of an endosseous implant and the other had an intraosseous injection making it difficult to determine if paresthesia was the result of the procedure or the local anesthetic agent. Haas conducted a 21-year retrospective study of paresthesia of the lingual and inferior alveolar nerves after mandibular block injections and restorative procedures (no surgery). While the overall risk was small, the use of articaine and prilocaine was associated with an elevated risk of paresthesia.[22]

Any trauma to nerve tissues may lead to paresthesia.[4] Most paresthesias associated with dental procedures have been related to surgical procedures in the mandibular posterior region. In a small percentage of cases of dental related paresthesia, trauma from the needle, a contaminated solution, or the agent itself, may be the cause of paresthesia and may occur even with strict adherence to proper protocol. Since both prilocaine and articaine are used in a higher concentration (4% solutions), the possibility exists that local anesthetics of higher concentration are more neurotoxic.[4] At this point, no controlled clinical trials or prospective trials have confirmed the elevated risks of paresthesia associated with articaine and mandibular injections. Hawkins[23] reported that "high" block techniques (such as the Akinosi or the Gow Gates technique as opposed to the traditional inferior alveolar block) have not been associated with increased risk of paresthesia. He further suggests that these high approaches may hold promise for reducing the risk of paresthesia even further. Certainly, it is prudent to use informed consent any time local anesthesia is administered so the patient is aware of risks of adverse reactions, no matter how small.

Conclusions

New local anesthetic agents are periodically introduced and may have superiority over existing agents. Articaine has been used with good results in Europe for over 20 years. While it has not yet demonstrated superiority over existing local anesthetic agents in controlled clinical trials, it is comparable and some clinicians have indicated a preference for articaine. Articaine provides an option for pain control in dental hygiene practice. For the dental hygienist, articaine can be used when an intermediate duration anesthetic, such as lidocaine with vasoconstrictor, would be indicated. Articaine also provides the opportunity for research specific to dental hygiene practice. Dental hygiene researchers can build on the dental hygiene body of knowledge by examining articaine and other pain control agents and their effectiveness in dental hygiene practice. Dental hygienists should test this agent out when indicated and watch for future research to clarify its benefits and limitations.

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Notes

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