Articaine : Extended Role in Dentistry

Dr. Aashish Malik[1], Dr. Nisha Vashisth[2]

PG Student[1,2], Dept. of Oral & Maxillofacial Surgery, PDM Dental College & Research Institute, Bhadurgarh, Haryana.

Abstract:

It is observed in various studies that in any minor surgical procedure in dentistry articaine shows better results than conventional anaesthetic agent like lignocaine. The immunogenic potential of Articaine is very low. Articaine contains a thiophene ring instead of benzene like of Lidocaine which gives the molecule better diffusion properties compared with Lidocaine. One of the reasons why Articaine instantly became so popular in many countries was due to its excellent efficacy. Dentists claimed that they seldom missed with blocks and the buccal infiltration in maxillary arch often was enough before an extraction of tooth because of Articaine's bone penetration property. Articaine contains an additional ester group that is quickly hydrolysed by plasma esterases which gives an Articaine an elimination half-life of approximately 90 mins. This makes re-injection of Articaine safe.

Introduction

Pain is an unpleasant experience that motivates an individual for greater than any other life experience. Fear of pain has been associated with the dental treatment since ages. Effective control of pain during dental procedures has been one of the most important pre-requisite of painless dentistry. There are various methods used to control pain among which use of local anesthetic agent is the commonly employed technique in dental practice.[1]

Lignocaine hydrochloride (HCl) has been in use for more than 60 years and as a local anaesthetic it is considered by some to be perfect for dentistry. Anaesthesia can be achieved rapidly and lasts for a reasonable length of time making it suitable for infiltration and nerve block anaesthesia.(4) Articaine was introduced into UK clinical practice in 1998. Its structure is similar to other local anaesthetics but it is the only local anaesthetic to contain a thiophene ring (in place of a benzene ring). This increases lipid solubility leading to a greater portion of the administered dose entering neurons and an increase in drug potency. Articaine also possesses an ester link that allows hydrolysis by plasma esterase as well as in the liver. Both articaine and lignocaine are amides and block nerve conduction in a similar manner.[2]

The inadvertent intravascular injection of a full cartridge of adrenaline-containing local anaesthetic would lead to a plasma concentrations of adrenaline unlikely to exceed that of the hormone naturally produced by the body under stressful situations or when performing light physical exercise.(10) As articaine is hydrolysed quickly in the blood, the risk of systemic intoxication seems to be lower than with other anaesthetics, especially with repeated injection.[3]

Articaine (4-methyl-3-[2-(propylamino)-propionamido]-2-thiophene-carboxylic acid, methyl ester hydrochloride) differs from the other amide local anesthetics because it contains a thiophene ring (Figures 1 and 2). The thiophene ring allows greater lipid solubility, which facilitates diffusion across the lipid-rich nerve membrane to access target receptors.1 In addition, articaine contains an ester group, so that hydrolyzation occurs in the plasma by nonspecific cholinesterases, further metabolism, and excretion, primarily in the kidneys.

Mechanism of Action

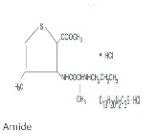
Blocks nerve conduction by reversibly binding to the α-subunit of the voltage-gated sodium channels within the inner cavity of the nerve, similar to other local anesthetics. Binding of articaine to the sodium channel reduces sodium influx so that the threshold potential will not be reached and impulse conduction stops. The blocking action of articaine on the sodium channel is state dependent: it has the highest affinity for the open state, an intermediate affinity for the inactivated state, and the lowest affinity for the resting state.5 The degree of neuronal block is affected by the diameter of the nerve. Larger-diameter fibers (touch/pressure/motor) require higher concentrations of local anesthetic compared with small myelinated fibers (pain afferents).6 Articaine is lipid soluble, highly protein-bound (94%), and has a dissociation constant (pKa) of 7.8. Articaine is an intermediate-potency, short-acting local anesthetic with a fast onset of action.1

Relative Potency

Ascribing local anesthetic potency is an attempt to define the sensitivity of nerves to different local anesthetics and to estimate anesthetic requirements during regional anesthesia. The potency of local anesthetics increases parallel with increasing lipid solubility. The binding ability of local anesthetics to the phospholipid membrane as a result of physicochemical features and in vivo interaction has also been found to be directly in parallel with the potency.7

In clinical practice, other factors affect the potency of a local anesthetic, including:

- Hydrogen ion balance
- Fiber size, type, and myelination
- Vasodilator/vasoconstrictor properties (affects rate of vascular uptake)
- Frequency of nerve stimulation ambient pH (lower pH results in greater ionisation and a reduction in efficacy)
- Electrolyte concentrations (hypokalemia and hypercalcemia antagonizes blockade) For assessing the potency.

Pharmacological details	4% Articaine hydrochloride
Chemical formula	3- N-Propylaminopraprionyla-mino-2-caromethoxy-4-methyl thiophene hydrochloride
Structure formula	
Classification	Amide
Molecular Mass	284.38
Partition coefficient	2.07
pH with 1: 100000 adrenaline	4.6 - 5.4
pK_a	7.8
Lipid solubility	1.5
Plasma protein binding	76% (pH 8.5)

Metabolism & Elimination

The molecular structure of articaine is characterized by having both lipophilic and hydrophilic ends connected by a hydrocarbon chain. The "CO linkage" between the hydrocarbon chain and the lipophilic aromatic ring classifies articaine as being an ester local anesthetic, in which the link is metabolized in the serum by plasma cholinesterase. Articaine is quickly metabolized via hydrolysis into its inactivemetabolite articainic acid, which is partly metabolized in the kidney into articainic acid glucuronide.

Clinical Trials

Articaine has been widely used in dental surgery. Dentists started to use carticaine around 1977.54 In dentistry, articaine has been investigated extensively. Clinical trials comparingarticaine mostly with lidocaine have varied in study design and site of action. The overwhelming majority of references in the literature describing the alleged neurotoxicity of articain concern paraesthesia and prolonged numbness after dental procedures. An excellent review of the dental literature was published last year.55 The authors concluded that articaine is a safe and effective local anesthetic drug to use in all aspects of clinical dentistry for patients of all ages, with properties comparable to other common local anesthetic agents. Although there may be controversy regarding its safety and advantages in comparison to other local anesthetics, there is no conclusive evidence demonstrating neurotoxicity or significantly superior anesthetic properties of articaine for dental procedures. The choice whether to use articaine or another local anesthetic is based on the personal preference and experiences of

individual clinicians.56 Currently, articaine is available as a 4% solution containing 1:100,000 or 1:200,000 epinephrine. Clinical trials comparing 4% with 2% solutions show no clinical advantage of 4% over a 2% solution.

Inferior alveolar nerve block (IANB)(20;23) Four per cent articaine with 1:100,000 adrenaline exhibited faster onset and had a longer duration of pulpal anesthesia when compared with two per cent lignocaine with 1:100,000 adrenaline. Mandibular posterior molars were examined and mean onset of pulpal anesthesia was significantly faster for articaine (7.4 minutes) over ligocaine (8.7 minutes) (p=0.037) and mean duration of pulpal anesthesia under articaine was also significantly longer at 61.8 minutes (106.6 minutes for lignocaine) ($p \leq 0.05$). In contrast Poorni et al found no statistical difference between articaine IANB, for overall success, when compared with ligocaine in mandibular molars with irreversible pulpitis. Of 52 participants receiving four per cent articaine 75 per cent secured successful anaesthesia compared with 69.2 per cent in lignocaine.[4]

The data obtained in the study included:

1. Onset of anesthesia—recorded from time of injection to the onset of anesthesia of the lip as subjective and objective symptoms.
2. Duration of surgery—measured from time of placing the incision to the last suture placed.
3. Duration of anesthesia—The duration of anesthesia was in turn recorded as the time from initial patient perception of the anesthetic effect to the moment in which the effect began to fade.
4. Blood pressure, oxygen saturation and heart rate were recorded before the administration of local anesthetic and after 5, 15, 30, 45 and 60 min.
5. Any signs of systemic toxicity like talkativeness, slurred speech, apprehension, localized muscular twitching and tremor of the hand and feet, rise in blood pressure, heart rate and respiratory rate were noted.
6. Intra operatively pain was scored on visual analog scale (0–10) (e.g. none, slight, mild, moderate, severe)

Results

No statistically significant differences were seen in the onset and duration of anesthesia between the Articaine and Lidocaine solutions.

Conclusions

4 % Articaine offers better clinical performance than 2 % Lidocaine, particularly in terms of latency and duration of the anesthetic effect. However, no statistically significant differences in anesthetic efficacy were recorded between the two solutions.[5]

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