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RESEARCH ARTICLE

To compare Clinical and Anesthetic Efficacy of 4% Articaine, 0.5% Bupivacaine, and 2% Lignocaine in Maxillary Extractions

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ABSTRACT

The objective of our study was to compare the clinical and anesthetic efficacy of 4% articaine, 0.5% bupivacaine, and 2% lignocaine in maxillary extractions.

Materials and methods: The study was conducted in Department of Oral and Maxillofacial Surgery, on 50 systemically healthy subjects (18–75 years) requiring multiple maxillary extractions. Patients were labeled into 3 groups (2% lignocaine, 4% articaine, 0.5% bupivacaine using split mouth technique. Parameters includes: Time of anesthetic onset, Duration of postoperative analgesia, Postoperative anesthesia, and visual analog scale (VAS). A volume of 1.8–2 ml of 2% lignocaine or 4% articaine or 0.5% bupivacaine was infiltrated in the buccal vestibule (local infiltration) before extraction.

Results: The results showed that time of onset of action was significantly faster in 4% articaine when compared to 2% lignocaine and 0.5% bupivacaine.

Conclusion: Articaine have being proved to have better potency and efficacy in terms of onset of action and lower pain scores comparison but lignocaine still remained the gold standard local anesthetic agent in Dental practice due to its faster time of onset, less time of anesthesia and cost effectiveness when compared articaine and bupivacaine. Bupivacaine proved more efficient in pain control and remained concentrated for major procedures.

Keywords: Articaine, Bupivacaine, Lignocaine, Maxillary extraction, Split mouth technique.

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INTRODUCTION

Local anesthetics (LA) form the backbone for pain contrivance, which is the key factor for diminishing the fear and anxiety associated with dental procedures. Pain leads to increase in patient's stress and strain, which causes release of endogenous catecholamines that may result into unwanted cardiovascular responses.[1,2] Furthermore, anxiety may even amend the functional activity of neurons that changes the pain process in the central nervous system.

Local anesthesias are chemicals that block nerve conduction in a specific, temporary, and reversible manner, without affecting the patient's consciousness.[2,3] Prompt LA is undertaken when inhibition of action potentials is occurring; in such a way that sensation cannot be diffused from the source of stimulation, such as a tooth or the periodontium, to the brain. Local anesthetics acts by blocking the entry of sodium ions into their channels, thus precluding the transient increase in permeability of the nerve membrane to sodium that is required for an action potential to occur.[4,5]

Several LA agents have been reviewed and conveyed in the literature. Lidocaine was first introduced in the souk in 1948;[4] Bupivacaine in 1957[3] while articaine[4] entered into clinical used in 1976 as a unique amide LA agent, which contains an ester and thiophene group increasing its liposolubility. Lignocaine, articaine and bupivacaine are all amide-type of LA agents, of almost equal potency.[3,4] However, lignocaine is considered the gold standard and is the most widely used anesthetic agent because of its potency, safety, and efficiency.[3,4] Articaine is fast acting and bupivacaine is a long-lasting LA. Bupivacaine is often chosen for prolonged postoperative pain control and analgesia in extended operations. Moreover, some invesigators have attributed its ability to attain longer postoperative analgesic periods, reducing analgesic requirements in the early postoperative hours when the maximum pain intensity is reached.

Numerous studies have been reported in the literature comparing articaine and lignocaine and; articaine and bupivacaine. However, the dreath of our study aiming to assess the clinical efficacy of 2% lignocaine, 4%

articaine, and 0.5% bupivacaine in maxillary extractions using infiltrations in patients presenting for regular uncomplicated dental treatments, which was analyzed using split-mouth technique, that reduces possible research bias by avoiding physiologically and psychologically.

PURPOSE OF STUDY

To compare and evaluate:

- Time of onset of anesthesia
- Comparison of VAS score on VAS scale
- Quantity of drug administered (Drug volume in ml)
- Duration of action of anesthesia (in minutes)
- Duration of postoperative analgesia (in minutes)
- Intra- or post-administration complications
- The efficacy of articaine hydrochloride (HCl) anesthesia in the palatal region without palatal injection with lignocaine HCl and bupivacaine HCl using a VAS for pain.

MATERIALS AND METHODS

Three treatment modalities were compared for which 50 within-patient experimental units related with dental extractions after providing written informed consent to the patients visiting the Department of Oral and Maxillofacial Surgery; were divided using split-mouth design in which 150 sites were anesthetized using lignocaine 2% with adrenaline 1:200,000 (X-cain ADR), bupivacaine 0.5% with adrenaline 1:200,000 (marcaine 0.5%), articaine 4% with adrenaline 1:200,000 (Septodont with adrenaline). The study design comprised a triple-blind scheme.

Eligibility criteria included ASA I or II patients, aged between 18 and 75 years including both males and females, who were indicated for multiple maxillary teeth extractions of the teeth which cannot be saved; periodontally compromised, mobile teeth (Grade I, Grade II, Grade III), root pieces, endodontically poor prognosis and advised for extraction.

Exclusion criteria included antipathy to sulphites/amide type of LAs or any other medication, participants on anticoagulants, systemic steroids and immunosuppressive drugs. Immunodeficiency or HIV patients, diabetic, hypertensive and medically compromised participants and pregnant women.

The study scheme encompassed a triple-blind scheme. The subject, the surgeon and the statistician who performed the data analysis did not know which anesthetic solution had been used at respective areas to perform the procedure. Each patient was given the same treatment for the removal of multiple maxillary teeth. All extractions were carried out at the same time. All extractions were performed and monitored by the same person. The anesthetic technique used was local infiltration, which involved supraperiosteal injection maxillary arch.

RESULTS

The study group consisted of 50 patients who underwent multiple maxillary teeth extraction. All the participants were evaluated preoperatively. All of them received and 2% lignocaine with 1:100000 epinephrine, 4% articaine with 1:100000 epinephrine and 0.5% bupivacaine with 1:100000 applying spilt mouth technique using triple-blind scheme.

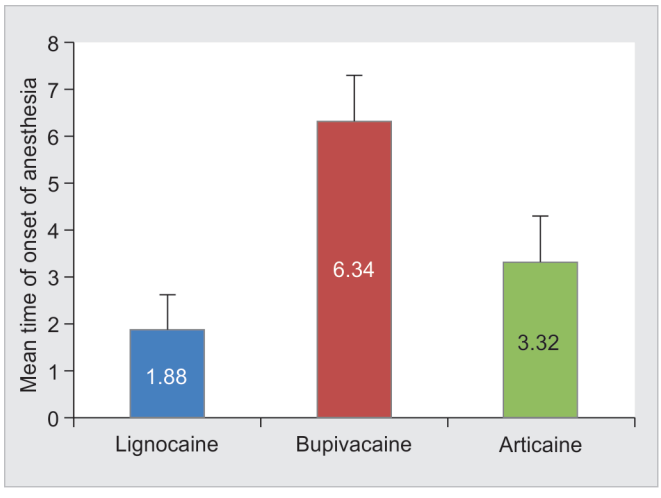
The detailed record for all the participants for the amount of anesthesia injected, the time of injection, quantity of anesthesia administered and the onset and duration of anesthesia and analgesia and the postinjection complications. Pain experience was analyzed through a VAS. The values were compared and statistically analyzed (ANOVA test, t-test paired samples statistics; Fischer's exact test, Turkey *post hoc* test for multiple comparisons). The results are tabulated and depicted in the graphs.

DEMOGRAPHICS

Fifty patients were treated with 2% lignocaine HCl 4% articaine HCl and 0.5% bupivacaine.

Time of Onset

The study showed the onset period ranging between 2 and 4 minutes in the lignocaine group; between 1 and 1.5 minutes in the articaine group and between 5 and 6 minutes in bupivacaine group. The mean values obtained were 1.8800 ± 0.75970 for lignocaine, 3.3200 ± 0.96235 for articaine, whereas 6.3400 ± 0.94777 for bupivacaine group. The time of onset of anesthesia in lignocaine is significantly higher than that in articane and bupivacaine groups ($p < 0.001$) (Graph 1).



Graph 1: Time of onset

Comparison of VAS Score

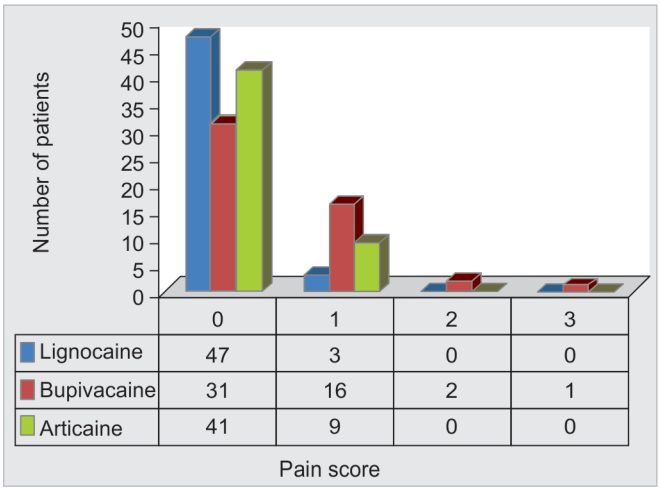
We included VAS evaluation for the efficacy analysis. We found significant difference in pain score in the lignocaine, articaine and bupivacaine groups (p-value <0.001) which was achieved using Fisher's exact test (Graph 2); whereas significant difference was noted in buccal (Graph 3) and palatal regions ($p < 0.001$) amongst lignocaine, articaine, and bupivacaine groups. While evaluating the pain score using VAS in palatal region (Graph 4), the mean values achieved were 9.12 ± 0.961 for lignocaine, 0.58 ± 1.197 for articaine while 9.58 ± 0.609 for bupivacaine which revealed statistically significant p value ($p < 0.001$) both in between groups and within groups and confirmed by using Turkey *post hoc* test for multiple comparisons which also revealed statistically significant values ($p < 0.001$).

Drug Volume

The study compared the quantity of local anesthetic solutions that were injected to achieve adequate anesthesia. The mean volume of lignocaine, articaine and bupivacaine administered was 1.57 ± 0.509, 1.04 ± 0.390 and 1.63 ± 0.510 ml respectively. The volume used is less in the articaine group, which is statistically significant ($p < 0.001$) in both between groups and within groups. Turkey HSD *post hoc* test for multiple comparisons, keeping lignocaine as control group, the values were statistically significant ($p < 0.001$) and comparing within groups also the values obtained were statistically significant ($p < 0.001$) (Graph 5).

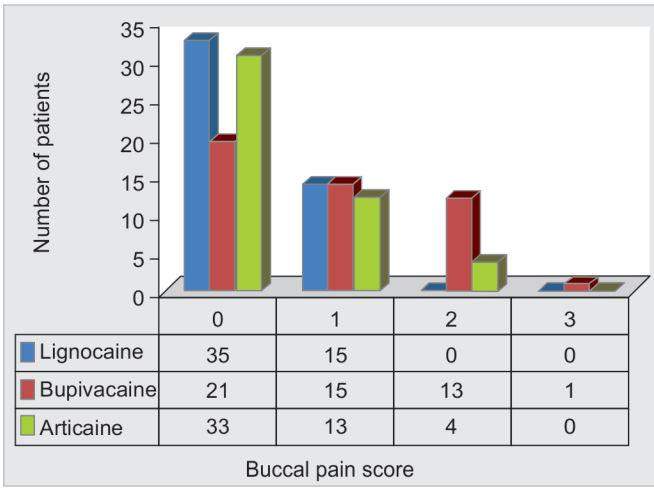
Duration of Action of Anesthesia

A mean duration of 49.40 ± 6.518 minutes was seen with the lignocaine group, 59.00 ± 14.846 minutes was seen with the articaine group and 154.40 ± 48.788 minutes with bupivacaine group. The difference is statistically significant ($p < 0.001$), giving an inference that Bupivacaine has a longer duration of anesthesia when compared between the groups and within the groups, whereas results revealed using Turkey HSD *post hoc* test for multiple comparisons also paraded statistically significant



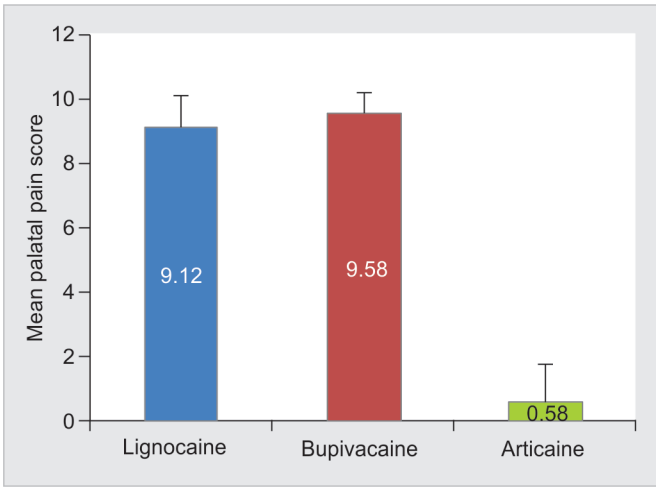
	0	1	2	3
Lignocaine	47	3	0	0
Bupivacaine	31	16	2	1
Articaine	41	9	0	0

Graph 2: Comparison of VAS score

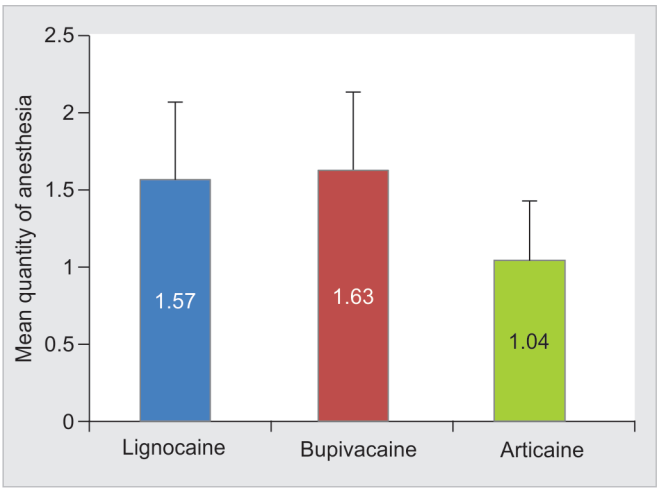


	0	1	2	3
Lignocaine	35	15	0	0
Bupivacaine	21	15	13	1
Articaine	33	13	4	0

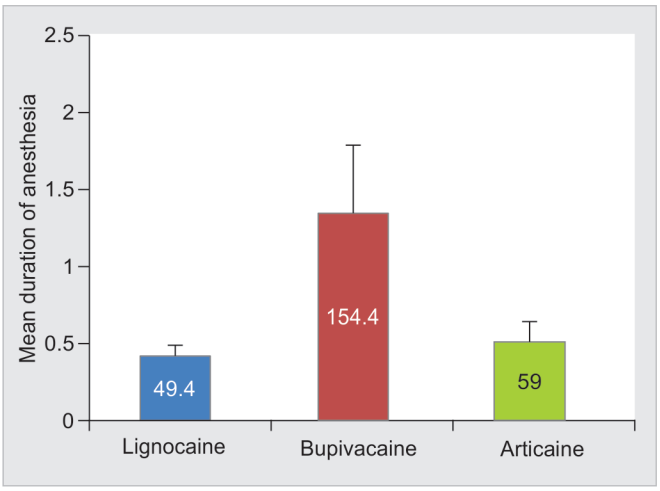
Graph 3: Buccal pain score (VAS score)



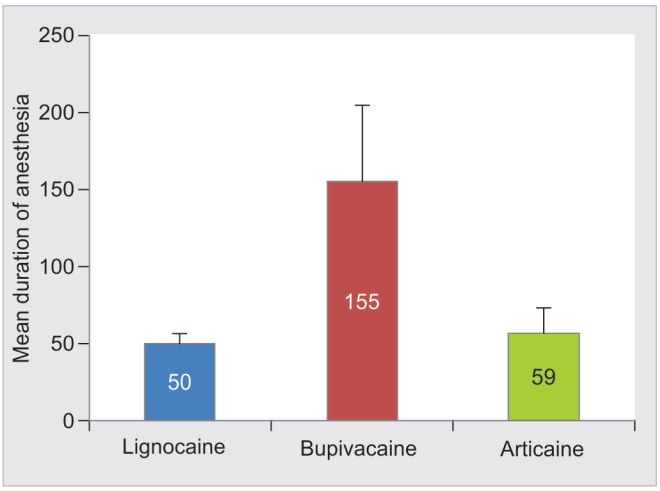
Graph 4: Palatal pain score (VAS score)



Graph 5: Quantity of anesthesia administered (Drug volume in ml)



Graph 6: Duration of action of anesthesia in minutes



Graph 7: Duration of postoperative analgesia in minutes

values ($p < 0.001$) when compared keeping lignocaine as control group and also within groups (Graph 6).

Duration of Postoperative Analgesia

Duration of analgesia was calculated by the time of first rescue analgesic medication which was prescribed was Tablet Dan-P. The patient took the analgesic medication upon halting of the anesthetic action and appearance of first symptom of pain in postoperative period. The mean values for time of first rescue of analgesia were calculated using ANOVA test, and the results obtained 50 ± 6.776 for lignocaine, 59.00 ± 14.846 for articaine while 155.00 ± 49.00 for bupivacaine. The duration of postoperative analgesia was significantly longer with bupivacaine when compared with articaine and lignocaine, because of its significantly longer duration of action. The results revealed statistically significant values ($p < 0.001$) both between the groups and within the group (Graph 7).

Intra and Postinjection Complications

We did not locate any complications either in the lignocaine group or in the articaine group or the bupivacaine group. Second injection (palatal injection) was required in orthodontic extractions in 2 patients who were apprehensive and not cooperative. And in 2 patients with 3rd molar extractions.

DISCUSSION

It is essential to homogenize the procedure for comparing the efficacy of three anesthetic drugs. In the present study we compared the clinical properties and anesthetic efficacies of local anesthetic solutions including; 2% lignocaine, 4% articaine, and 0.5% bupivacaine; all with 1:100000 epinephrine in maxillary teeth extractions. The study followed split mouth design; the key reason for using such design was to minimize the variability due to responses between comparison groups. Time of onset, VAS score, quantity of drug administered, duration of action of anesthesia, duration of postoperative analgesia, and intra- and postoperative complications were the parameters discussed in the study. The main difference between the three anesthetic solutions was the anesthetic effect; duration; permitting bupivacaine longer anesthetic periods, thus reducing early postoperative pain.

Clinically, with the exemption of bupivacaine, which has a somewhat higher pKa; there are no significant differences in pKa among the amides, and hence a slower onset of action is observed with bupivacaine group. Time of onset was calculated as the interval between injection and the time when anesthesia was achieved. The time of onset was within the range of 1–6 minutes, which was confirmed for their anesthetic effect by subjective and objective signs. Subjective sign was confirmed by asking the subjects about tingling sensation and were even asked to pinch their lip on the side of the injection to determine if the lip was profoundly numb. The subjects then confirmed objective signs by pin prick test at the injection side in the particular region of maxillary arch. Upon the onset of anesthesia, there was no sensitivity in the associated mucosa after probing it with a Moon probe.

Articaine, unlike other amide LAs, undergoes biotransformation in both the liver and plasma and is thus cleared rapidly from the body. Articaine is an amide derivative with a thiophene ring in its molecular structure instead of the usual benzene ring, making it more lipophilic and thus accounting for its faster dispersion properties within tissues and bones. This is the reason we could achieve complete anesthesia even on the palatal side, with infiltration of 4% articaine only on the buccal side. In comparison with other amide-type LA agents, articaine contains a carboxylic ester group. Thus, articaine

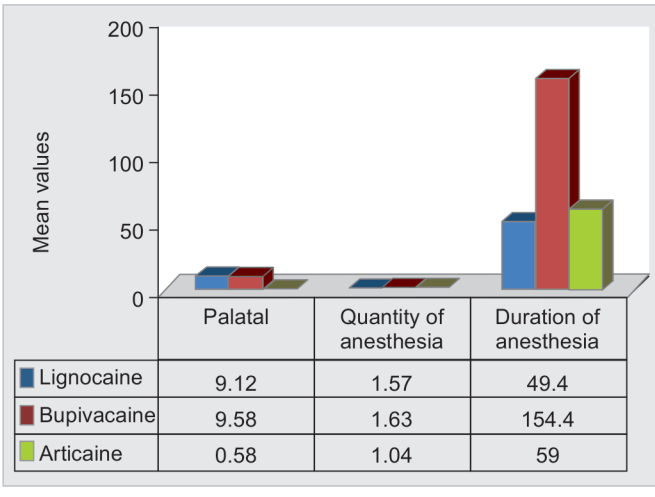
is inactivated in the liver as well as by hydrolyzation in the tissue and blood. Articaine is the only LA agent that is inactivated by both means.

It is finely acknowledged that palatal injection is a painful experience to the patients even though surface anesthesia does allow for atraumatic needle penetration. Because of the density of palatal tissues and their firm adherence to the underlying bone, palatal injection is still painful. Thus, was perceived that on the side where lignocaine and bupivacaine was injected, palatal infiltration was requisite in order to accomplish effortless extraction.

When articaine is injected, the deliberation of effective drug at the site of injection is nearly 2–4 times that obtained when lignocaine and bupivacaine is used; hence, half the volume of articaine was sufficient to achieve similar anesthesia.

In our study the volume of LA administered was between 1 and 2 ml. This revealed that on comparisons between 3 solutions; more volume of bupivacaine was required to achieve anesthetic effect followed by lignocaine and articaine. Our study showed similar results in accordance to the study done by Gregorio et al,[3] where author concluded that bupivacaine was less effective in infiltration technique. The authors also concluded that, additional anesthesia which authors called as reinforcement anesthesia was required in 14% surgeries while only 2% those with articaine was required (Graph 8).

It was also revealed that VAS scores were higher in bupivacaine group when compared to its counterparts. This proved the anesthetic efficacy of articaine and lignocaine was significantly better. This could be due to better diffusion of articaine and lignocaine in the tissues interpreting profound anesthesia. Due to higher protein binding capacity and lipid solubility properties higher pKa of 8.1 of bupivacaine; the duration of action



	Palatal	Quantity of anesthesia	Duration of anesthesia
Lignocaine	9.12	1.57	49.4
Bupivacaine	9.58	1.63	154.4
Articaine	0.58	1.04	59

Graph 8: Mean values of need of palatal injection, quantity of anesthesia (Drug volume in ml) and duration of anesthesia (in minutes)

of anesthesia and duration of postoperative analgesia was found to be longer with bupivacaine group when compared articaine group and lignocaine group with same pKa value of 7.8. Likewise, the rapid metabolism and hydrolyzation of articaine makes the duration of postoperative analgesia shorter. As the elimination of bupivacaine takes longer duration, postoperative analgesia attainable with bupivacaine is significantly longer when compared to articaine and lignocaine.

Rosenquist and Nystrom[6] reported that 34% of patients described prolonged soft-tissue numbness caused by bupivacaine anesthesia as unpleasant. The results of the studies done by Oliveira et al and Costa et al[7] suggested that the duration of pulpal anesthesia also lasts longer with articaine than with Lignocaine. Some studies have shown that articaine use may lead to a higher incidence of paresthesia, while none of the subjects in our study revealed any signs of paresthesia. In the study done Haas and Lennon,[9] it was shown that paresthesia associated with articaine or prilocaine is rare, with an incidence of 1:785,000 injections. Malamed et al[7,8] reported equal incidence of paresthesia for articaine and lidocaine in their study of 1325 patients, which was not found in our study.

To the best of our knowledge, no study has compared the clinical efficacy and anesthetic effects of ligocaine, articaine and bupivacaine when administered as buccal infiltrations in the maxillary arch. Our results show that the difference between lignocaine, articaine and bupivacaine was most obvious toward the end of the study period.

CONCLUSION

Keeping the efficacy in mind, articaine is safer and has similar potency as other groups of LA agents as it has better diffusion in tissues and offers more profound analgesia with minimal pain. Although articaine provided considerably less postoperative analgesia as compared to bupivacaine, the pain experience and the volume of anesthetic required was also less. Although lignocaine is considered the gold standard LA agent for most dental procedures, articaine is a best substitute. Articaine seems to be superior to bupivacaine in spite of its longer postoperative analgesia. Bupivacaine failed to provide profound anesthesia and the patients experienced pain and discomfort, requiring additional volumes of anesthetic agent when compared with articaine.

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