

# ARTICAINE FOR PEDIATRIC PATIENTS



**Clinical tip**



## A Review of Articaine used in Pediatric Patients

Local anesthesia (L.A.) can be one of the most challenging aspects of pediatric dentistry. Unpleasant childhood experiences have made many adults acutely phobic with regard to dental treatment. Special concerns in pediatric dentistry relevant to local anesthetic injection include anesthetic overdose with toxic reaction, self-inflicted soft tissue injury related to the prolonged duration of soft tissue anesthesia, and technique variations related to the smaller skulls and differing anatomy of younger patients. The anesthetic, should provide maximum efficacy using the minimum number of injection while causing negligible adverse effects.<sup>3</sup>

Articaine was the latest agent developed in the early '70s, and although its safety and efficacy has been proven and reported to be comparable or superior to lidocaine, a survey of American general and pediatric dentists found that the majority of respondents still prefer to use lidocaine in children.

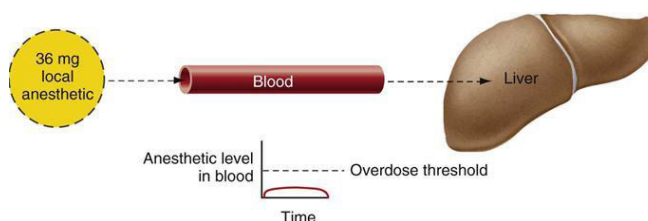
In this clinical tip review, we'd like to sum up questions that might rise when administering articaine in pediatric patients.



## Articaine Characteristics

Articaine is an amide type local anesthetic that acts similarly to other amides, as well as lidocaine, but its unique chemical structure offers advantages over others.<sup>1</sup>

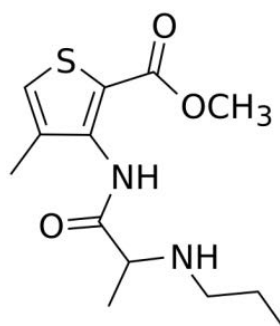
Articaine contains a thiophene ring which makes it more potent and more lipid-soluble, thereby diffusing more readily through both hard and soft tissue.



About 90% of articaine metabolises quickly via hydrolysis in the blood into its inactive metabolite articainic acid.

Articaine has a high affinity for plasma protein binding and it is the only amide analgesia to contain an ester group. This allows it to be rapidly broken down into its inactive state in two ways: in the liver and the blood serum, thus decreasing systemic toxicity.<sup>1</sup> Unlike the other amide local anesthetics that undergo metabolism in the liver only, the biotransformation of articaine occurs in both the liver but mostly in plasma.

Articaine 4% solutions achieve highest level



Articaine

of anesthetic potency and lowest systemic toxicity in all clinical situations thanks to high lipid solubility, high plasma protein binding rate, fast metabolism, fast elimination half life; and a low plasma level.

Articaine is available in two formulations as a 4% solution with 1:100,000 or 1:200,000 (the lower concentration) epinephrine. Both impart a rapid onset of anesthesia and a similar degree of pulpal and soft tissue analgesia (1 hour and 3-5 hours respectively). The two articaine formulations have been used with adults and children.

### Toxic reactions

Toxic reactions are usually due to an inadvertent intravascular injection or use of excessive dose (i.e. repeated injections).

In general, overdose occurs when the drug

**TABLE 1.** Commonly Used Local Anesthetics for Pediatric Dental Patients<sup>9</sup>

Drug	Maximum Recommended Dosage	Pulpal Duration of Anesthesia (Minutes)	Soft Tissue Duration of Anesthesia (Minutes)	Milligrams of Local Anesthetic Per (1.8 mL) Cartridge
2% Lidocaine with epinephrine 1:100,000	7.0 mg/kg (3.2 mg/lb)	60	180 to 300	36 mg
4% Articaine with epinephrine 1:100,000	7.0 mg/kg (3.2 mg/lb)	60 to 75	180 to 300	72 mg
3% Mepivacaine without vasoconstrictor	6.6 mg/kg (3.0 mg/lb)	5 to 10	90 to 120	54 mg

blood level in target organs (such as the brain and myocardium) become excessive. Overdose to local anesthetics is related to the blood level of the local anesthetic that occurs in certain tissues after the drug is administered. Many factors influence the rate at which this level is elevated and the length of time it remains elevated.

The presence of one or more of these factors predisposes the patient to the development of an overdose.

The first group of factors relates to the patient, the second group to the drug and the area into which the drug is administered.

### Patient factors <sup>3</sup>

#### Age:

In the very young pediatric population and geriatric patients increasing the half-life of the

drug, elevating circulating blood levels can influence the risk of overdose.

#### Weight:

The greater the (lean) body weight of a patient (within certain limits), the larger the dose of a drug that can be tolerated before overdose reactions occur (providing the patient responds “normally” to the drug).

#### Other medications:

Administration of concomitant medications may influence local anesthetic drug levels but is highly unlikely.

Medications that should be avoided are tricyclic antidepressants, butyrophenones, MAO inhibitors and phenothiazines.

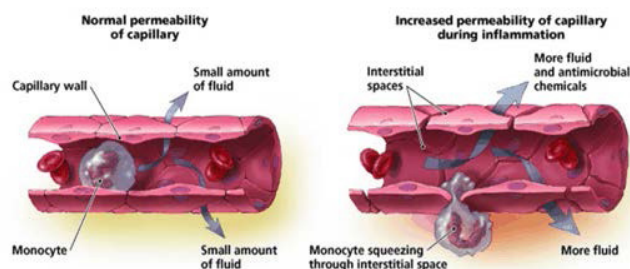
#### Presence of disease:

Disease may affect the ability of the body to transform the drug into an inactive by-product. Hepatic and renal dysfunction impairs the body’s ability to break down and excrete the local anesthetic.

#### Inflammatory process<sup>4</sup>:

If a LA is injected into an area of infection, its onset will be delayed or even prevented.

The inflammatory process in an area of injection lowers the pH of the extracellular tissue from its normal value (7.4) to six or lower inhibiting anesthetic action because little of the free form of the anesthetic is allowed to cross into the nerve sheath to prevent conduction of nerve impulse.



#### Mental attitude and environment:

The apprehensive patient who overreacts to stimulation (experiencing pain when gentle pressure is applied) is more likely to receive a larger dose of local anesthetic, which would seemingly increase the risk of local anesthetic overdose.

## Drug factors<sup>3</sup>

### Vasoactivity:

All local anesthetics currently used by injection in dentistry are vasodilators. This causes two undesirable effects: a shorter duration of clinical anesthesia and an increased blood level of the local anesthetic.

### Concentration:

The greater the concentration (percent solution injected) of the local anesthetic administered, the greater the number of milligrams per milliliter of solution and the greater the circulating blood volume of the drug in the patient. For example, 1.8 mL of a 4% solution is 72 mg of the drug, but 1.8 mL of a 2% solution is only 36 mg.

### Dose:

The larger the volume of a local anesthetic administered, the greater the number of milligrams injected and the higher the resulting circulating blood level.

Drug	Formulation	Manufacturer's MRD	mg/kg (mg/lb)
Articaine	4% with epinephrine	N/A	7.0 (3.2)
Lidocaine	Plain	300	4.4 (2.0)
Lidocaine	Epinephrine 1 : 100,000	500	7.0 (3.2)
Lidocaine	Epinephrine 1 : 50,000	500	7.0 (3.2)
Mepivacaine	Plain	400	6.6 (3.0)
Mepivacaine	With levonordefrin	400	6.6 (3.0)
Prilocaine	Plain	600	8.0 (3.6)
Prilocaine	With epinephrine	600	8.0 (3.6)
Bupivacaine	With epinephrine	90	—

Note: to avoid overdoses, the maximum recommendation dose (MRD) must not be exceeded and aspiration test always be performed prior local anesthetic injections.

### Route of Administration:

Local anesthetics exert their clinical effects in the area of deposition. A factor in local anesthetic overdose in dentistry is an inadvertent intravascular injection.

Extremely high drug levels can be obtained in a short time, leading to serious overdose reactions. Absorption of local anesthetics through oral mucous membranes is also potentially dangerous because of the rate at which some topically applied anesthetics enter the circulatory system.

### Rate of Injection:

The rate at which a drug is injected is a very important factor in the causation or prevention

of overdose reactions. Rapid administration (15 seconds or less) of 1 cartridge of lidocaine produces greatly elevated levels and virtually ensures an overdose reaction.

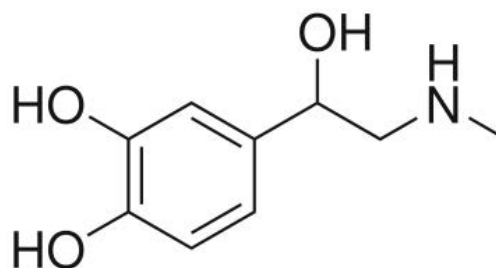
Slow administration (60 seconds or more) produces significantly lower levels in the blood, with a lesser risk that a severe overdose reaction will develop.

### Vascularity of the Injection Site:

The greater the vascularity of the injection site, the more rapid the absorption of the drug from that area into the circulation, and the oral cavity is one of the most highly vascular areas of the entire body.

### Presence of Vasoconstrictors<sup>4</sup>:

Vasoconstrictors are added to local anesthetics to constrict blood vessels in the area of injection, lowering the LA absorption rate into the blood stream, decreasing rate of systemic absorption of the drug, thereby lowering the risk of toxicity and prolonging the anesthetic action in the area L.A. toxicity can be prevented by a careful injection technique, watchful observation of the patient, and knowledge of the maximum dosage based on weight and age. Practitioners should aspirate before every injection and inject slowly. After the injection someone should remain with the patient while the anesthetic begins to take effect. When signs or symptoms of toxicity are noted, administration of the local anesthetic agent should be discontinued, and additional emergency management is based on the reaction.



Adrenaline

## Approach on use of Articaine in children

<sup>4</sup>In pediatric dentistry, dental professionals should be aware of proper dosage based on patient weight and age during administration

of articaine to minimize the chance of toxicity and prolonged anesthesia which can lead to accidental trauma to lip, tongue, or soft tissue.



Administration of large volumes of local anesthetic is not necessary when one is seeking to achieve pain control in younger patients.

Because of differences in anatomy smaller volumes of local anesthetics provide the depth and duration of pain control usually necessary to successfully complete planned dental treatment in younger patients.

<sup>1</sup>Articaine 4% 1:100,000 is reported to be a well-tolerated, safe and effective local analgesia for use in children.

Articaine is 1.5 times as potent as lidocaine so administration uses a smaller volume of solution but a higher concentration of drug.

This reduced volume may be of value in decreasing the discomfort of anesthetic administration, particularly where co-operation in children is inadequate.

As with all medication, dosage should be calibrated on a mg/kg basis for children.

Metabolism of articaine is age dependent and the clearance and volume of distribution decreases with increasing age.

Due to these age related differences in pharmacokinetics, it has been reported that there is no need to fix a lower mg/kg articaine dose limit for children.

The current pediatric dosage recommendation for articaine is 7mg/kg in children 4 years and older; however some authors have advocated a lower limit of <5mg/kg for children aged 4-12 years, especially if used in conjunction with sedative agents.

In any case, while smaller volumes of articaine can be administered it must be remembered that the concentration of articaine is twice that of lidocaine so that the safe number of cartridges must be halved.

This maximal dosage could easily be exceeded if dentists are not vigilant in children.

## Use of Articaine in children under 4 years of age

<sup>1</sup>Some studies specifically investigated the use of articaine in paediatric dental patients less than 4 years of age with promising results, however the manufacturers still do not recommend it for children younger than 4 years. A recent systematic review had to conclude that there was insufficient data to support use of articaine in very young children.<sup>1</sup> On the other hand, a retrospective survey was conducted reporting the use of articaine hydrochloride as an anesthetic in children under 4 years of age.<sup>2</sup> Data was collected by a record audit in two pediatric dentistry offices. Articaine anesthetic was administered to 211 patients, 29 having additional administrations of the agent. In some instances, the dosages exceeded the recommended concentrations for older children. No systemic adverse reactions were noted in the charts or known to the clinicians. Data provide initial evidence for the use of articaine in children under 4 years of age.

This retrospective study supported the use of articaine in children under 4 years of age. Considering both groups of children, 211 patients received a total of 240 doses of articaine without any reported adverse effects. These data provide a rationale for a larger, prospective study documenting the efficacy of articaine for pediatric dental patients under 4 years of age.

## Articaine vs. Lidocaine in pediatric patients

<sup>5</sup> Three identical single-dose, randomized, double-blind, parallel-group, active-controlled multicenter studies were conducted to compare the safety and efficacy of articaine HCl (4% with epinephrine 1:100,000) to that of lidocaine HCl (2% with epinephrine 1:100,000) in patients aged 4 years to 79 years, with subgroup analysis on subjects 4 to <13 years. Fifty subjects under the age of 13 years were treated with articaine and 20 subjects under the age of 13 were treated with lidocaine.

Patients received comparable volumes of articaine and lidocaine for both simple and complex procedures, but higher mg/kg doses of articaine in both types of procedures due to the higher concentration of articaine (4%) versus lidocaine (2%).

Mg/kg articaine:  $2.37 \pm 0.182$  (simple),  $2.91 \pm 1.009$  (complex);

lidocaine:  $1.27 \pm 0.144$  (simple),  $1.43 \pm 0.296$  (complex).

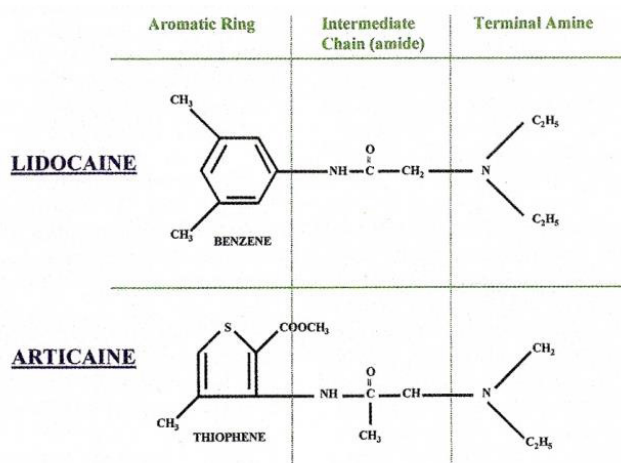
One patient received articaine in excess of the maximum recommended dose of 7.0 mg/kg (5 yo/18 kg). No adverse event or other sequelae developed in this patient.

provides total pain relief during most dental procedures. In these randomized, double-blind studies, no significant difference in pain relief was observed between articaine 4% with epinephrine 1:100,000 and lidocaine 2% with epinephrine 1:100,000.

## Conclusion

Articaine is a safe and effective local anesthetic which offers many advantages when providing dental analgesia in children,<sup>1</sup> nonetheless manufacturers not recommend it in children under the age of 4 years.

Most noteworthy is the potential that IANB can be replaced by infiltration technique. Soft tissue anesthetic may be prolonged, but the risk of other adverse reactions is similar to other local anesthetic agents. It is important that the dose of articaine be calculated for each child as smaller volumes of the more concentrated local anesthetic solutions are required than lidocaine. Practitioners should be aware of the effectiveness of articaine to diffuse through bone and soft tissue to give excellent depth of anesthesia, while avoiding block and palatal anesthesia for dental treatment in children.



No serious adverse events related to the study medication occurred.

Efficacy of articaine was evaluated among 50 children between 4 and <13 years of age. Mean pain (VAS) scores were slightly higher among the children when compared with the adult age groups. Overall pain was judged greatest by the children undergoing complex procedures, but these scores were still very low. The comparison shows that Articaine 4% with epinephrine 1:100,000 is a safe and effective local anesthetic for use in pediatric dentistry. Time to onset and duration of anesthesia are appropriate for clinical use and are comparable to those observed for other commercially available local anesthetics.

Articaine can be used effectively in children. Articaine 4% with epinephrine 1:100,000

## References

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