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The Articaine Era: Reassessing Pediatric Local Anesthesia - A Review

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Abstract
Articaine, a hybrid amide-ester anesthetic introduced in 1976, has gained prominence due to its rapid onset, superior bone penetration, and dual metabolism, which reduces systemic toxicity. Its unique structure—featuring a thiophene ring and an ester side chain—enhances lipid solubility and tissue diffusion, making it particularly effective in dental infiltrations. Despite its widespread adult use, lidocaine remains the preferred anesthetic among many pediatric dentists, especially in India and the U.S. This comprehensive review evaluates the pharmacology, mechanism of action, efficacy, safety profile, and clinical applications of articaine in pediatric dentistry. Studies demonstrate that articaine provides comparable or superior anesthetic efficacy to lignocaine, particularly in buccal infiltrations for mandibular molars, reducing the need for invasive inferior alveolar nerve blocks. Its pharmacokinetics, including a short half-life (\~27 minutes) and rapid metabolism, contribute to its safety in children, even under 4 years of age. Clinical trials and meta-analyses confirm articaine's effectiveness in pulpotomies, extractions, and restorative procedures, with minimal adverse effects. Reported complications like paraesthesia and methemoglobinemia are rare and often related to concentration or injection technique. Comparative data suggest articaine offers better patient comfort, cooperation, and reduced reinjection rates. In conclusion, 4% articaine with epinephrine is a potent, safe, and well-tolerated anesthetic in pediatric dentistry. Broader clinical adoption, supported by age-specific dosing protocols and further safety research, could significantly enhance pediatric dental care outcomes.

Key Words: *Articaine, Articaine 4%, Articaine 2%, Articaine in Pediatric Dentistry, Local anesthetic, Anesthesia*

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I. Introduction

Effective pain management is essential in both pediatric and adult dentistry to alleviate discomfort, promote healing, and improve treatment outcomes. According to the International Association for the Study of Pain, pain is both a sensory and emotional experience linked to actual or potential tissue damage. In children, early pain experiences can shape long-term attitudes toward dental care. Lidocaine, introduced in 1949, remains the most commonly used local anesthetic due to its safety and efficacy. However, its delayed onset and short duration have led to the development of alternatives such as mepivacaine, prilocaine, bupivacaine, ropivacaine, and Centbucridine each offering specific advantages in terms of vasodilation, toxicity, or duration. Among these, articaine has emerged as a superior agent, particularly in dentistry. Introduced in 1976, it features a thiophene ring and an ester group, enhancing lipid solubility, bone penetration, and dual metabolism, which reduces systemic toxicity. Available in 2% or 4% solutions with adrenaline, articaine is also used in spinal and epidural anesthesia. Despite its growing use in adults, surveys in India and the U.S. show many pediatric dentists still preferring lidocaine. Therefore, further evaluation of articaine's safety and efficacy in children is essential to support its broader adoption in pediatric dental care.[1 2]

II. Classification Of Local Anesthetic

A) Classification of local anesthetics based on structure [1]

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 [3]
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

III. Articaine

Articaine was initially synthesized as "carticaine" in 1969 and introduced into clinical practice in Germany in 1976. It was later renamed "articaine" in 1984, aligning with its release in Canada under the trade name Ultracaine D-S. Over the following decades, articaine gained international recognition, entering the United Kingdom in 1998, the United States in 2000 under the brand name Septocaine, and Australia in 2005. The U.S. Food and Drug Administration (FDA) approved articaine in the year 2000 as a 4% solution with 1:100,000 epinephrine, followed by the approval of a 4% formulation with 1:200,000 epinephrine in 2006. Today, more than two decades later, articaine ranks as the second most widely used local anesthetic globally, following lidocaine. As the first hybrid local anesthetic combining both ester and amide characteristics, articaine was specifically developed to meet the demands of dentistry for a potent, long-lasting anesthetic with relatively rapid systemic detoxification.[1]

IV. Structure Of Articaine

Articaine stands out among local anesthetics due to its distinctive hybrid chemical structure, which combines an amide backbone with an ester side chain—an uncommon feature that enables dual metabolism in both the plasma and liver. This dual pathway facilitates rapid systemic clearance, significantly reducing the risk of accumulation and systemic toxicity, particularly in pediatric and medically compromised patients. Additionally, the presence of a thiophene ring, rather than the typical benzene ring found in other amides, enhances lipid solubility and improves diffusion through both soft and hard tissues, making articaine effective for dental infiltrations. Its short elimination half-life of approximately 20 minutes further contributes to its safety profile. Moreover, articaine exhibits high protein binding and is available in higher concentrations (typically 4%), which together result in a more profound and longer-lasting anesthetic effect. These combined properties i.e. enhanced tissue penetration, rapid metabolism, and superior clinical efficacy in both maxillary and mandibular regions—makes articaine a preferred choice in contemporary dental and regional anesthesia, particularly when safety, efficiency, and patient comfort are paramount.[2]

- IUPAC Name: 3-N-Propylaminoproprionylamino 2-carbomethoxy-4-methylthiophene hydrochloride.
- Molecular Formula: C H N O S
- Molecular Weight: 284.37 g/mol (base) 320.84 g/mol (hydrochloride salt)

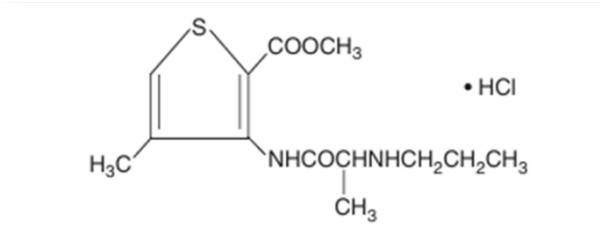

Figure 01 Chemical structure of articaine (source-Malamed 7th edition 2000)

Table 01 Chemical structure component and its significance

Component	Description	Clinical Significance
Thiophene Ring	A five-membered sulfur-containing aromatic ring replacing the typical benzene.	Increases lipid solubility, enhancing membrane penetration and potency.
Amide Linkage	Connects the aromatic ring to the intermediate chain.	Classifies articaine as an amide-type anesthetic, offering greater stability.

Ester Group	Present on the thiophene ring as a carbomethoxy group.	Allows rapid hydrolysis by plasma esterases, reducing systemic toxicity.
Propylamino Side Chain	Attached to the intermediate chain	Contributes to anesthetic potency and duration of action.
Hydrochloride Salt	The drug is administered as a hydrochloride salt.	Enhances water solubility for injectable formulations.

V. Mechanism Of Action

Articaine, like other local anesthetics, exerts its effect by blocking voltage-gated sodium (Na) channels on neuronal membranes, thereby inhibiting the initiation and propagation of action potentials. Its action is state-dependent, meaning it binds with the highest affinity to open Na channels, followed by inactivated channels, and least to resting channels. This selective binding occurs at the S6 segment of domain IV, a region accessible only when the channel is open.[4 5 6] Once inside the neuron, the lipophilic, unionized form of articaine crosses the phospholipid membrane. Within the cytoplasm, it re-equilibrates based on intracellular pH and its pKa of 7.8, forming the ionized active form, which binds to the Na channel receptor. This binding is reversible and concentration-dependent, stabilizing the inactivated state of the channel and preventing further depolarization.[7]

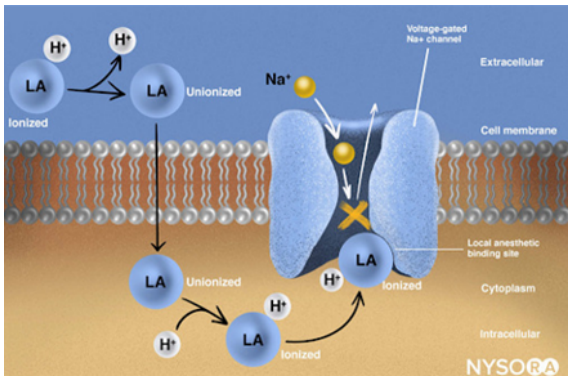

Figure 02 Mechanism of action (source-NYSORA. Clinical Pharmacology of Local Anesthetics)

It exhibits a use-dependent (phasic) block, meaning its efficacy increases with the frequency of nerve stimulation. At higher concentrations, it reduces the peak of the action potential, raises the firing threshold, prolongs the refractory period, and ultimately inhibits all nerve conduction. Additionally, articaine demonstrates differential nerve fiber sensitivity. It preferentially blocks Aδ and Aγ fibres (pain and proprioception) before blocking C fibers (unmyelinated pain fibers), and sympathetic fibers are found to be most sensitive. This gradient of blockade is particularly evident during epidural anesthesia, where sensory block may precede motor block.[8]

VI. Pharmacology Of Articaine

Pharmacokinetics: Metabolism

Articaine undergoes rapid hydrolysis to form its inactive primary metabolite, articainic acid(M1), which is later glucuronidated; its peak plasma concentration appears around 45 minutes post-administration, with slightly higher levels in the absence of epinephrine, while its distribution volume of 1.67 ± 0.32 L/kg supports effective tissue penetration. In pediatric dentistry, 2% articaine is preferred for its lower peak concentration and shorter half-life, minimizing systemic toxicity, though 4% articaine with 1:100,000 epinephrine is also validated as safe and effective, offering swift onset and adequate anesthesia duration.[9 10 11]

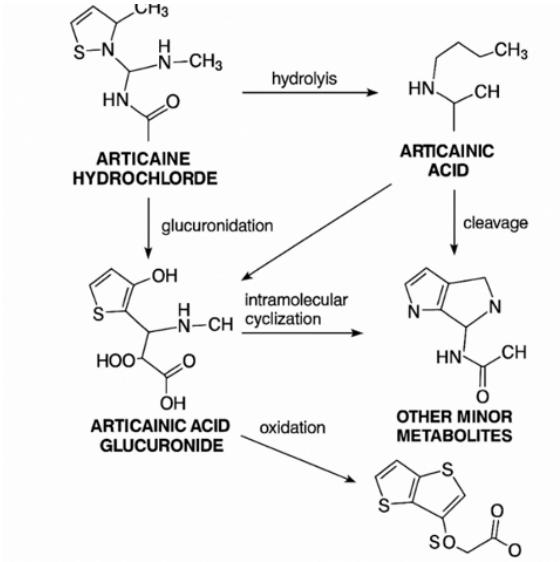

Figure 03 Schematic diagram of metabolism of Articaine

Articaine is primarily excreted through the kidneys, with approximately 90% eliminated as metabolites—predominantly M1 (87%) and a smaller fraction as M2 (2%)—while only about 5% to 10% is excreted unchanged in the urine.[12]

Pharmacodynamics [12]

Parameter	Details
Onset of Action (Infiltration)	1–2 min (with 1:100,000 or 1:200,000 epinephrine)
Onset of Action (Mandibular Block)	2–2.5 min (1:100,000), 2–3 min (1:200,000)
Duration	144min
Pulpal Anesthesia Duration	1 hour (infiltration), 2 hours (nerve block)
Soft Tissue Anesthesia Duration	3–5 hours
Elimination Half-Life	0.5 hours (≈27 minutes)
Maximum Recommended Dose	5–7 mg/kg

VII. Pharmacological Properties Of Articaine [12]

Property	Details
Concentration	4%, 2%
pka	7.8
Molecular weight	320.84 g/mol
Protein binding	95%
vasoactivity	Vasodilating
pH (with Epinephrine 1:100,000)	4.5-5.2
pH (with Epinephrine 1:200,000)	4.6-5.4
pH (Plain Solution)	4-5
Volume of Distribution (Vd)	1.67 ± 0.32 L/kg
Cmax (with 1:200,000 epinephrine)	2000 µg/L
Cmax (without epinephrine)	2300 µg/L
Tmax (Time to Peak)	45 minutes
Adverse Effects	Paresthesia, dizziness, tremors, depression, headache, facial edema
Toxicity Risks	CNS, cardiac, and tissue toxicity; allergic reactions (rash, itching)

VIII. Adverse Reactions To Articaine

Articaine may cause systemic adverse effects due to overdose, rapid absorption, or accidental intravascular injection. Patient-specific factors like hypersensitivity or low tolerance can also play a role.

Central Nervous System (CNS) [12 13]

CNS reactions may present as either excitatory or depressant symptoms. Initial signs include nervousness, dizziness, blurred vision, and tremors. These may progress to sedation, seizures, unconsciousness, and respiratory arrest. In some cases, excitatory symptoms may be absent, with drowsiness and respiratory failure as primary indicators of toxicity.

Articaine's reported incidence of permanent paraesthesia is very low (1 in 4.8 million, per European Medicines Agency data), and evidence does not support higher neurotoxicity compared to other anesthetics. In fact, some cytotoxicity studies suggest articaine may be among the least neurotoxic agents used in dentistry.

Due to the rarity of permanent paraesthesia, its exact frequency remains uncertain, with estimates ranging from 1 in 140,000 to 1 in 4.16 million. Ultimately, choosing articaine for IA blocks should rely on clinical discretion, as multiple and sometimes unidentified factors may contribute to paresthesia.[15]

Cardiovascular System [12 14]

Articaine, particularly when administered in high doses or inadvertently via intravascular injection, may impair myocardial conduction and contractility. These cardiovascular effects tend to be suppressive, manifesting as hypotension, bradycardia, myocardial depression, and—under severe conditions—cardiac arrest. In patients with hypertension or vascular disease, the epinephrine component commonly included in articaine formulations can exacerbate these cardiac risks due to increased catecholamine sensitivity.

Pharmacodynamically, articaine primarily exerts its action by blocking voltage-gated sodium channels within ventricular myocytes, resulting in a reduced maximum rate of depolarization (Vmax) during ventricular depolarization. This blockade leads to alterations in action potential dynamics, most notably a shortened action potential duration (APD) at both 50% and 90% levels of repolarization. The drug has been shown to suppress early repolarization and diminish the plateau phase of the action potential—especially at concentrations exceeding therapeutic thresholds, such as those occurring during accidental intravenous administration.

Clinically, articaine use is associated with transient changes in heart rate and T-wave morphology, attributed to its systemic absorption, particularly when compounded by epinephrine. Although highly effective as a local anesthetic, articaine's impact on ventricular electrophysiology and cardiac performance warrants careful monitoring—especially in vulnerable or medically compromised patients undergoing dental or minor surgical procedures.

Hypersensitivity and Allergic Reactions [15]

Articaine may provoke allergic manifestations such as,

- Cutaneous Symptoms: Rash, itching, urticaria, edema
- Severe Reactions: Anaphylaxis, especially in sulfite-sensitive individuals due to sodium metabisulfite in epinephrine-containing formulations
- Clarification: Despite containing a sulfur atom (thiophene ring), articaine is not contraindicated in patients with sulfa-allergies. Skin sensitivity testing is considered unreliable for definitive diagnosis.

Localized Complications [16]

Following inferior alveolar nerve blocks, cases of swelling and prolonged paraesthesia in the lips and oral tissues have been reported.

Tissue Toxicity

- ***Neurotoxicity*****:** Studies suggest it is not more harmful to nerves than other anesthetics. Persistent paraesthesia (especially lingual nerve) has been reported, particularly after mandibular blocks [17]. Animal studies show no significant axonal damage, suggesting injection technique and concentration may play roles[18].
- ***Myotoxicity*****:** Articaine inhibits Ca-ATPase activity, potentially leading to sustained muscle contraction and tissue damage.[19 20]

Articaine and Methemoglobinemia

Articaine, like other local anesthetics, can trigger methemoglobinemia, especially when combined with other agents that raise methemoglobin levels. It is relatively contraindicated in patients with: Congenital or idiopathic methemoglobinemia and those receiving methemoglobin-inducing drugs. Reactions have been observed when articaine was given intravenously for regional anesthesia, but no such cases have been reported with standard dental dosing and techniques.[21]

IX. Clinical Significance

Equal or Superior Efficacy[22]: Articaine at lower volumes (0.2–0.5 mL) has shown anesthetic success comparable to 2% lignocaine IANB, especially for extractions and vital pulp therapies. Its higher lipid solubility and thiophene ring structure allow better diffusion through soft and hard tissues, including the dense cortical bone of the mandible. The study found that 2% articaine did not demonstrate superior anesthetic efficacy compared to 2% lignocaine in pediatric patients. While articaine is known for its enhanced diffusion and rapid metabolism, its clinical performance at 2% concentration was comparable but not superior to lignocaine.

Longer Duration of Action: Articaine provides prolonged pulpal anesthesia (up to 75 minutes), compared to lignocaine (45–60 minutes). This extended duration is beneficial for procedures like pulpotomy and extractions, reducing the need for reinjection[12].

Infiltration vs. Nerve Block (IANB)

- **Minimally Invasive Technique**: Studies show that buccal infiltration with 4% articaine can effectively anesthetize mandibular molars, eliminating the need for IANB in many cases. This is especially valuable in pediatric patients, where IANB demands high cooperation and may cause anxiety or discomfort.[23]
- **Reduced Injection Pain:** Articaine infiltration is less painful and quicker to administer than nerve blocks, improving child acceptance and behavior during treatment [12].

Pediatric Safety Profile

- **Low Systemic Toxicity:** Due to its rapid metabolism into articainic acid, articaine has a short half-life (~27 minutes) and reduced risk of systemic toxicity. Even in children under 4 years, retrospective studies report no adverse systemic reactions[24].
- **Minimal Side Effects**: Meta-analyses and RCTs show no significant difference in adverse events between articaine and lignocaine in pediatric patients.[25] Common side effects like soft tissue injury or postoperative pain are either comparable or lower with articaine[26].

X. Commercially Available Articaine Preparation And Concentrations [27]

Septocaine & **Orabloc**: 4% Articaine with 1:100,000 epinephrine (0.01 mg/mL) and 4% Articaine with 1:200,000 epinephrine (0.005 mg/mL).

XI. Articaine In Children: Advantages V/S Disadvantages

Articaine offers rapid onset and prolonged action (up to 75 minutes) thanks to its thiophene ring structure. It is effective for buccal infiltrations, reducing the need for IANBs, and is metabolized by plasma esterases, lowering toxicity risk. It performs well in MIH cases, is better accepted by children due to less painful injections, and works efficiently even at low volumes. Studies show it's comparable or superior to lignocaine. It may cause side effects like restlessness, anxiety, and rarely, convulsions. Rare visual disturbances and soft tissue injuries due to prolonged numbness are reported. Hypersensitivity reactions, higher cost, and increased paraesthesia risk with 4% concentration are noted [8 12 16 17].

XII. Comparative Summary Of Studies On Anesthetic Efficacy Of Articaine

Study	Procedure	Comparison	Sample & Design	Outcome Measures	Key Findings
Bahrololoomi et al. 2008	Maxillary primary molar extraction	Articaine (buccal only) vs Lidocaine (buccal + palatal)	30 children, crossover RCT	Wong-Baker Faces, FLACC, BP, pulse	Articaine comparable in pain levels; palatal injection required
Daneshvar et al. 2011	Pulpotomy in mandibular primary molars	Articaine (BI) vs Lidocaine (IANB)	40 children, crossover RCT	FIS, SEM scale	Lidocaine IANB showed better pain control and behavior
Ann Mary Thomas et al. 2012	Pulpotomy in molars with MIH	Articaine (IANB & BI) vs Lignocaine (IANB)	27 children, 3-arm RCT	VAS	Articaine IANB provided superior pain control
Alinejhad et al. 2018	Pulpotomy in mandibular primary molars	Articaine (BI) vs Lidocaine (IANB)	40 children, parallel RCT	VAS	Articaine group showed significantly lower pain scores
Silva SA et al. 2019	Pulpectomy in mandibular molars	1.8 mL vs 3.6 mL of 4% Articaine	90 patients, RCT	Pulpal anesthesia success	No significant improvement with increased volume
Erfan parast et al. 2021	Pulpotomy in mandibular molars	Articaine (BI) vs Mepivacaine (IANB)	50 children, splitmouth RCT	MBPS, VAS, Frankl scale	Comparable efficacy; articaine showed better cooperation
Ramzan S et al. 2021	Pulpectomy in mandibular molars	Articaine vs Lidocaine	192 patients, cross-sectional	Pain scores, anesthesia efficacy	Articaine equally effective as lidocaine
Neha Singhal et al. 2022	Irreversible pulpitis in mandibular molars	Articaine vs Mepivacaine (as supplement to Lidocaine IANB)	120 patients, RCT	Success rate (BI & IL techniques)	Articaine BI showed 90% success; superior in both techniques
Wani NI et al. 2023	Pulpectomy in pediatric patients	Articaine vs Lignocaine	25 children, split-mouth study	Onset, duration, pain control	Articaine had better onset, longer duration, and pain control
Salma Badr et al. 2023	Pulpotomy in mandibular primary molars	Articaine (BI) vs Mepivacaine (IANB)	50 children, crossover RCT	MBPS, VAS, Frankl scale	Articaine favored in VAS; better cooperation seen with BI

These collected evidence from recent pediatric dental studies suggests that articaine is a safe and effective anesthetic agent, especially when used via buccal infiltration, offering comparable or superior pain control to traditional inferior alveolar nerve blocks. Its benefits include faster onset, longer duration, and improved patient cooperation, making it a promising choice for routine procedures in children and reinforcing its potential as a viable alternative to lidocaine and mepivacaine.

XIII. Studies On Articaine Use In Pediatric Dentistry

Study Type	Key Findings	Age Group	Reference
Randomized Controlled Trials (RCTs)	Articaine is safe and effective for pulpotomy, extractions, and restorations; comparable to lignocaine	3–13 years	JOCPD Meta-analysis [26] Ling li et al 2023
Split-mouth Trials	Articaine infiltration less painful than lignocaine IANB; similar efficacy during extraction	5–10 years	JCDP RCT [25] Grover J et al 2024
Retrospective Reports	No systemic adverse reactions in 211 children <4 years receiving articaine	<4 years	Wright et al. (1989) [24]
Prospective Trials	Articaine showed less pain during pulpotomy than lidocaine; no post-op complications	36–47 months	Elheeny et al. (2020) [28]
Protocol Studies (Ongoing RCTs)	Evaluating articaine vs mepivacaine in 3-year-olds for extractions; IRB-approved	3 years	BMJ Open Trial[29] AlRashdi M et al 2023
Meta-analyses & Systematic Reviews	No significant difference in adverse events between articaine and lignocaine	3–13 years	JOCPD Meta-analysis[26] Ling li et al 2023
Survey Studies	21% of dentists reported using articaine in 2–3-year-olds	2–3 years	Brickhouse et al. (2008)[30]
Pharmacokinetic Studies	Serum concentrations of articaine in children are comparable to adults; 2% solution safer than 4%	3–12 years	ChemicalBook Monograph
Review Articles	Articaine is 1.5× more potent and 0.6× less toxic than lidocaine; effective for MIH cases	All pediatric ages	Springer Review[31] Leith,Rm et al 2012
Clinical Guidelines & Commentary	Articaine can replace IANB in many pediatric cases due to superior diffusion and patient acceptance	≥4 years (off-label <4)	AAPD Clinical Trial [32]

Articaine, when appropriately dosed, is effective and well-tolerated across pediatric age groups—including children under four, despite lacking formal manufacturer guidance. Buccal infiltration often eliminates the need for IANB, enhancing patient cooperation and minimizing discomfort. Retrospective and prospective studies support its off-label use in younger children, with no reported serious systemic toxicity, even after repeated administration, reinforcing its clinical viability.

XIV. Comparative Table Of Articaine V/S Lignocaine

Study	Year	Population	Comparison	Outcome
Malamed et al.	2001	4–8 yrs	Articaine vs Lignocaine	Articaine superior in onset and diffusion
Oliveira et al.	2004	Adults	Buccal & palatal infiltration	No significant difference in onset, duration, or pain experience
Katyal et al.	2010	Meta-analysis	Articaine vs Lignocaine	Articaine more effective in posterior molars; similar safety; not recommended under age 4
Evans et al.	2011	Maxillary infiltrations	Articaine vs Lidocaine	Articaine showed better efficacy and patient comfort
Brandt et al.	2011	Meta-analysis	Articaine vs Lidocaine	Articaine had higher pulpal anesthetic efficacy
Kung et al.	2015	Meta-analysis	Symptomatic irreversible pulpitis	Articaine had higher anesthetic success odds
Grover et al.	2017	Primary molar extraction	Articaine vs Lignocaine	Articaine better during injection, equal during extraction
Tortamano et al.	2018	Irreversible pulpitis	Articaine vs Lignocaine	Similar efficacy
Aggarwal et al.	2019	Mandibular molars	Articaine vs Lignocaine	Comparable success rates
Martin et al.	2020	Meta-analysis	Articaine vs Lignocaine	Articaine safe and effective
Kumar et al.	2020	Adults (oral surgery)	Articaine vs Lignocaine	Articaine had faster onset, less pain, and reduced need for re-anesthesia

Jain et al.	2022	Pediatric patients	Articaine BI vs Lignocaine IANB	Articaine showed lower pain scores during injection and extraction
Chen et al.	2022	Systematic review (children)	Buccal infiltration	Articaine may be better, but difference not clinically significant
Arrow et al.	2022	5–10 yrs	Articaine BI vs Lignocaine IANB	Articaine significantly reduced pain scores
Singh et al.	2024	9–14 yrs	IANB comparison	Articaine slightly better in onset and pain experience; not statistically significant
Javed et al.	2024	Maxillary irreversible pulpitis	Articaine vs Lignocaine	Articaine significantly more effective ($p < 0.001$)
Sharma et al.	2025	6–9 yrs	IANB comparison	Articaine faster onset and longer duration
Arora et al.	2025	Adults	Articaine vs Lignocaine with 27G & 30G needles	Articaine with 30G needle had highest success rate and least pain

Several meta-analyses and RCTs (Malamed, Katyal, Brandt, Martin, Kung) consistently highlight Articaine's efficacy across various infiltration techniques and in managing irreversible pulpitis. Recent pediatric trials (Jain, Arrow, Javed, Sharma) show marked pain reduction, while adult studies (Kumar, Arora) report greater comfort and decreased reliance on supplementary anesthesia. Though some studies (Oliveira, Tortamano, Aggarwal) suggest comparable outcomes, the overall body of evidence strongly favours Articaine for superior anesthetic success and patient satisfaction.

XV. Lignocaine Allergy And Articaine Substitution In Pediatric Dentistry

Lignocaine allergy, though uncommon, may present as Type I or IV hypersensitivity reactions. Articaine, due to its unique thiophene ring structure, shows minimal cross-reactivity and is considered a safe alternative. Case reports of seventy-year-old patient by **Mansi Dey et al.** and **Dr. Bibhu Prasad Mishra** confirm successful use of articaine following negative skin testing in lignocaine-allergic patients.[33] **Skin prick and intradermal testing** are recommended prior to LA administration in suspected cases, as per **Mysore V, Nischal KC** guidelines.[34]

XVI. Barriers To Articaine Cartridge Adoption In Indian Dental Practice

Cartridge-based local anesthetic systems, commonly used in developed countries, have yet to gain widespread acceptance in India due to factors such as higher cost, limited availability, minimal inclusion in dental training, and lack of domestic production. Although cartridges offer enhanced sterility and precision, most Indian practitioners continue using vial-based systems, which are more affordable and familiar. Survey data from **Nirmala et al.**[35] revealed that lidocaine with epinephrine remains the preferred anesthetic among Indian pediatric dentists, with only 18% reporting regular use of articaine. Its adoption tends to increase with patient age, and decisions are influenced primarily by peer guidance and continuing education. While a broader practitioner survey by **Shree et al.**[36] indicated 60% usage of articaine, many still refrain from using it for inferior alveolar nerve blocks—highlighting a gap between supportive research evidence and cautious clinical practice.

XVII. Conclusion

Articaine 4% with epinephrine is a well-tolerated and highly effective local anesthetic in pediatric dentistry, providing rapid onset, superior tissue diffusion, and longer duration than 2% lignocaine. Though officially approved for children aged 4 and above, current literature supports its safe use in children as young as 3 years when appropriately dosed, thanks to its dual metabolism and favourable pharmacokinetics that minimize systemic toxicity. However, rare but notable concerns like paraesthesia—particularly involving the lingual nerve—and methemoglobinemia, especially in susceptible children or in combination with oxidizing agents, necessitate clinical caution and informed patient selection. Future research should focus on establishing age-specific dosing guidelines, identifying genetic and metabolic risk factors, and refining administration protocols to further optimize safety and broaden usage in early.

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