Articaine: An Effective Adjunctive Local Anesthetic for Painless Surgery at the Depth of the Muscular Fascia

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BACKGROUND Articaine is a unique amide anesthetic that contains a thiophene ring and an additional ester group. The rapid diffusion and enhanced tissue-penetrating properties of articaine enable its use for infiltrative anesthesia.

OBJECTIVE To describe the effective use of articaine as an adjuvant local anesthetic for surgical excisions requiring dissection at the level of the muscular fascia.

METHODS AND MATERIALS We discuss the successful adjunctive use of articaine to provide effective infiltrative anesthesia of muscular fascia. We review the composition, the pharmacologic properties, and the safety profile of articaine.

RESULTS Adjuvant local anesthesia using articaine results in painless surgery at the level of the muscular fascia without any perioperative complications.

CONCLUSION Articaine is not only well tolerated but also rapidly effective for anesthesia in the fascial plane of the trunk and extremities. We recommend it be considered as an adjunctive local anesthetic for consistently painless cutaneous surgery near the muscular fascia.

Keith E. Schulze, MD, Philip R. Cohen, MD, and Bruce R. Nelson, MD, have indicated no significant interest with commercial supporters.

Cutaneous surgery for skin neoplasms that have an aggressive pattern of growth, such as atypical fibroxanthoma, dermatofibrosarcoma protuberans, malignant melanoma, and Merkel cell carcinoma, typically involves deep surgical dissection at the level of the underlying investing muscular fascia as the initial appropriate surgical plane.[1,2] The generation and conduction of electrical impulses in the unmyelinated C fibers of the cutaneous and subcutaneous sensory nerves are rapidly and completely blocked by local infiltration anesthesia with most agents.[3] Lidocaine, 1 to 2% with or without epinephrine, administered with local infiltration is the most widely used local anesthetic and the standard to which other local anesthetics are compared.[3] Lidocaine typically results in rapid onset of complete anesthesia of the skin and adipose tissue.[4]

However, it has been our observation that adequate anesthesia of the penetrating nerves of the muscular fascia is more difficult to consistently obtain with local infiltration of lidocaine and other common local amide anesthetics. We suspect that local infiltrative anesthesia in the fascial plane is probably more akin to regional nerve block anesthesia because of the size and myelinization (Aδ fibers) of the sensory nerves penetrating the muscular fascia.[5] The rapidity of onset and the likelihood of complete block are dependent on the lipophilicity and concentration of the local anesthetic at the surface of the nerve. For example, in lumbar epidural

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anesthesia, 10 mL of lidocaine 2% has been shown to produce more intense blockade of both large diameter and small diameter sensory nerve fibers than 20 mL of lidocaine 1%.[6] Therefore, an anesthetic in higher concentration with enhanced tissue and nerve cell membrane penetrating properties would be more likely to produce rapid and reliable anesthesia in this plane.[3]

Articaine hydrochloride 4% with 1:100,000 epinephrine (Septocaine®; Septodent, New Castle, DE, USA) was approved for use in the United States by the Federal Drug Administration in April 2000. It is supplied in a box of 50, 1.7 mL sterile glass cartridges. A standard or self-aspirating dental syringe with an appropriate needle is required for administration (Table 1).

Articaine is primarily used as a dental anesthetic in the United States. Indeed, articaine is the most commonly used dental anesthetic in Europe, where it has been available since 1976. The composition of articaine is unique; it is the only amide anesthetic that contains a thiophene ring, which increases its liposolubility (Figure 1).[7] It also contains an ester group which allows rapid biotransformation by hydrolysis with a plasma esterase as compared with the other amide anesthetics which undergo hepatic metabolism.[8,9]

The onset of articaine anesthesia is between 1 and 3 minutes, and the average duration of anesthesia with 1:200,000 epinephrine is 71 minutes.[8] In addition to its lipophilicity, its ability to diffuse through nerve membranes, soft tissue, and bone is also enhanced because of the 4% concentration of articaine in solution. Higher tissue concentrations of the local anesthetics allow a higher concentration of the uncharged form of the anesthetic outside the nerve cell membrane which enhances penetration and speeds the onset of anesthesia.[3] The rapid diffusion of articaine through soft tissue and bone has prompted dentists to use this anesthetic not only for local infiltration, but also for infiltrative anesthesia of areas that traditionally require the use of nerve blocks for adequate anesthesia.[8]

We previously used local infiltration with lidocaine and bupivacaine for cutaneous surgical procedures requiring dissection at the level of the muscular fascia on the trunk and extremities. However, based on articaine's pharmacologic properties of having superior penetration of tissue and relatively rapid onset of action, as compared with the other local anesthetics, we added articaine to our anesthetic regimen for patients requiring excisions that extend to the level of the muscular fascia. Subsequently, we have repeatedly confirmed that painless surgery at this depth of dissection has been easier to obtain when using articaine as an adjunctive local anesthetic. We use between 1.7 mL (one cartridge) and 6.8 mL (four cartridges) to infiltrate deep into the subcutaneous adipose tissue, and thereby anesthetizing the investing fascia.

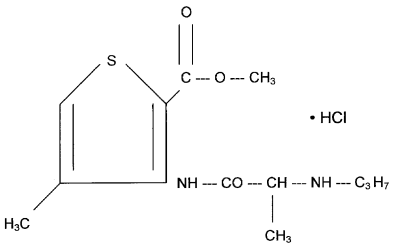

Figure 1. The chemical structure of articaine HCl includes a thiophene ring with an attached ester group.

TABLE 1. Suppliers and Item Numbers of Articaine Hydrochloride and Injection Instruments

Item	*Septodont, Inc. (www.septodontusa.com) Item Number*	*Henry Schein, Inc. (www.henryschein.com) Item Number*
Fifty, 1.7 ml cartridges of Septocaine®—Articaine 4% with 1:100,000 epinephrine	01-A1400	2284404
Aspiject®—self-aspirating dental syringe	01-N2020	2280067
Septoject®—27 gauge disposable needles (box of 100)	01-N1272	2285972

TABLE 2. Volume of Articaine With or Without Concurrent Lidocaine Required to Reach the Toxicity Threshold*

Number of articaine cartridges used (1.7 mL each)	*Volume of articaine 4% with epinephrine (mL) used*	*Volume of lidocaine 1% with epinephrine (mL) required to reach toxicity threshold*
0	0	49†
1	1.7	42
2	3.4	35
3	5.1	29
4	6.8	22
5	8.5	15
6	10.2	8
7	11.9	1
7.2	12.2‡	0

*The volumes of local anesthetics are calculated for a 70 kg person.†In a 70 kg patient, the volume of lidocaine 1% with 1:100,000 epinephrine required to reach the threshold for local anesthetic toxicity is calculated by first determining the total dose by multiplying 70 kg by 7.0 mg/kg = 490 mg. As the anesthetic is prepared at a concentration of 10 mg/mL (1%), the volume of lidocaine 1% with epinephrine needed to reach the toxicity threshold is determined by dividing 490 mg by 10 mg/mL = 49 mL.‡In a 70 kg patient, the volume of articaine 4% with epinephrine to reach the threshold of toxicity is calculated by multiplying 70 kg by 7.0 mg/kg = 490 mg and then dividing 490 mg by 40 mg/mL (the concentration that articaine 4% is prepared) which equals 12.25 mL.

Pharmacologically, articaine has enhanced tissue penetrating properties. Multiple ophthalmological investigations have shown that articaine is more effective than lidocaine plus bupivacaine in studies conducted with peribulbar anesthesia and sub-Tenon's anesthesia for cataract surgery.[10–13] In an intravenous regional anesthesia double-blind study, articaine 0.5% had the fastest onset of sensory block and the lowest peak plasma concentration after release of the tourniquet when compared with lidocaine 0.5% and prilocaine 0.5%.[14]

The safety of articaine is well documented. The onset of action and duration of anesthesia with articaine 4% with epinephrine is similar to lidocaine 1% with epinephrine. Moreover, the maximum recommended dose of 7 mg/kg for articaine with epinephrine is similar to that of lidocaine with epinephrine (Table 2).[15]

Lidocaine has previously been demonstrated to have the least tissue toxicity of the amide anesthetics.[16,17] Articaine has statistically been shown to have no greater tissue toxicity or adverse effect on wound healing than the other local anesthetics, including lidocaine. In addition, articaine is rapidly hydrolyzed by a plasma carboxyesterase into an inactive metabolite (articainic acid). This allows for reinfiltration of articaine with less likelihood of toxicity as compared with reinfiltration of the other amide anesthetics which are metabolized in the liver.[7,8,14]

In conclusion, articaine is a unique amide anesthetic that has both increased liposolubility and the enhanced ability to diffuse through nerve membranes, soft tissue, and bone. It is not only well tolerated but also rapidly effective for anesthesia in the fascial plane of the trunk and extremities. We have found articaine to be a useful adjunct for consistent painless cutaneous surgery when working near the muscular fascia under local anesthesia and recommend that physicians consider using articaine for this purpose.

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