



## Comparative Evaluation of Anesthetic Efficacy of 4 % Articaine and 2 % Lidocaine Administering Inferior Alveolar Nerve Block in Mandibular Primary Molar of Children Aged 6-9 Year

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### KEYWORDS

Articaine, Duration of Anesthesia, Lignocaine, Local Anesthesia, Onset of Anesthesia

### ABSTRACT:

**Background:** Local anesthetic agents have greatly enhanced dental practice by providing safer and pain-free surgical procedures. Lignocaine is widely considered the gold standard due to its high potency, safety profile, and effectiveness. However, articaine is thought to outperform lignocaine because of its superior tissue and bone diffusion, faster onset, and lower toxicity.

**Aim:** The purpose of this study is to evaluate and compare the onset time and duration of action, of lignocaine and articaine in pediatric dental patients.

**Method:** A total of 34 children, aged 6-9 years, attending the outpatient clinic of Pediatric and Preventive Dentistry, were randomly divided into two equal groups. One group was administered lignocaine, while the other received articaine for patient undergoing dental procedure involving nerve block

**Results:** Articaine demonstrated a faster onset of action and a longer duration of anesthesia compared to lignocaine.

**Conclusion:** Articaine appears to be a more effective local anesthetic agent than lignocaine, particularly in pediatric dental patients.

### Introduction

Painless dentistry is pivotal to the effective management of pediatric patients, with the role of local anesthesia being particularly significant. The advent of local anesthetic agents has transformed dental practice, enabling safer and more comfortable surgical procedures. Lignocaine, the first non-ester type local anesthetic, was synthesized by Nils Lofgren in 1943 and introduced to the market in 1948.<sup>1</sup> It remains the most widely utilized anesthetic in dentistry due to its potency, safety, and effectiveness, thus serving as the benchmark against which newer agents are measured.<sup>2</sup> Articaine, introduced in 1969 by Rusching et al. under the name Carticaine, is administered in a 4%

concentration and is recognized as a safe and efficacious local anesthetic for clinical dental applications.<sup>2</sup> It is the only amide-type anesthetic with a thiophene ring in its structure, as opposed to the benzene ring found in other agents, which enhances its liposolubility.<sup>3</sup> Articaine is considered superior to lignocaine due to its enhanced diffusion through soft tissues and bone, rapid onset, superior anesthetic quality, and reduced toxicity. Being 1.5 times more potent than lignocaine, it requires a smaller volume of solution, despite its higher concentration.<sup>4</sup> In clinical decision-making, key considerations for selecting a local anesthetic agent include onset time, duration of action, and overall efficacy, as these factors are critical



to ensuring optimal pain management and patient comfort during dental procedures.<sup>5</sup>

### Materials and Method

This study was conducted in the Department of Pediatric and Preventive Dentistry.

### Inclusion Criteria

- Children aged between 6 - 9 years of age were chosen for the study.
- Procedures requiring inferior alveolar nerve block
- Children not undergoing any medication
- Parents ready to give consent form

### Exclusion Criteria

- Patient not treated under inferior alveolar nerve block
- Patient allergic to lignocaine and articaine
- Teeth exhibiting one or more of following were excluded from study (a) swelling, cellulitis
- Children lacking cooperative ability,
- Children those having a systemic illness, or special care needs were excluded from the study
- Children treated under conscious sedation and general anesthesia was excluded from study.

### Sample Selection

A total of 34 children attending the outpatient department of pediatric and preventive dentistry at our institution were included in the study. Informed consent was obtained from the parents prior to enrolling the participants. Children aged 6-9 years were selected and equally divided into two groups n=17 based on the anesthetic agent used.

- **Group I:** Lignocaine 2% was used for local anesthesia (n=17).
- **Group II:** Articaine 4% was used for local anesthesia (n=17).

**Ethical Approval and Consent:** Approval for this study was obtained from the Ethical Clearance Committee of our institution, and informed consent was obtained from the parents of all participants.

### Methodology

Participants in each group underwent preparation for the procedure, which involved disinfecting the cheeks and lips with povidone-iodine using a swab. Topical anesthesia, in the form of 2% lignocaine gel, was applied to the injection site for one minute. The local anesthetic solution was then injected according to the participant's assigned group. A single researcher administered the local anesthetic for all patients. All nerve blocks were performed using a breach-loading, metallic, cartridge-type, aspirating, non-disposable syringe with a disposable 27-gauge, one-inch needle.

The anesthetic agents used were 2% lignocaine hydrochloride with 1:80,000 adrenaline (Septodont) and 4% articaine hydrochloride with 1:200,000 epinephrine (Septodont). The dosage of local anesthetic was determined based on the child's age and weight, using Young's formula and Clark's formula for drug dosage calculation. Up to one cartridge (1.8 ml) of lignocaine (maximum dose 4 mg/kg) or articaine (maximum dose 5 mg/kg) was administered per patient.

### Study Procedure

1. **Onset of Action:** The onset time of anesthesia was defined as the interval between the completion of the anesthetic injection and the confirmation of anesthesia through both subjective and objective indicators. A standard digital stopwatch was used to measure and record the onset time, which was documented in minutes.

2. **Duration of Action:** The duration of anesthesia was defined as the time between the onset of anesthesia and the return of normal sensation, indicated by both subjective and objective signs.

➤ **Subjective confirmation:** lack of sensation in the mucosa, tongue, and lip. Patients were asked to record the time when the anesthesia wore with the help of questionnaires it was recorded. Patients who did not report this information were excluded from the study.

### Data Analysis

The results were statistically analyzed using SPSS version 19 software. An independent t-test was employed to compare the onset and duration of action between articaine and lignocaine.

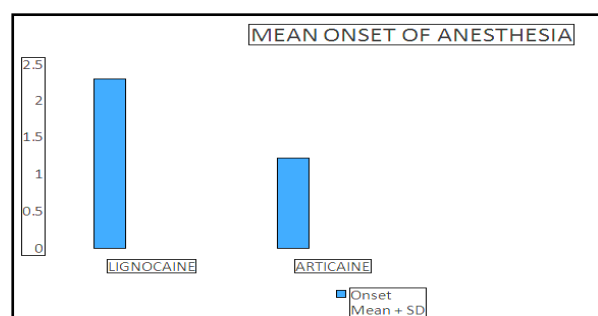
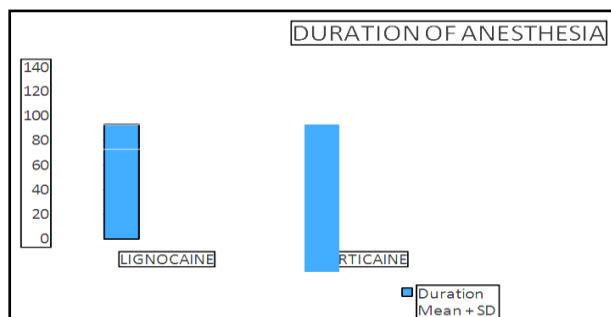
### Result

A total 34 study subjects (17 – Articaine, 17 – Lignocaine) between the age of 6 – 9 years were taken in the study, out of which 45 (56.25%) were males and 35 (43.75%) were females. Mean age of study subjects was 8.48 years. Mean time interval for onset of anesthesia in articaine group was 1.220 minutes and for lignocaine it was 2.298 minutes (Table 1). Onset of anesthesia was found to be early in articaine group as compared to lignocaine group and difference of time in onset of anesthesia was found to be statistically very highly significant ( $p < 0.001$ ). Mean duration of action in articaine group was 121.47 minutes and for lignocaine group it was 92.47 min. Duration of action was found to be more in articaine group as compared to lignocaine group and difference of time in duration of action was found to be statistically very highly significant (Graph 2).

**Table 1:** Evaluation of the time of onset of anesthetic efficacy of 2% lignocaine and 4% articaine and 2% lignocaine in children aged 6- 9 year



Variable	Onset Mean + SD	Duration Mean + SD
Lignocaine	2.29 ± 0.253	92.9 ± 14.038
Articaine	1.229 ± 0.199	121.47 ± 41.070



**Table 2:** Comparison of time of onset of anesthesia after administration of 4% articaine with 2% lidocaine

Variable	Mean	Std. Deviation	F-value	p-value, S/NS
Lignocaine	2.294	0.2536	185.221	<b>0.000, S</b>
Articaine	1.229	0.1993		

**p ≤ 0.05 – Significant, CI = 95 %**

**Table 3:** Comparison of duration of anesthesia after administration of 4% articaine with 2% lidocaine

Variable	Mean	Std. Deviation	F-value	p-value, S/NS
Lignocaine	92.94	14.038	7.345	<b>0.011, S</b>
Articaine	121.47	41.070		

**p ≤ 0.05 – Significant, CI = 95 %**

## Discussion

**Local anesthesia** plays a crucial role in modern dentistry. Effective pain control during pediatric dental procedures is essential not only to minimize patient discomfort but also to alleviate the stress experienced by the operator. Local anesthetic agents primarily aim to manage pain effectively. Successful pediatric dental practice is achieved by providing pain-free treatment, fostering positive behavior in children toward dental procedures, and preventing any adverse psychological

impact.<sup>3</sup> Local anesthetics enable dental surgeons to block pain through their pharmacological properties. The choice of anesthetic solution should be based on three primary clinical factors: the onset of anesthesia, the duration of its effect, and its overall efficacy. According to literature, 90-95% of articaine is metabolized in the bloodstream, with only 5-10% metabolized in the liver. The plasma half-life of articaine is approximately 20 minutes. Both articaine and lignocaine have the same maximum recommended dose of 500 mg (6.6–7 mg/kg) for adult patients.<sup>3</sup> In the present study, we compared articaine and lignocaine in terms of onset of anesthesia, and duration of action by administering nerve blocks using these two anesthetic agents in different patients. These two solutions were selected as they are the most commonly used anesthetics in pediatric dental practice for pain management.<sup>4</sup>

## Onset of Anesthesia

In the literature, some inconsistencies exist regarding the calculation of anesthesia onset time. Some authors defined the onset period as beginning with the injection, but in the present study, we considered it to begin after the completion of the injection until anesthesia was confirmed, aligning with most published studies. An ideal anesthetic agent should exhibit a rapid onset. The onset of anesthesia is influenced by factors such as the intrinsic properties of the drug and the technique used. Latency, or onset time, is also directly related to the drug's pKa value, with lower pKa values resulting in a shorter latency. Therefore, 4% articaine (pKa = 7.8) is expected to have a faster onset than 2% lignocaine (pKa = 7.9). In this study, the mean onset time for articaine was 1.22 minutes, while for lignocaine, it was 2.29 minutes, a difference that was statistically highly significant. These findings are consistent with the study by Kalia et al. (2011), who reported a mean onset time of 1.08 minutes for articaine and 1.88 minutes for lignocaine, with statistically significant results. The faster onset of articaine may be attributed to its high lipophilicity and 4% concentration, which enhance its ability to diffuse through nerve membranes, soft tissues, and bone. Similarly, Sripathi Rao et al. reported an onset time of 0.5-1 minute for articaine and 2-4 minutes for lignocaine, a statistically significant difference. They concluded that articaine has a faster onset than lignocaine. In alignment with our findings, Saraf SP et al. also found a faster onset of anesthesia with articaine compared to lignocaine, concluding that articaine is 1.5 times more potent than lignocaine. However, in contrast to our findings, Kambalimath DH et al. (2013) reported similar onset times for articaine and lignocaine, with mean onset times of 1.35 minutes and 1.40 minutes, respectively, which were not statistically significant. Similarly, Vahatalo K et al. (1994) found no statistically



significant difference between articaine and lignocaine when comparing onset times using infiltration techniques.<sup>10</sup>

### Duration of Action

The duration of anesthesia is proportional to the degree of protein binding, but it is also influenced by other factors such as the injection site and the concentration of vasoconstrictor present in the anesthetic solution. Local anesthetics work by binding to a protein receptor in the sodium channel, so greater protein binding results in prolonged sodium channel blockade and a longer duration of anesthesia. Articaine has a protein binding rate of 95%, compared to 65% for lignocaine.<sup>12</sup> Among amide local anesthetics, articaine's protein binding is comparable to that of ultra-long-acting agents like bupivacaine, ropivacaine, and etidocaine, suggesting a longer duration of effect. In this study, the mean duration of action for articaine was 121.05 minutes, while for lignocaine, it was 92.80 minutes, a statistically highly significant difference.<sup>13</sup> This finding indicates that articaine provides a longer duration of anesthesia than lignocaine. Similarly, Ram D and Amir E (2006) reported a mean duration of numbness of 205.8 minutes for articaine and 180.6 minutes for lignocaine, with the results being statistically significant. Costa CG et al. also observed similar results, reporting a mean duration of 56.7 minutes for articaine infiltration and 39.2 minutes for lignocaine.<sup>15</sup> Kalia V et al. (2011) found that articaine had a mean duration of action of 232.8 minutes compared to 160.8 minutes for lignocaine, with statistically significant results, concluding that articaine has a longer duration of action. In agreement with our study, Sripathi Rao BH et al. reported a mean duration of 72 minutes for articaine infiltration and 49 minutes for lignocaine infiltration, again statistically significant.<sup>16</sup> However, in contrast to our findings, Arali V and Mytri P (2015) reported that the duration of anesthesia was 160 minutes for articaine infiltration and 200 minutes for lignocaine nerve blocks, with no statistically significant difference. Similarly, Vahatalo K et al. (1994) and Kambalimath DH et al. (2013) reported no significant differences in duration between the two solutions. Jaikaria A et al. (2018) observed a shorter duration of anesthesia with articaine compared to lignocaine when articaine was used for infiltration and lignocaine for nerve blocks.<sup>17</sup>

### Conclusion

This study aimed to compare the onset and duration of action of 2% lignocaine with 4% articaine. Based on the findings, it can be concluded that articaine represents a more effective alternative to lignocaine, particularly in pediatric dental patients. Local anesthesia is an indispensable aspect of modern dental practice, making the selection of an optimal anesthetic agent essential for achieving the best clinical outcomes.

Consequently, the use of a more efficacious anesthetic agent, such as articaine, is highly recommended.

### Limitations and Future Studies

The number of studies comparing articaine and lignocaine with respect to onset, duration of action, and efficacy in pediatric dental patients is limited. Further research is needed in this area to provide more definitive evidence and strengthen the conclusions regarding the comparative effectiveness of these anesthetic agents.

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