

Articaine VS Lignocaine in Orthodontic Extraction of Maxillary Premolars - A Randomized, Double-Blinded Study

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ABSTRACT

BACKGROUND

Local anaesthetics helps in preventing pain during surgical and dental procedures by blocking the peripheral nerves. The primary objective of this investigation was to compare and evaluate 4 % articaine hydrochloride (with 1 : 100000 adrenaline) and 2 % lignocaine hydrochloride (with 1 : 80000 adrenaline) in terms of pulpal anaesthesia, volume of anaesthetic solution administered, need of re-anaesthesia and difficulty of extraction during orthodontic extraction of maxillary first premolars.

METHODS

This prospective randomized, double-blinded study was conducted on 43 patients of less than 40 years of age requiring bilateral maxillary first premolar extractions for orthodontic purposes. Each patient was randomly assigned to receive either 2 % lignocaine hydrochloride or 4 % articaine hydrochloride for premolar extraction of one side and other solution was administered for premolar extraction of contralateral side spaced 1 to 3 weeks apart. In each patient, the difference in pulpal anaesthesia, volume of anaesthetic solution administered, need of re-anaesthesia, difficulty of extraction and duration of anaesthesia was assessed on administration of lignocaine hydrochloride and articaine hydrochloride.

RESULTS

Statistically significant difference in pulpal anaesthesia levels was found when the articaine and lignocaine groups ($P > 0.05$) were compared, with a higher mean pulpal anaesthesia among the articaine group. There was no difference in volume of anaesthetic solution administered on buccal and palatal side among the articaine and lignocaine groups. Only 2.3 % of patients in both the groups required re-anaesthesia on the buccal side. There was no significant difference in difficulty of extraction in both the groups. The articaine group had a longer mean duration of anaesthesia as compared to the lignocaine group which was highly significant.

CONCLUSIONS

Articaine may be used to replace lignocaine in orthodontic extraction of maxillary premolars with clinical advantages like higher pulpal anaesthesia and longer duration of anaesthesia.

KEY WORDS

Local Anaesthetic, Lignocaine Hydrochloride, Articaine Hydrochloride, Orthodontic Extraction, Prospective Study, Double-Blinded Study.

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BACKGROUND

In dental procedures, effective control of pain is the utmost requirement. There are various methods used to control pain in dentistry, among which use of local anaesthetic agent is the commonly employed technique. The ability to provide safe, effective local anaesthesia is the corner stone of successful clinical and surgical practice. Local anaesthetics form the backbone of pain control techniques in dentistry. Prior to their introduction, general anaesthesia, was the only viable method of managing surgical pain. Administration of drugs that depressed the central nervous system to the point that the patient loses consciousness allowed the surgeon to successfully complete the otherwise painful and potentially lethal procedures.

However, general anaesthesia has its own significant adverse effects. Local anaesthetics block the peripheral nerves and are used to prevent pain, during surgical and dental procedures.¹ In 1859, the first local anaesthetic agent, cocaine was isolated by Niemann. Since the introduction of the cocaine, local anaesthesia, and the subsequent development of the procaine and other related anaesthetics, dentistry has prided itself on being as close to "painless" as possible. The lidocaine was developed by Nils Lofgren in 1943 and in 1948 it was marketed with the name of Xylocaine. The initial amide local anaesthetic, lidocaine or properly known as the xylocaine, revolutionized pain control and became the gold standard. This local anaesthetic became the choice of all dentists.

The key benefits of the lidocaine were its shorter onset of action and longer duration of anaesthesia as compared to the esters.² In succeeding years, other amide local anaesthetics such as mepivacaine, prilocaine, bupivacaine, and etidocaine were introduced. These popular drugs proved to be more rapid acting than older ester - type drugs. Rusching and colleagues prepared Articaine in 1969 and in 1976 its name was changed to articaine.³ Articaine instantly became so popular in many countries due to its excellent efficacy.

Articaine differs from the previous amide local anaesthetic in being that it was derived from a thiophene ring instead of the usual benzene ring which gives the molecule better diffusion properties as compared to lidocaine. It has a half-life of 90 minutes due to presence of additional ester group which is hydrolysed by plasma esterase. This makes re-injection of articaine safer.^{1,4} Articaine can be considered superior than other local anaesthetic agents as it has better soft tissue and bone diffusion, faster onset of block, high anaesthesia quality, and low toxicity.

The concentration of articaine in the alveolus of a tooth in the upper jaw after extraction was about 100 times higher than systemic circulation. In dentistry, 4 % articaine with adrenaline 5 µg/ml is widely used for infiltration and conduction anaesthesia. Biotransformation of articaine occurs in both the plasma (hydrolysis by plasma esterase) and the liver (hepatic microsomal enzymes). This study aimed to evaluate and compare 4 % articaine and 2 % lignocaine in terms of pulpal anaesthesia, volume of anaesthetic solution administered, need of re-anaesthesia and difficulty of extraction in bilateral extraction of maxillary premolars for orthodontic purposes.

METHODS

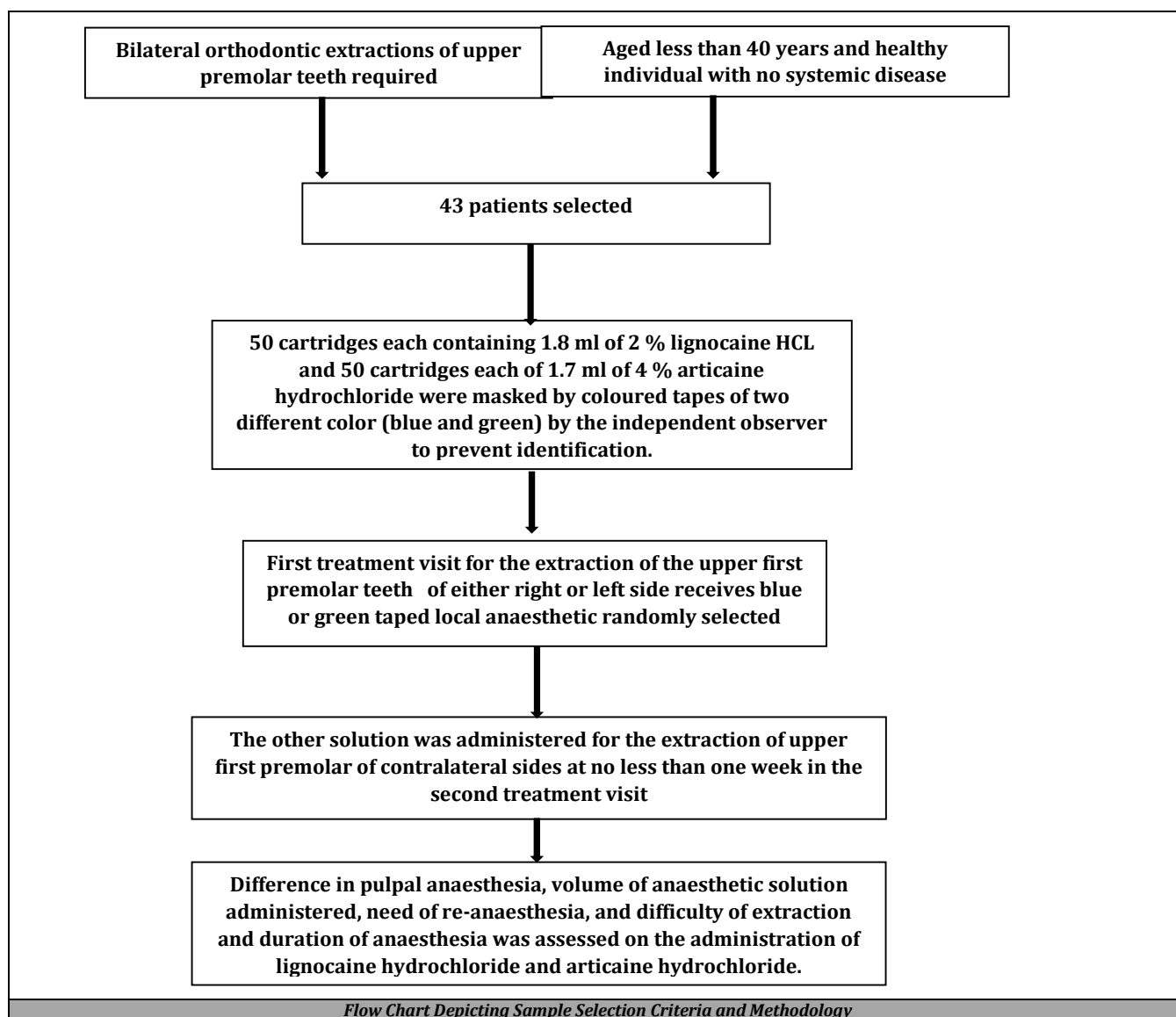
This prospective randomized, double-blinded study was conducted on 43 patients (28 females and 15 males), aged less than 40 years who reported for bilateral orthodontic extractions of upper premolar teeth to the department of oral and maxillofacial surgery from February 2013 to September 2014. Sample size was calculated using the findings of Lombardo et al. Keeping $\alpha = 0.05$ and power of study as 99 %, sample size of 40 subjects was required. Hence, 43 patients were selected.

Inclusion and Exclusion Criteria

The participants were selected under the following criteria - age less than 40 years, American Society of Anaesthesiologists (ASA) Grade - I patients (a healthy individual with no systemic disease), having co-operative behaviour for dental treatment under local analgesia.⁵ But the participants who were excluded from the study under the following criteria were - Medically compromised patients, pregnancy, history of allergy to lignocaine/articaine or any of the constituents in local anaesthetic solutions, age more than 40 years, and children below the age of reasoning infection/inflammation near the site of injection, smokers, and alcoholics.

50 cartridges each containing 1.8 ml of 2 % lignocaine HCl and 50 cartridges each of 1.7 ml of 4 % articaine hydrochloride were masked by coloured tapes of two different color (blue and green) by the independent observer to prevent identification. Randomization codes were held by the staff member who were responsible for giving masked cartridges but had no role in drug administration or in assessing outcomes. Neither the patient nor the surgeon had any knowledge of the identity of the solution so that the double-blind nature of the trial was ensured. In all patients, a thorough medical history and preoperative radiographs (OPG) were taken. After a brief examination, patients who met all the criteria had the first treatment visit for the extraction of the upper first premolar teeth of one side and were randomly assigned to receive either 2 % lignocaine hydrochloride with 1 : 80000 adrenaline (Lignocaine special, Septodont India private health care) or 4 % articaine hydrochloride with 1 : 100000 adrenaline (Septanest, Septodont India private health care) for the first procedure and the other solution was administered for the extraction of upper first premolar of contralateral sides at no less than one week (to eliminate possible carry - over effects) and not greater than three-week interval. Before administration of local anaesthetics at both appointments, electric pulp testing was done in the tooth to be extracted and the contralateral canine (control) with the electric pulp tester to obtain baseline information. The electrode was inserted in the corner of the mouth of the patient and the patient was asked to raise his/her hand in case sensations were felt. The number associated with the initial sensation was recorded to obtain the baseline reading.

A standard maxillary infiltration injection containing either of the two solutions, 0.8 ml solution of 1.7 ml of 4 % articaine hydrochloride or 1.8 ml of 2 % lignocaine hydrochloride was administered in the buccal vestibule using a self - aspirating syringe with 30-G needle [(0.31 mm × 25 mm) DENJECT disposable needle 30G - L].



Palatal infiltration was administered 10 minutes after buccal infiltration when it was observed that palatal anaesthesia was not achieved with buccal injection. If the patient complained of pain on the buccal or palatal side, then the need for re-anaesthesia was considered. Simultaneously electric pulp testing was done every 1, 3, 5, 7 and 9 minutes to observe the onset of pulpal anaesthesia. After palatal injection, the onset of palatal anaesthesia was checked on every 30 seconds till 10 minutes until no response was observed and similarly pulp testing was done on every 1 minute, 3 minutes, 5 minutes, 7 minute and 9 minute to note the onset of pulpal anaesthesia. After successful anaesthesia had been achieved, the tooth was extracted using a standard forceps' technique under sterile aseptic conditions and a pressure pack was placed. Post-operative instructions were given and only analgesics (Tab. 1 Ibugesic plus TDS × 3 days) was prescribed. Difficulty of extraction was recorded by the surgeon on a self-made 2-point category scale mentioned below:

Point Category Scale

1. Normal

2. Complicated (dilacerated roots, multiple roots, fracture of root / buccal cortical plate, need for surgical procedure)

The duration of anaesthesia was also measured. Patient marked fliers distributed to them representing the loss of intensity of heaviness (+ + + + + to -), as the time elapsed from 30 minutes to 6 hours, after extraction, of 15-minute interval. This was also confirmed by a telephone conversation with the patient. Post-operative complications if present were observed.

Statistical Analysis

The data were entered in the Microsoft Excel spreadsheet 2013. Student's unpaired t-test analysis was performed using IBM Statistical Package for Social Sciences (SPSS version 24.0) (Armonk, NY: IBM Corp.). Paired t-test was used for comparison of mean pulpal anaesthesia between the two groups. Chi square test was used to investigate whether distributions of categorical variables differ from one another. P value < 0.05 was considered as statistically significant.

RESULTS

Table 1 illustrates the age distribution among males and females. Out of 43 patients included in the study, 34.9 % patients were male and 65.1 % of patients were females. There were 14 male patients of 10 - 15 years age group and 1 male in 15 - 20 years age group. 11 patients in the female group were in the age group of 10 - 15 years, 8 in the age group of 15 - 20 years of age, and 9 in 20 – 25 years of age.

Gender	10 - 15 Years	15 - 20 Years	20 - 25 Years	Total
Male	14	1	0	15
	56.0 %	11.1 %	.0 %	34.9 %
Female	11	8	9	28
	44.0 %	88.9 %	100.0 %	65.1 %
Total	25	9	8	43
	100.0 %	100.0 %	100.0 %	100.0 %

Table 1. Age Distribution among Males and Females

Anaesthetic agent	Number	Mean	Standard Deviation	Mean Difference	t Test Value	P Value
Pulpal blue	39	39.95	9.57	3.59	2.701	0.010*
Pulpal green	39	36.36	6.52			

Table 2. Mean Pulpal Anaesthesia of Blue (Articaine) and Green (Lignocaine) Group
Unpaired T - Test, * Significant difference

Table 2 shows comparison of mean pulpal anaesthesia between blue (articaine) and green (lignocaine) groups using paired t-test. There was a significant (P value < 0.05) difference between the blue and green groups with a significantly (P value < 0.05) higher mean pulpal anaesthesia among blue (articaine) group.

	Number	Mean	Std. Deviation	Mean Difference	t-Test Value	P Value
Vol of anaesthetic solution blue - Buccal	43	0.80	0.00	No P value can be computed as there is no mean difference		
Vol of anaesthetic solution green - Buccal	43	0.80	0.00			
Vol of anaesthetic solution blue - Palatal	43	0.186	0.05	0.005	0.374	0.710
Vol of anaesthetic solution green - Palatal	43	0.181	0.06			

Table 3. Volume of Anaesthetic Solution Administered in Blue (Articaine) and Green (Lignocaine) Group on Buccal and Palatal Side.
P > 0.05 - Non-Significant (N.S);

Table 3 represents the comparison of volume of anaesthetic solution for buccal and palatal infiltration between blue (articaine) and green (lignocaine) groups using paired t-test. There was no significant (P value > 0.05) difference between the blue and green groups.

Blue Group	Green Group	Total
1	1	2
2.3 %	2.3 %	2.3 %
42	42	84
97.7 %	97.7 %	97.7 %
43	43	86
100.0 %	100.0 %	100.0 %
Need for Re-Anaesthesia Palatal		Total
Blue group	Green group	
43	43	86
100.0 %	100.0 %	100.0 %
43	43	86
100.0 %	100.0 %	100.0 %

Table 4 Need for Re-Anaesthesia on Buccal and Palatal Side in Blue (Articaine) and Green (Lignocaine) Group.
Chi - Square Test, P - value = 1.000

Only 2.3 % of patients in both the groups required re-anaesthesia on the buccal side. No significant differences between the need for re-anaesthesia with blue (articaine) or

green (lignocaine) group was found when chi square test was applied. Similarly, out of 43 patients, none of the patient required need for re-anaesthesia on the palatal side in both the groups. Table 5 illustrates the comparison of difficulty of extraction in both groups using chi - square test. There was no significant (P > 0.05) difference between blue and green groups.

Difficulty of Extraction Recorded by Surgeon	Groups		Total
	Blue	Green	
1	36	38	74
	83.7 %	88.4 %	86.0 %
2	7	5	12
	16.3 %	11.6 %	14.0 %
Total	43	43	86
	100.0 %	100.0 %	100.0 %

Table 5. Difficulty of Extraction Recorded by the Surgeon
Chi-square test, P - value = 0.534

Duration of Anaesthesia (in min)	Number	Mean	Standard Deviation	Mean Difference	t Test Value	P Value
Blue	43	254.95	43.55	61.28	11.218	0.000*
Green	43	193.67	40.29			

Table 6 Mean Duration of Anaesthesia of Articaine and Lignocaine in Minutes
Unpaired T - test, *** Very highly significant difference

The mean duration of anaesthesia was compared in both groups using a paired “t” test. Table 6 illustrates the mean duration of anaesthesia of 193.67 minutes with the green (lignocaine) group and 254.95 minutes with the blue group (articaine) group. Statistically significant (P value < 0.05) difference was seen between the two groups indicating that longer duration of anaesthesia is achieved with the blue (articaine) group as compared with the green (lignocaine) group.

DISCUSSION

Successful dental practice demands painless dentistry procedures which can be achieved with best quality local anaesthesia. Vasoconstrictors are an important constituent of local anaesthetics. Adrenaline is such a vasoconstrictor that helps in increasing the duration and depth of anaesthesia and thus contributed to the success of local anaesthesia.^{6,7} Vasoconstrictors are present in all available preparations and also help in providing hemostasis.⁸

Local infiltration is the most common technique used in many dental surgeries. When used correctly, it provides excellent comfort and safety for the patients as well as for the operator. Local anaesthetics must be chosen on the basis of their pharmacokinetics and degree of toxicity.⁹ Lignocaine is, today the ‘gold standard’ local anaesthetic agent with which all new local anaesthetics are compared.¹⁰ Lignocaine 2 % with 1 : 1, 00,000 ratio of vasoconstrictor helps in achieving pulpal anaesthesia (60 minutes) and soft tissue anaesthesia (3 to 5 hours). Articaine is 1.5 times potent than lignocaine which is due to the substitution of the aromatic ring.⁹

In vital asymptomatic teeth, pulpal anaesthesia can be evaluated by electrical stimulation. The criteria for pulpal anaesthesia was based upon the findings of Dreven et al.¹¹ If no response of patient occurs at a reading of 80 then it indicates pulpal anaesthesia in vital teeth. Certosimo and Archer showed that electronic pulp tester of less than 80

resulted in pain in asymptomatic teeth.¹² Therefore it is important to perform electronic pulp testing on vital teeth to ensure pulpal anaesthesia. Hass et al. also described the reading of 80 on the pulp tester as the criteria for pulpal anaesthesia in accordance to above studies.¹³ We however, in our study did not achieve this reading in both the solutions groups.

Difficulty of extraction was assessed by the surgeon. 83.7 % of extractions among the blue (articaine) group and 88.4 % in the green (lignocaine) group were assessed by the surgeon to be simple where as 16.3 % in blue group and 11.6 % in green group extraction was assessed complex.

In this study, mean duration of anaesthesia achieved with the articaine group was longer than that achieved with the lignocaine group. Similar results were reported by Rebolledo et al. and Bansal et al.^{14,15} The duration of the effect of an anaesthetic depends upon its protein binding degree. The duration of the effect of the local anaesthetic is also affected by the injection site or concentration of vasoconstrictor present in the anaesthetic solution. Among all amide local anaesthetics, Articaine has highest protein binding percentage. This in turn implies a longer duration of the anaesthetic effect. Articaine has potential to cause methaemoglobinemia, neuropathies, paraesthesia, hypersensitivity, and allergy. Headache, gingivitis and facial oedema were the most commonly reported adverse events in the articaine group. It was noted that the paraesthesia resolved in all the involved patients. The incidence of adverse events was similar in lignocaine group. No adverse effects were observed in our study. Thus, articaine can be considered as an alternative to other local anaesthetic agents.

CONCLUSIONS

Higher level of pulpal anaesthesia was achieved with 4 % articaine as compared to 2 % lignocaine, indicating that articaine provides adequate analgesia for the procedure to be performed. There was no difference in volume of anaesthetic solution administered on buccal and palatal side among the articaine and lignocaine groups. Only 2.3 % of patients in both the groups required re-anaesthesia on the buccal side. There was no significant difference in difficulty of extraction in both the groups. 4 % articaine with 1 : 100,000 epinephrine was found to have a longer duration of action than 2 % lignocaine with 1 : 80,000 epinephrine, thus adding to the patient comfort after the extractions by increasing the pain-free duration. This difference was statistically highly significant. Thus, for orthodontic extraction of maxillary premolars, articaine can be a local anaesthetic of choice.

Future Scope

Further controlled clinical trials with similar local anaesthetic agents in other areas of the oral cavity in the form of infiltration and nerve block are necessary to evaluate the safety and efficacy of articaine.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

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