

Comparison of Anesthetic Efficacy of 4% Articaine versus 2% Lignocaine

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Abstract

Objective: Lignocaine is the most widely used local anesthetic agent in dentistry. It has been labeled as the “gold standard” to which all new local anesthetics are compared. **Aim:** The aim of this prospective, randomized study was to compare the anesthetic efficacy of 4% articaine HCl with 1:100,000 adrenaline in comparison with 2% lignocaine HCl with 1:80,000 adrenaline in extraction of maxillary premolars for orthodontic considerations. **Materials and Methods:** A total of fifty patients were included in this study. Drug volume, onset and duration of anesthesia, pain during injection and extraction, and postanesthetic complications were recorded for all patients. The values were compared and analyzed statistically using paired *t*-test. **Results:** In the present study, drug volume solution for articaine group was less than that of lignocaine group. The mean difference in pain rating (for palatal injection), onset, and also duration of anesthesia for articaine was highly significant statistically on palatal aspect ($P < 0.001$). **Conclusion:** The present investigation asserts that articaine HCl has shorter onset time, longer duration of action, and similar efficacy to lignocaine HCl and thus can also be used. Further controlled comparative clinical trials with similar local anesthetic agents in oral cavity with multicenter studies and a larger sample size are desirable to bring valuable attention to this research area and evaluate the safety and clinical efficacy of articaine HCl.

Keywords: Articaine, dental surgery, injection, lignocaine, local anesthesia

INTRODUCTION

Lignocaine was marketed in 1948 and is up to now the most commonly used local anesthetic in dentistry worldwide. Proven efficacy, low allergenicity, and minimal toxicity through clinical use and research have confirmed the value and safety of this drug. Thus, it has been labeled as the “gold standard” to which all new local anesthetics are compared.^[1] An amide solution was prepared by Rusching *et al.* in 1969 which was known as carticaine. When it entered clinical practice in Germany in 1976, its generic name was changed to articaine. It differed from other amides as it contains a thiophene ring with additional ester ring.^[2] Articaine is able to diffuse through soft and hard tissues more reliably than other local anesthetics, and the maxillary buccal infiltration of articaine provides palatal soft tissue anesthesia obviating the need for a painful palatal injection.^[3] Another advantage with articaine is that patients will be drug free more quickly than those who receive other local anesthetics.^[4] In addition, superiority of articaine to lignocaine has been claimed in terms of fast onset, excellent quality of anesthesia, and low degree of

toxicity. Hence, a prospective, randomized study was carried out to compare the anesthetic efficacy of 4% articaine HCl with 1:100,000 adrenaline in comparison with 2% lignocaine HCl with 1:80,000 adrenaline in extraction of maxillary premolars for orthodontic considerations.

MATERIALS AND METHODS

This study was carried out in fifty patients visiting the Department of Oral and Maxillofacial surgery; BJS Dental College and Hospital, Ludhiana, for bilateral extraction of maxillary premolars for orthodontic considerations from July 2014 to April 2016. An ethical clearance was sought from the departmental review committee, and informed written consent was obtained from each participant. The study was not funded by any organization and is not promoting any product. Drug

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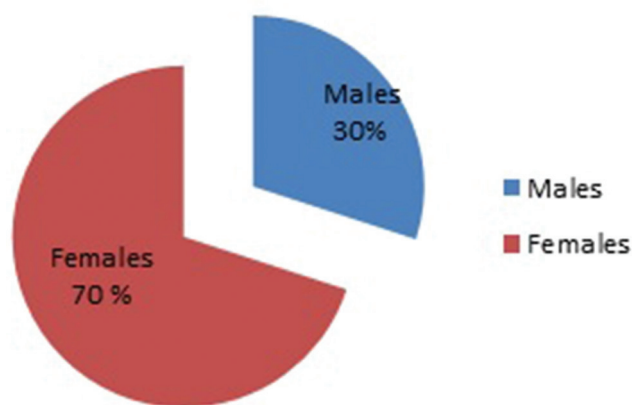


Figure 1: Distribution according to gender

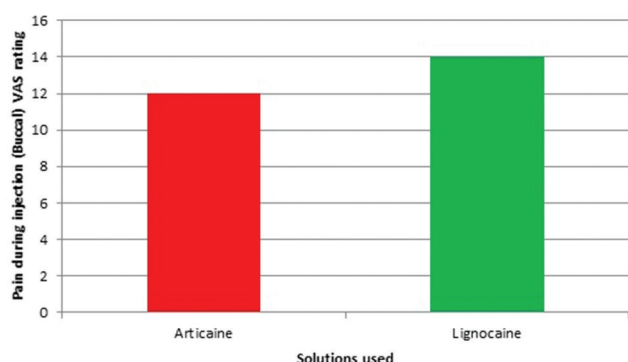


Figure 3: Pain during injection (buccal side)

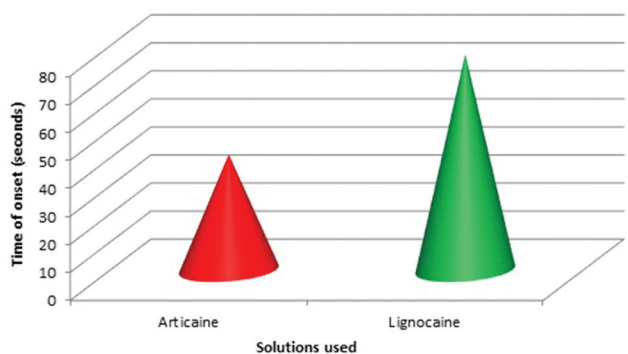


Figure 5: Onset of anesthesia (in seconds)

volume, onset and duration of anesthesia, pain during injection and extraction, and postanesthetic complications were recorded for all patients. Pain was evaluated using visual analog scale (VAS). The values were compared and analyzed statistically using paired *t*-test. Results are tabulated in the tables and depicted in graphs.

Criteria for selection of patients for study

Inclusion criteria

- Patients requiring extraction of bilateral premolars for orthodontic reasons irrespective of age and sex were included in the study.

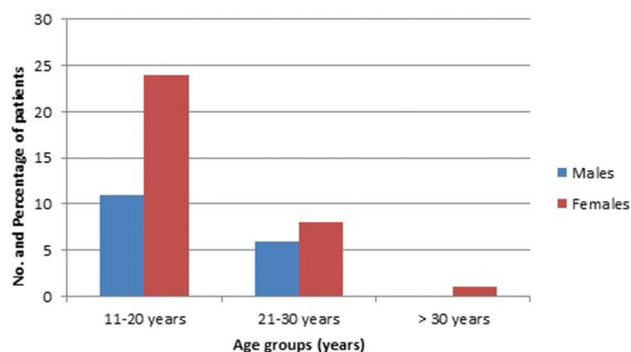


Figure 2: Distribution according to age

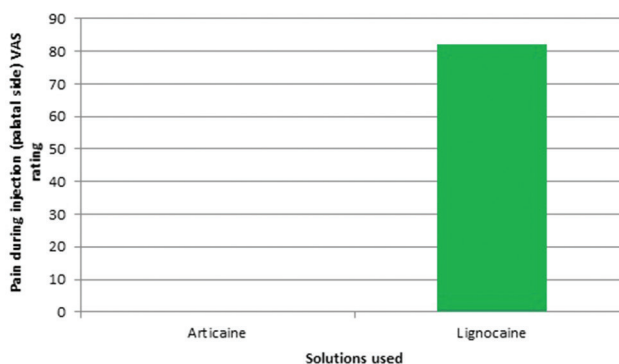


Figure 4: Pain during injection (palatal side)

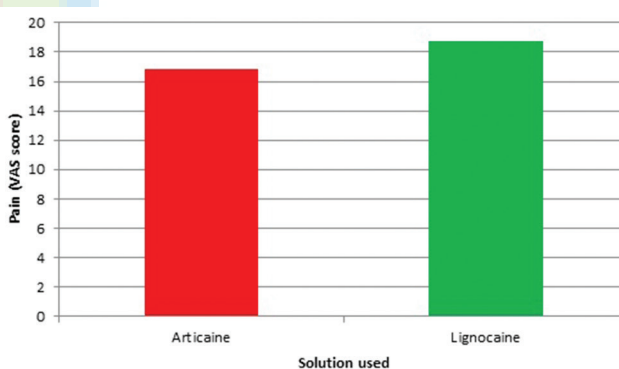


Figure 6: Pain during extraction

Exclusion criteria

- Medically compromised patients were excluded from the study.

Materials used in this study

- 4% articaine HCl with 1:100,000 adrenaline
- 2% lignocaine HCl with 1:80,000 adrenaline
- Disposable syringe with 1 1/2 inch, 26-gauge needle
- Standard extraction instruments were used in this study.

Techniques used in administration of local anesthesia

The patients were randomly assigned for the use of local anesthetic solution either 4% articaine HCl with 1:100,000 adrenaline or 2% lignocaine HCl with 1:80,000 adrenaline on the first appointment for extraction of maxillary right premolar;

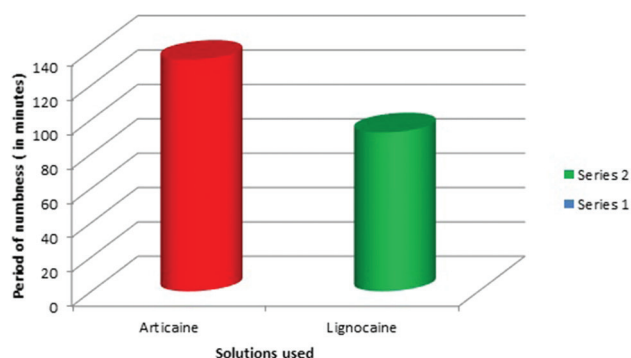


Figure 7: Duration of anesthesia (in minutes)

subsequently, the other solution was used for the extraction of other side premolar. Thus, each patient acted as his or her own control. Patients were blinded for the solution used and all the extractions were performed by the same operator. The selected patients were made to sit comfortably on the dental chair and were asked to rinse their oral cavity with antiseptic mouthwash (Hexidine). A sterilized gauge piece was used to dry the tissues around the site of needle penetration.

Local infiltration

In local infiltration technique (submucosal), small nerve endings in the area of the dental treatment were flooded with local anesthetic solution, preventing them from getting stimulated. Local infiltration technique is commonly used in anesthesia of maxillary teeth.

In our study, 0.5 ml of 4% articaine HCl with 1:100,000 adrenaline solution was injected in buccal vestibule (submucosal) only for anesthetizing maxillary teeth. After latency period of 5 min, objective symptoms were checked on both buccal and palatal sides.

Similarly, 0.5 ml of 2% lignocaine HCl with 1:80000 adrenaline solution was injected in the buccal vestibule (submucosal) for anesthetizing maxillary teeth (control side). After latency period of 5 min, objective symptoms were checked on both buccal and palatal sides. Additional palatal infiltration of 0.2 ml of 2% lignocaine HCl with 1:80000 adrenaline solution was given to anesthetize the palatal mucosa before carrying out extraction procedure.

After achieving complete anesthesia, normal extraction procedure was carried out. During extraction procedure, patients were periodically questioned about pain and were evaluated using VAS.

Acquisition of data

All patients were explained about the VAS preoperatively and informed to report the numbness of lip as soon as they feel. Time of injection, onset of anesthesia, and amount of anesthetic agent injected were recorded. Patients were told to report to the doctor about time of loss of numbness as soon as noticed. All patients were reviewed for any postoperative complications.

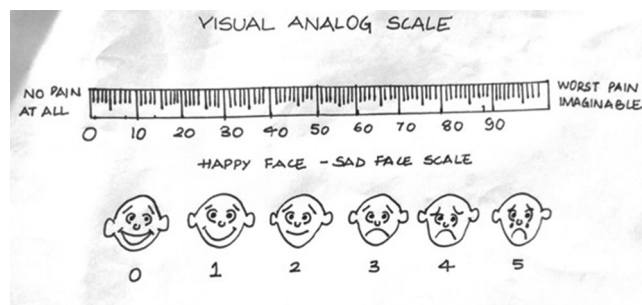


Figure 8: Visual analog scale

Parameters

Drug volume

Amount of anesthetic solution used (volume in ml) in each case and any additional injections required were recorded.

Onset of anesthesia

Time of onset of anesthesia is calculated by recording the time of injection and time of patient's first report of numbness of the upper lip. Objective signs were checked using Moon's probe.

Time of onset of anesthesia = time of soft tissue anesthesia – time of withdrawal of needle.

Duration of anesthesia

It was calculated by recording the time of onset of anesthesia and patient reporting the loss of numbness.

Duration of anesthesia = time of wearing of anesthesia – time of onset of anesthesia.

Pain ratings

Pain on injection after withdrawal of needle and efficacy of anesthesia was determined on a gross scale immediately after the extraction using the VAS ranging from 0 to 100 where 0 = no pain and 100 = worst imaginable pain.

Postoperative complications

Any postoperative complications, local or systemic, were observed and recorded.

RESULTS

Demographics

Among the 50 patients, 15 (30%) were male and 35 (70%) were female [Table 1 and Figure 1]. Thirty-five (70%) patients were in the age group of 11–20 years, 14 (28%) in 21–30 years, and 1 (2%) in above 30 years of age [Table 2, Figure 2]. In the present study, most common age group requiring orthodontic extraction was between 11 and 20 years (70%).

Drug volume [Table 3]

Volume of solution in articaine group was less than that of lignocaine group.

Pain ratings during injection

VAS was used to rate pain during injection. The mean injection pain rating buccally for articaine was 12.00 ± 15.12 , and for lignocaine, it was 14.00 ± 14.14 . There was no statistical

Table 1: Distribution of patients according to gender

Gender	Number of patients (%)
Male	15 (30)
Female	35 (70)
Total	50 (100)

Table 2: Distribution of patients according to age

Age group	Number of patients (%)
11-20	35 (70)
21-30	14 (28)
>30	1 (2)
Total	50 (100)

Table 3: Drug volume (ml)

Anesthetic used	4% articaine HCl	2% lignocaine HCL	
		Buccal	Palatal
Drug volume	0.5	0.5	0.2

difference between the groups ($P > 0.05$) [Table 4 and Figure 3]. However, the mean injection pain rating palatally for articaine was 0 ± 0 and 82.00 ± 13.55 for lignocaine. The difference is highly significant statistically on palatal aspect ($P < 0.001$) [Table 4 and Figure 4].

Time of onset of anesthesia

The mean onset time of anesthesia in articaine group was 41.14 ± 24.65 s and 76.86 ± 34.10 s in lignocaine group. Statistically significant difference ($P < 0.001$) was found between the two groups. The time of onset of anesthesia was significantly faster in articaine group than in lignocaine group [Table 5 and Figure 5].

Pain ratings during extraction

VAS was used to rate pain during extraction. In articaine group, the mean pain score was 16.80 ± 15.84 and 18.78 ± 14.95 for the lignocaine group. No statistically significant difference was noted ($P > 0.05$). It indicated that without palatal injection in the articaine group, the extraction was similar to lignocaine group where buccal and palatal injections were given. [Table 6 and Figure 6].

Duration of anesthesia

In articaine group, the mean duration of anesthesia was 134.52 ± 46.81 and 92.30 ± 44.58 min with the lignocaine group. There is a statistically significant difference ($P < 0.001$) showing that articaine has longer duration of action compared to lignocaine group. [Table 7 and Figure 7].

Postanesthetic complications

No complications were found in the articaine or lignocaine group. Visual analog scale (VAS) as shown in Figure 8 was given to the patients to evaluate postoperative pain.

DISCUSSION

One of the most important factors for successful treatment is

adequate pain control which has been a concern of dentists throughout the dental profession and of the patients they treat. A revolutionary advancement was made in the late 1800s with the discovery of local anesthetics that facilitated pain prevention without the loss of consciousness. A broad spectrum of local anesthetics has been developing gradually. These developments in pain control have enabled the selection and use of local anesthetic drugs based on the individual requirements of patients and the type of procedures.

Comparing articaine to lignocaine, the potency of articaine is believed to be 1.5 times to that of lignocaine and its toxicity is 0.6 to that of lignocaine.^[5] The plasma protein binding of articaine is 95% which is higher than that observed with lignocaine which is 65%. This higher protein binding property accounts for its longer duration of action as compared to lignocaine.^[2] It has also been documented that articaine is able to diffuse through soft and hard tissues more reliably than other local anesthetics, and the maxillary buccal infiltration of articaine also provides palatal soft tissue anesthesia, thus obviating the need for a painful palatal injection.^[3]

An ideal local anesthetic agent should have a rapid onset and should last long enough to allow the completion of the procedure. In our study which included both subjective and objective recordings of soft tissue anesthesia, statistically significant variation between the two agents was observed in terms of onset and duration of anesthesia. The mean time of onset in our study was 41.14 ± 24.65 s for articaine group and 76.86 ± 34.10 s for lignocaine group, which is better than findings of the study by Hassan *et al.*^[6] in which an onset period of 0.97 ± 0.1118 and 2.950 ± 0.5104 min was recorded for articaine and lignocaine group, respectively, and Costa *et al.*^[7] in which the mean value for onset was 1.4 min for articaine and 2.8 min for lignocaine. In our study, the statistical analysis showed significant difference ($P < 0.001$) with shorter onset for articaine group compared with lignocaine group which is in accordance to the above-mentioned studies. Thus, with faster onset time of articaine compared to lignocaine, procedure can be started almost immediately after infiltration.

The mean duration of anesthesia in our study was 134.52 ± 46.81 min for articaine group and 92.30 ± 44.58 min for lignocaine group which statistically confirms ($P < 0.001$) that 4% articaine with 1:100000 adrenaline has longer duration of anesthesia when compared to 2% lignocaine with 1:80000 adrenaline. The mean duration of anesthesia in the study by Hassan *et al.*^[6] and Costa *et al.*^[7] was 72 ± 17.275 and 66.3 min for articaine and 49 ± 5.026 and 39.2 min lignocaine group, respectively. In our study, the mean duration of anesthesia for both the articaine and lignocaine group was found to be prolonged than the previously mentioned studies. Although there was difference in mean score for duration of anesthesia in our study and above-mentioned studies, all the three studies showed significant differences with longer duration for articaine group when compared with lignocaine group. Hence, it can be concluded that longer duration of action with

Table 4: Pain during injection

Pain during injection (VAS)	Mean±SD		Z	P	Significance
	4% articaine HCl (n=50)	2% lignocaine HCl (n=50)			
Buccal aspect	12.00±15.12	14.00±14.14	0.920	0.358	Not significant
Palatal aspect	0.00±0.00	82.00±13.55	6.297	<0.001	Highly significant

VAS: Visual analog scale, SD: Standard deviation

Table 5: Time of onset (s)

Anesthetic solution	Mean±SD	Z	P	Significance
4% articaine HCl (n=50)	41.14±24.65	5.310	<0.001	Highly significant
2% lignocaine HCl (n=50)	76.86±34.10			

SD: Standard deviation

Table 6: Pain during extraction

Pain during extraction (VAS)	Mean±SD	Z	P	Significance
4% articaine HCl (n=50)	16.80±15.84	0.878	0.380	Not significant
2% lignocaine HCl (n=50)	18.78±14.95			

SD: Standard deviation, VAS: Visual analog scale

Table 7: Duration of anesthesia (min)

Anesthetic solution	Mean±SD	Z	P	Significance
4% articaine HCl (n=50)	134.52±46.81	5.514	<0.001	Highly significant
2% lignocaine HCl (n=50)	92.30±44.58			

SD: Standard deviation

articaine provides prolonged period of analgesia and minimal discomfort to the patient postoperatively.

In our study, 0.5 ml of 4% articaine HCl was deposited buccally on one side and 0.5 ml of 2% lignocaine HCl on the other side. When objective symptoms were checked, it was observed that on the side where lignocaine was injected, palatal anesthesia was not achieved, so an additional palatal infiltration of 0.2 ml was required to perform painless extraction, whereas palatal infiltration was not required on the side where articaine was injected. Complete palatal anesthesia was achieved without the need for palatal injection with articaine which is similar with the study conducted by Hassan *et al.*^[6] Due to articaine's better diffusion properties through hard and soft tissues, overall less amount of articaine was required to achieve profound anesthesia when compared to lignocaine. Our findings are also in accordance with studies by Fan *et al.*,^[8] Lima-Júnior *et al.*,^[9] and Uckan *et al.*^[3] which concluded that maxillary extractions can be performed without the use of palatal injection. In our study, we achieved 100% anesthetic success with maxillary infiltration using articaine and lignocaine for maxillary premolar in comparison to the study by Srinivasan *et al.*^[10] who reported success rate of 100% in articaine group and 80% in lignocaine group. Evans *et al.*^[11] in their study showed that in maxillary lateral incisors, infiltration anesthesia with articaine exhibits significantly higher success rate of 88% when compared with 62% success rate of lignocaine.

Above findings conclude that even lesser volume of articaine provides adequate anesthesia equivalent to lignocaine, with 100% success rate. Another important parameter that needs to be considered is to administer the local anesthetic as painlessly as possible to create an aura of trust and comfort with the patient. Pain measurement is difficult to establish because its perception and intensity are multifactorial, encompassing sensorial and affective factors. VAS was used to record pain ratings. Although VAS may show deficiencies regarding understanding and perception, it provides a validated and meaningful measure of anesthetic efficiency, being used for this purpose by many authors. Our study showed no significant difference in pain scores during injection on buccal side between articaine and lignocaine group while significant difference in pain score was recorded on palatal side between articaine and lignocaine group. This was due to an additional palatal infiltration required for lignocaine group to perform painless extraction of maxillary premolars, in contrast to articaine group in which there was no need for palatal injection due to its enhanced diffusing properties through hard and soft tissues. The mean pain score for articaine on buccal side was 12.00 ± 15.12 , and for palatal side, it was 0 ± 0 , while for lignocaine on buccal side, it was 14.00 ± 14.14 , and on palatal side, score was 82.00 ± 13.55 . Above-mentioned scores for both groups show statistical significant difference ($P < 0.001$) in pain scores on palatal side. Results of our study are comparable

to study by Hassan *et al.*^[6] which also showed significant difference ($P < 0.001$) in pain scores on palatal side between articaine and lignocaine groups. Depth of anesthesia in terms of pain during extraction was recorded in both groups using VAS. Pain scores with articaine and lignocaine were comparable in our study. In articaine group, the mean pain score was 16.80 ± 15.84 and 18.78 ± 14.95 for the lignocaine group. No statistically significant difference was noted ($P > 0.05$). Fan *et al.*,^[8] Lima-Júnior *et al.*,^[9] and Uckan *et al.*^[3] concluded that maxillary extractions can be performed without the use of palatal injection if articaine HCl is used as local anesthetic, which is similar to findings of our study. VAS scores indicated that extractions in the articaine group without palatal injection were similar to lignocaine group where buccal and palatal injections were given, which is an advantage to the patient. In our study of fifty patients, no postanesthetic complications or adverse effects were observed in either group, which is in contrast to study by Malamed *et al.* in which frequently reported adverse events in articaine and lignocaine groups were paresthesia (0.9%), hypesthesia (0.7%), headache (0.55%), infection (0.45%), rash (0.3%), and pain (0.3%).^[12] In another study by Malamed *et al.*, they found postprocedural pain (13%), followed by headache (4%), facial edema, infection, gingivitis, and paresthesia among other adverse effects in articaine group. In lignocaine group, incidence of adverse effects was similar that is postprocedural pain (12%) and headache (3%).^[13]

CONCLUSION

The present investigation asserts that articaine HCl has shorter onset time, longer duration of action, and similar efficacy to lignocaine HCl and thus can be used as an alternate to “gold standard” lignocaine. Further controlled comparative clinical trials with similar local anesthetic agents in oral cavity with multicenter studies and a larger sample size are desirable to bring valuable attention to this research area and evaluate the safety and clinical efficacy of articaine HCl.

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Conflicts of interest

There are no conflicts of interest.

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