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ARTICAINE IN PEDIATRIC DENTISTRY – A REVIEW

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Abstract
Background: Lidocaine is a tried-and-true local analgesia agent that has been used in dentistry for many years. Articaine is a newer generation of local anesthetic that has been gaining popularity in recent years. It is an amide type of analgesic, but it has unique structure i.e., have a thiophene ring and thus is different from other amide analgesics. Articaine has faster onset of action, longer duration of anesthesia, and lower risk of side effects. Hence, it is a safe and effective local anesthetic in children that can be used to achieve successful pain control. This article examines the most recent research on the use of articaine in dentistry, paying particular attention to safety and efficacy concerns.

Key words – local anesthetic, articaine, pain

INTRODUCTION

"Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage," said the International Association for the Study of Pain [1]. Children's attitudes and views about pain might be permanently impacted by the way we handle their discomfort [2]. Local anesthetic drugs are a safe and effective way to achieve pain control in dentistry [3]. Since 1949, Lidocaine has been the preferred local anesthetics because it is safe, effective, and versatile [4]. However, it takes a few minutes to show its effect, and also its effects don't last very long, hence development of alternative was required [3]. Articaine was the most effective alternative to lidocaine to treat dental pain.

Articaine is manufactured as 2% or 4% solution with 1:100,000 or 1:200,000 adrenaline [7,5]. Apart from being used as local anesthetic, it is the anesthetic agent which can be used in spinal and epidural anesthesia [17]. They are widely used in dentistry because of its faster onset and also, they are effective and safe[17]. Articane is unique as it is an amide analgesic but contains thiophene ring instead of benzene ring and also the thiophene ring contains an ester group [19]. It has become increasingly popular for adult dentistry; however, an uncertainty exists among dentists regarding its safety in children[7]. A survey of pediatric dentists in India found that most dentists still prefer lidocaine with epinephrine as a local anesthetic for children [6]. A similar result performed was found from the survey carried by the American general and pediatric dentists [7]. Thus, properties and structure of articaine need to be studied so that its safety and efficacy can be known in children.

CLASSIFICATION OF LOCAL ANESTHETIC

A) Classification of local anesthetics based on structure --
1) ESTERS -- Procaine, Chloroprocaine, Butacaine, Cocaine etc.
2) AMIDE -- **Articaine**, Bupivacaine, Dibucaine, Etidocaine, lidocaine etc.
3) QUINOLONE -- Centbucridine
B) Classification of local anesthetic based on potency and duration—

1) INJECTABLE	--	Low Potency, Short Duration – Procaine, Chloroprocaine
	--	Intermediate potency & duration – **Articaine**, Lidocaine
	--	High potency, long duration – Bupivacaine, prilocaine
2)SURFACE ANAESTHETIC	--	Soluble – cocaine, tetracaine, benoxinate, lignocaine
	--	Insoluble – benzocaine, Oxethazaine

HISTORY

Articaine, originally synthesized as carticaine in 1969 by Rusching and colleagues, and entered for clinical use in Germany in 1976 [20]. Its generic name was modified from its original and was changed to articaine in 1984, the year when it was released in Canada [3]. It was introduced in the United Kingdom in 1998 [3]. The US Food and Drug Administration (FDA) approved articaine for use in the United States in April 2000 [6]. Articaine use began in Australia in 2005 [3]. 4% articaine with 1:200,000 adrenaline solution was approved for clinical use by the US Food and Drug Administration (FDA) in 2006 [8]. Since, then articaine is becoming popular for its use in dentistry. Currently, 1:100,000 or 1:200,000 adrenaline solutions combined with 4% articaine are frequently utilized in clinical practice [3].

STRUCTURE

The chemical name of articaine was (4-methyl-3-[2-(propylamino)-propionamido]-2-thiophene carboxylic acid, methyl ester hydrochloride) [8].
Articaine is an amide type of local anesthetic. Despite its similar mechanism of action to other amide analgesics, its unique chemical structure gives it several advantages over traditional amide analgesics [7].
Firstly, articaine contains a thiophene, instead of a benzene ring. The thiophene ring gives this agent a higher affinity for lipid membranes, which allows it to cross nerve membranes and fatty sheath more easily [9]. It can diffuse through soft tissue more easily and has a higher plasma protein binding than other local anesthetics [6].

Secondly, articaine contains an ester group. This ester group allows articaine to be quickly broken down into inactive compounds, which gives articaine a short half-life of 20 minutes and also reduces the risk of systemic toxicity [6-7].

Due to its uniqueness, articaine has the ability to replace inferior alveolar nerve block (IANB) technique with infiltration technique and hence can be preferred local anesthetic agents in case of children as infiltration technique is less painful and technique sensitive, so children acceptance more.

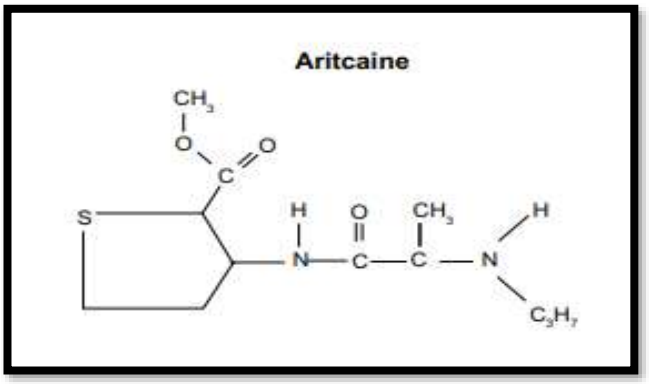

Fig 1 – structure of articaine

MECHANISM OF ACTION OF ARTICAINE

Mechainsm of action of articaine is no different from other local anesthetic. It works by quickly blocking nerve impulses. It does this by binding to sodium channels in nerve cells, which prevents the flow of sodium ions and prevents the nerve cell from reaching its threshold potential and firing an impulse [5].

Articaine is most effective at blocking nerve conduction when the sodium channels in the nerve cells are open or inactivated. This contributes to its rapid onset of action [5].

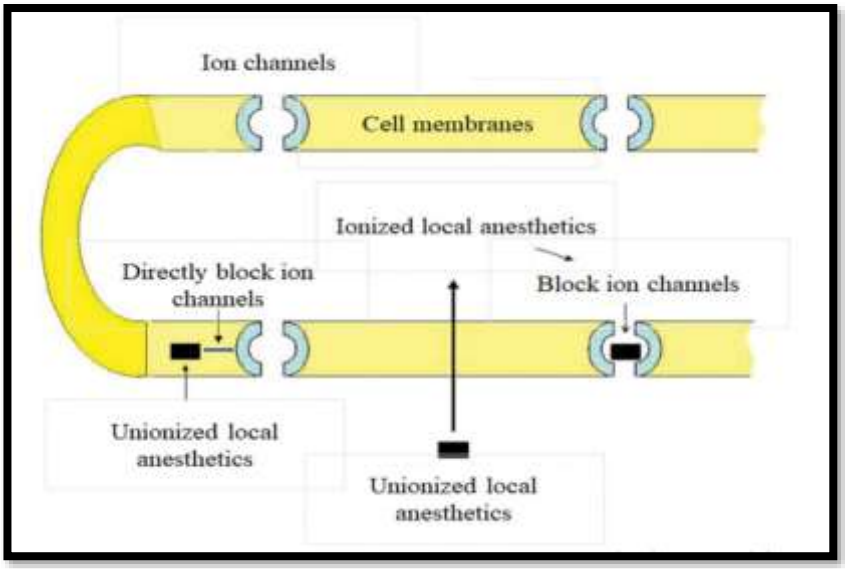

Fig 2- mechanism of action of articaine

PHARMACOLOGY OF ARTICAINE

Pharmacokinetic

Articaine is a local anesthetic with a similar amide structure to other local anesthetics, but it contains a thiopene ring, so More lipid solubility and potency are made possible by the thiophene ring as more of a given dosage can reach the neurons [3]. Also, it contains an additional ester group [16], so easily metabolized. Systemic absorption of articaine, can be increased by its vasodilatory effect [5]. It is 94% protein-bound, so articaine has longer duration of action [6]. It has small volume of distribution, so is more concentrated in the tissues when injected intraorally[16]. Half-life of articaine is 20 minutes, so it is less toxic than other local anesthetic.

Articaine is broken down in the body in two ways:

- **Biotransformation in the liver**: This is a slower process that breaks articaine down into different chemicals, including articainic acid, which is inactive [3].

- **Inactivation by serum esterases**: This is a faster process that breaks articaine down into articainic acid directly [3].

The articaine is **excreted** from the body through the kidneys [9], 90% of articaine is rapidly hydrolyzed in the blood to produce the inactive metabolite articainic. acid, which the kidneys eliminate as articainic acid glucuronide [3].

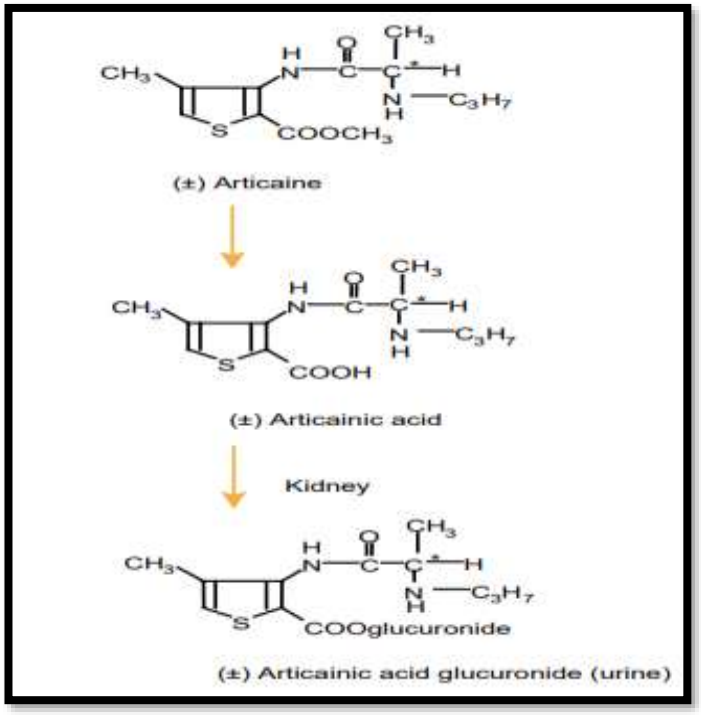

Fig 3 – articaine and its metabolites

It takes around 45 minutes for articainic acid to reach its peak (t_{max}), regardless of the presence of adrenaline. For articaine with epinephrine 1: 200 000, the mean Cmax of articainic acid is around 2000 µg/L, whereas for articaine without epinephrine, it is approximately 2300 µg/L [16]. For intraoral administration, the volume of distribution (Vd) is 1.67 ± 0.32 L/kg. Use of 2% articaine in pediatric dentistry is preferred due to its shorter half-life and lower Cmax, however 4% articaine combined with 1:100,000 epinephrine has also been demonstrated to be safe and effective in pediatric dentistry [5].

Pharmacodynamic

- Efficacy of articaine -- 4% articaine and 2% articaine are equally effective in providing local anesthesia [5]. 4% Articaine with either 1;100,000 or 1:200,000 epinephrine is commonly used [6].
- Safety of articaine – It has **lower therapeutic index**. The amount of articaine that can be safely given to a child between the ages of 4 to 12 year is 5 to 7 milligrams for every kilogram of body weight[6].
- Drug toxicity – articaine may lead to tissue toxicity, CNS toxicity, cardiac toxicity, allergic reaction such skin rash, itching etc.
- Adverse effects – paresthesia, dizziness, tremors, depression, headaches, facial edema etc.

PROPERTIES OF ARTICAINE

1.pka -- The pka value of articaine is 7.8 [18]

2.ph -- of vasoconstrictor containing solution is 4.5 to 5.2 for 1:100,000 and is 4.6 to 5.4 for 1:200,000 [18].

3.onset of action -- for articaine with 1:200,000 epinephrine in case of infiltration is 1-2 minutes and in case of mandibular block is 2-3 minutes and Onset of action of articaine with 1:100,000 epinephrine in case of infiltration is 1-2 minutes and in case of mandibular block is 2 to 2.5 minutes[18].

4.Duration of articaine -- it is about 144 hours [8].
5. Maximum Recommended Dose -- the ages of 4 to 12 year are 5 to 7 milligrams for every kilogram of body weight [6].

USE OF ARTICINE IN CHILDREN

- Articaine is a safe and effective local anesthetic for children over the age of 4 as it is 1.5 times more potent than lidocaine, so less volume of articaine is needed to achieve the same anesthetic effect.
- Injections with articaine are less painful, especially for children who are difficult to cooperate with.
- Articaine has a lower therapeutic index than lidocaine, which means that it is less likely to cause harmful side effects, even if too much is used [6].
- It can **replace inferior alveolar nerve block,** avoiding inferior alveolar nerve block (IANB) in children can help to prevent damage to the inferior alveolar and lingual nerves [7]. Replacement of IANB with buccal infiltration with artcaine is also helpful for children with special healthcare needs [7].
- The amount of articaine considered to be safe for children between 4-12 years is 5 to 7 mg/kg of body weight. When used with sedative agent 5 mg/kg of body weight is considered to be safe and effective [6]. It is important to be extra careful when giving articaine to sedated children, as they may not be able to show the same signs of toxicity as a non-sedated child [10].

ARTICAINE IN CHILDREN BELOW 4 YEARS OF AGE

Articaine can be used safely in children under 4, but it is still important to be cautious. This is because younger children have less developed bodies and may be more susceptible to side effects[8].A study conducted by Wright et al concluded that no adverse reaction was observed by the use of articaine in children under 4 years of age even if the doses of articaine given to children exceeded the recommended guidelines for older children [11].Elhenny conducted a study and found that Articaine hydrochloride 4% with epinephrine 1:100,000 is a safe and effective local anesthetic for children between the ages of 3-4 years old and also comparable to lidocaine hydrochloride 2% and epinephrine 1:100,000 [12]. A survey of American dentists found that 21% of them had used articaine in children aged 2-3 years old, even though the manufacturer does not recommend it for this age group [3]. All these reports supported the use of articaine in children below 4 years of age for achieving anesthesia. However, further investigation is need to validate these results.

CLINICAL SIGNIFICANCE

In the dental clinics, articaine as local anesthetic should be used while treating children undergoing extractions, vital pulp therapies etc. as lesser dose of articaine provides equal effectiveness when compared to lignocaine. Effect of articaine lasts longer. It has the ability to replace nerve blocks such as IANB (injection technique requiring lot of child cooperation), merely 0.2 -0.5 ml of infiltration with articaine can cause effect similar to that of nerve block by lignocaine. Infiltration with articaine is helpful as it takes less time to inject as compared to nerve blocks and also it is less painful. Because of all these reasons articaine is well accepted by the pediatric patients. Since, the amount of dose used is very less there is no side effects seen among the pediatric patients hence it is safe for use.

COMPARISON BETWEEN LIGNOCAINE AND ARTICAINE

In the studies conducted by **Malamed et al., Ram and Amir et al., Rathi NV et al., Shapiro M et al., Jain k et al.** and many others it was concluded that 4% articaine was superior as an anesthetic agent than 2% lignocaine.
However, in other studies conducted by **Tortamano IP et al., Arrow et al., Aggarwal V et al., Bonifacio et al., Tong et al.** it was observed that articaine and lignocaine had similar anesthetic efficacy. Several other studies also have also found no significant difference in the anesthetic effectiveness of 4% articaine and 2% lidocaine when used for a variety of dental procedures in children[14]. From all the evidences it was found that Articaine is safe for children, with few adverse ffects, or similar to those seen with lidocaine.

ADVANTAGE OF ARTICAINE IN CHILDREN

- Articaine acts more quickly
- lasts longer than other drugs
- It is both safe and useful for children
- Is useful to anesthetize teeth having molar incisor hypomineralization
- The success rate of articaine as an anesthetic is higher etc.

DISADVANTAGE OF ARTICAINE IN CHILDREN

- adverse effect and toxicity associated with articaine
- restlessness, anxiety, tinnitus, light headedness, excitement, convulsions,
- Ophthalmologic complications
- facial edema
- costly as compared to lignocaine

CONCLUSION

Articaine is an effective drug to achieve analgesia prior to dental treatment and works well and has few side effects. Articaine is a faster-acting and longer-lasting local anesthetic than lidocaine when injected into the soft tissues of the mouth. This makes it a better choice for many dental procedures. It is a more effective local anesthetic than lidocaine for dental infiltration anesthesia [9].

Pediatric dentists should be aware that articaine is a highly effective local anesthetic that can diffuse through bone and soft tissue to provide excellent depth of analgesia. This makes it a good choice for dental procedures in children to control pain [7]. However, we need to do more research and clinical trials on articaine to make sure it is safe and effective for children [6].

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