Original Article

Comparative Evaluation of Anesthetic Efficacy of 4% Articaine and 2% Lidocaine for Buccal Infiltration in Adult Patients with Irreversible Pulpitis of Maxillary First Molar: A Prospective Randomized Study

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Abstract

Objective: The purpose of this prospective, randomized study was to evaluate and compare the anesthetic efficacy of 0.8 ml of 4% articaine and 1.6 ml of 2% lidocaine administered through buccal infiltration (submucosal) only in adult male and female patients with irreversible pulpitis of maxillary 1st molar. **Study Design:** Two hundred patients with irreversible pulpitis of the maxillary first molar were divided into four study groups and received only buccal infiltration of either 0.8 ml of 4% articaine or 1.6 ml of 2% lidocaine. Endodontic access was begun 7 min after the solution deposition. The success was defined as "no pain (0 mm)" or "weak/mild pain (>0 mm and ≤54 mm)" during access opening, and during the first file insertion till working length. **Results:** The compiled data of the number of failed cases were analyzed by two sample proportion test and of mean pain scores were analyzed by Student's unpaired *t*-test. $P < 0.05$ was taken as statistically significant. No significant difference was found in the number of failed cases on using 4% articaine and 2% lidocaine ($P > 0.05$). Moreover, no significant difference was found in the number of failed cases between the genders in Group I (4% articaine with 1:100,000 epinephrine) and also in Group II (2% lidocaine with 1:80,000 epinephrine). On comparing the mean pain scores of failed cases, it has been found that females experience more pain than males in Group I (not significant) and Group II (significant). **Conclusion:** The efficacy of 4% articaine with 1:100,000 epinephrine has been found to be better than 2% lidocaine with 1:80,000 epinephrine, as only 0.8 ml of 4% articaine with 1:100,000 epinephrine was effectively used as compared to 1.6 ml of 2% lidocaine with 1:80,000 epinephrine. Furthermore, females experience more pain as compared to males.

Keywords: *2% lidocaine, 4% articaine, buccal infiltration, irreversible pulpitis, local anesthesia*

Introduction

The patients have always associated dental treatment with pain.[1] Immediate pain control is the prime objective of any clinician and endodontist in particular. Of various methods, effective local anesthesia is the bed rock of pain control in endodontics. A number of local anesthetics are available, of which lidocaine is most commonly used and because of its safety and effectiveness, it became the gold standard[2] and also the pattern for comparison among newer agents.[3] However, lidocaine proved to be less effective in anesthetizing teeth with irreversible pulpitis successfully, thus creating a need to develop a better alternative anesthetic agent.

This led to the development of articaine. With the popularity in the use of articaine, various researches have been carried out to determine its anesthetic efficacy in different concentrations, volumes, techniques of use, comparing it with other available anesthetic agents, especially with 2% lidocaine. Most of these studies were done on mandibular molars, where some studies reported no significant difference in the anesthetic efficacy between 4% articaine and 2% lidocaine when used for the primary inferior alveolar nerve block, intraligamentary injection, supplementary injection, or infiltration injection,[4-11] whereas, other studies have found that 4% articaine is more effective than 2% lidocaine in producing pulpal anesthesia in lower molars.[2,12]

Few studies have been done on maxillary molars also, and researchers have found that buccal infiltration alone with 1.7 ml of articaine is sufficient to anesthetize the pulp of molars (100%) and premolars (100%)

How to cite this article: Syed GA, Mulay SA. Comparative evaluation of anesthetic efficacy of 4% articaine and 2% lidocaine for buccal infiltration in adult patients with irreversible pulpitis of maxillary first molar: A prospective randomized study. Contemp Clin Dent 2022;13:61-8.

Submitted : 07-Aug-2020
Revised : 26-Sep-2020
Accepted : 21-Nov-2020
Published : 23-Mar-2022

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Access this article online

Website: www.contempclindent.org

DOI: 10.4103/ccd.ccd_710_20

Quick Response Code:

as compared to 1.7 ml of lidocaine (30% and 80% respectively).[13] Later, Hassan *et al*.,[14] found that only 0.5–0.6 ml of 4% articaine with 1:100,000 adrenaline when injected in the buccal vestibule only (submucosal) for anaesthetizing maxillary premolar, palatal anesthesia was successfully achieved without palatal infiltration when objective symptoms were checked before the extraction procedure. Thus, it not only surpasses the need of additional palatal anesthesia, but it also shows that 4% articaine in volume of <1 ml is sufficient to anesthetize palatal mucosa when injected in the buccal vestibule only.[14]

Thus, there is a need for further investigation to find that whether the volume of <1 ml of 4% articaine when administered through buccal infiltration only, is enough to eliminate extremely painful palatal infiltration and achieve successful pulpal anesthesia of symptomatic irreversible pulpitis of human maxillary 1st molars. Furthermore, research on the difference in gender perception is scarce. Hence, the purpose of this prospective, randomized study is to evaluate and compare the anesthetic efficacy of 0.8 ml of 4% articaine and 1.6 ml of 2% lidocaine administered through buccal infiltration (submucosal) only in adult male and female patients with irreversible pulpitis of maxillary 1st molar.

Materials and Methods

Inclusion criteria

1. Patients in the age group of 20–40 years
2. Moderate-to-severe pain in maxillary 1st molar tooth along with a positive response to cold test with an ice spray (Hygenic Corp., Akron, OH, USA) and an electric pulp tester (Digitest, Edgewood, New York, USA)
3. Patients able to understand the use of pain scales
4. Patients not having consumed any medication in the last 24 h that would alter pain perception (determined by oral and written questionnaire)
5. The absence of any periapical radiolucency on diagnostic radiograph (except for widening of periodontal ligament) was included in the study.

Exclusion criteria

1. Patients with systemic disorders such as diabetes, hypertension, asthma, etc.,
2. Patients having active pain in more than one maxillary molar in the same quadrant
3. Patients having consumed any analgesics within last 24 h
4. Patients taking any antibiotics within 4 weeks before enrolment in the study
5. Swelling associated with the tooth in question.

Methodology

A pilot study was conducted on 20 patients in each group to determine the sample size, which revealed that more than 36 patients in each group will be required to detect a proportional difference of 25% in the anesthetic success rate between 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:80,000 epinephrine for buccal infiltration in adult patients with irreversible pulpitis at an alpha of 0.05 with power of 80% (SPSS version 20).

Ethical clearance was obtained from the "Research Board of the Pacific University, Udaipur, India." The trial followed CONSORT guidelines. The registration number for this trial is CTRI/2016/12/007610.

Two hundred adult patients with symptomatic irreversible pulpitis in maxillary first molars were selected by simple sequential randomization procedure (Coin toss method), in order to determine that out of two anesthetic agents, which patient will be administered by which anesthetic agent. Preoperative radiovisiography (Kodak 6100, Carestream health, Rochester, NY, USA) or IOPA (Kodak Dental Films, Care street Health India, Mumbai, Maharashtra, India) were obtained. The intracutaneous test was done on all patients to rule out sensitivity to the local anesthetic agent. The patients were explained regarding pain scales and the clinical procedure, and written consent was obtained from each patient.

The pain scale used was Heft-Parker Visual Analog Scale (HP VAS), which was divided into four categories.

i. No pain corresponds to 0 mm
ii. Mild pain was defined as >0 mm and ≤54 mm
iii. Moderate pain was defined as >54 mm and <114 mm
iv. Severe pain was defined as ≥114 mm.

Patients were randomly allocated to two groups, Group I (n = 100) and Group II (n = 100). Each group was further subdivided into two subgroups (n = 50 each):

I. Group I:
   i. Group IA: Buccal infiltration anesthesia with 4% articaine with 1:100,000 epinephrine in males
   ii. Group IB: Buccal infiltration anesthesia with 4% articaine with 1:100,000 epinephrine in females.
II. Group II:
   i. Group IIA: Buccal infiltration anesthesia with 2% lidocaine with 1:80,000 epinephrine in males
   ii. Group IIB: Buccal infiltration anesthesia with 2% lidocaine with 1:80,000 epinephrine in females.

Fifty male patients (Group IA) were given submucosal buccal infiltration with 4% articaine with 1:100,000 epinephrine (Septonest; Septodont India, New Delhi, India). An approximate length of the tooth was measured on the preoperative radiographs and a rubber stop was placed accordingly on the needle. A topical anesthetic gel (Lignocaine 2% jelly, Neon lab Ltd., Mumbai, Maharashtra, India) was placed with a cotton tip applicator, buccally to the involved tooth for 60 s. The needle (30 gauge) (Septoject; Septodont India, New Delhi, India) was gently placed into the buccal alveolar mucosa with the bevel towards the bone. The needle was then advanced

until the stopper corresponded with the level of buccal cusps of the molar, thus indicating that the needle tip has reached the apex of the roots. After reaching the target area, aspiration was performed and 0.8 ml of 4% articaine with 1:100,000 epinephrine was deposited at the rate of 1 ml/min. After a time interval of 7 min post injection of anesthetic agent, the patients were again asked to rate their pain on HP VAS.

The access opening (AO) was initiated only when the patient experienced either no pain or pain less than or equal to 54 mm (≤54 mm). No patient experienced pain which is more than 54 mm (>54 mm), otherwise it would have been categorized as failure. The involved tooth was isolated with rubber dam (Hygenic, Dental Dam Kit, Coltene/Whaledent; USA) and conventional AO was initiated, with Endo access bur no. 2 (Dentsply, India) directed toward the palatal canal. Patients were instructed to raise their left hand if any pain was felt during the procedure. In case of experiencing pain during the treatment, the procedure was stopped, and patients were asked to rate the pain again on HP VAS. The extent of AO and/or instrumentation was recorded as within dentin, within pulpal space and the insertion of first instrument (K-files #10 or 15 [Mani, Japan]) in the canal till the working length using apex locator (Root ZX II Apex locator/J Morita, Kyoto, Japan). The success was defined as "no pain (0 mm)" or "weak/mild pain (>0 mm and ≤ 54 mm.)" during AO and during first file insertion till working length. The failure was defined as "Moderate pain (>54 mm and <114 mm)" or "severe pain (≥114 mm)" during AO and during first file insertion till working length.

Same procedure was repeated for the female patients in Group IB using 0.8 ml of 4% articaine with 1:100,000 epinephrine for buccal infiltration. In Group 2, buccal infiltration with 1.6 ml of 2% lidocaine with 1:80,000 epinephrine was given in 50 male patients (Group IIA) and in 50 female patients (Group IIB). Rest of the procedure followed was similar to Group I. During the entire procedure, in order to eliminate any bias, all the patients were blinded and unaware about the anesthetic agent administered to them. The findings were recorded onto a Microsoft Excel Sheet for statistical evaluation.

Results

The compiled data of number of failed cases were analyzed by two sample proportion test and of mean pain scores was analyzed by Student's unpaired *t*-test. No significant difference ($P = 0.293$) was found in the number of failed cases between Group I (30) and Group II (37) [Table 1]. In all the failed cases, anesthesia failed while negotiating palatal canals only. No significant difference was found in the number of failure cases between the genders in Group I ($P = 0.662$) (4% articaine with 1:100,000 epinephrine) and in the number of failure cases between the genders in Group II ($P = 0.836$) (2% lidocaine with 1:80,000 epinephrine) [Table 2]. No significant difference was found in the number of failed cases among males ($P = 0.389$) in both the groups and among females ($P = 0.529$) in both the groups [Table 3].

On comparing the mean pain scores while inserting the file in the palatal canal:

a. In failed cases, of both, Group I (4% articaine with 1:100,000 epinephrine) and Group II (2% lidocaine with 1:80,000 epinephrine), female patients experienced more pain as compared to the male patients which was not significant ($P = 0.391$) in Group I (4% articaine with 1:100,000 epinephrine), but significant ($P = 0.001$) in Group II (2% lidocaine with 1:80,000 epinephrine) [Table 4]
b. In failed cases, males of Group II (2% lidocaine with 1:80,000 epinephrine) experienced more pain as compare to the males of Group I (4% articaine with 1:100,000 epinephrine) though the difference was not significant ($P = 0.336$), but the females of Group II (2% lidocaine with 1:80,000 epinephrine) experienced significantly ($P \leq 0.001$) more pain as compare to the females of Group I (4% articaine with 1:100,000 epinephrine) [Table 4]
c. In success cases, of both, Group I (4% articaine with 1:100,000 epinephrine) and Group II (2% lidocaine with 1:80,000 epinephrine), female patients experienced more pain as compared to the male patients which was significant ($P = 0.049$) in Group I (4% articaine with 1:100,000 epinephrine), but not significant ($P = 0.508$) in Group II (2% lidocaine with 1:80,000 epinephrine) [Table 5]
d. In success cases, males of Group II (2% lidocaine with 1:80,000 epinephrine) experienced significantly ($P \leq 0.001$) more pain as compare to the males of the Group I (4% articaine with 1:100,000 epinephrine) and also the females of Group II (2% lidocaine with 1:80,000 epinephrine) experienced significantly ($P = 0.003$) more pain as compare to the females of the Group I (4% articaine with 1:100,000 epinephrine) [Table 5].

Discussion

In the present study, only 0.8 ml of 4% articaine with 1:100,000 epinephrine (Group I) was compared with 1.6 ml of 2% lidocaine with 1:80,000 epinephrine (Group II), so as to compare the equal-milligram doses (0.8 ml of 4% articaine is 0.032 g and 1.6 ml of 2% lidocaine is 0.032 g) of anesthetic agent instead of equal volumes.

In the present study, only 0.8 ml of articaine was administered in the buccal vestibule to anesthetize maxillary first molar, as studies have shown that maxillary buccal infiltration of 0.5–1 ml of articaine is sufficient to anesthetize palatal mucosa for the extraction of maxillary posteriors.[14,15] However, no study has evaluated the efficacy of 0.8 ml of articaine, administered through buccal

Table 1: Comparison of failed cases among Group I (4% articaine with 1:100,000 epinephrine) and Group II (2% lidocaine with 1:80,000 epinephrine)

Group	Total number of patients	Number of failed cases (%)	*P*
Group I (4% articaine with 1:100,000 epinephrine)	100	30 (30)	0.293
Group II (2% lidocaine with 1:80,000 epinephrine)	100	37 (37)	

Two sample proportion test. $P<0.05$ taken as significant

Table 2: Comparison of failed cases in between male and female in Group I (4% articaine with 1:100,000 epinephrine) and Group II (2% lidocaine with 1:80,000 epinephrine)

Group	Total number of patients	Number of failed cases (%)	*P*
Male (Group IA)	50	14 (28)	0.662
Female (Group IB)	50	16 (32)	
Male (Group IIA)	50	18 (36)	0.836
Female (Group IIB)	50	19 (38)	

Two sample proportion test. $P<0.05$ taken as significant

infiltration, in providing pulpal anesthesia of the maxillary first molar with irreversible pulpitis.

Maxillary first molars in particular were taken to standardize the study, because in the Indian population, 96.8% of maxillary first molars have three roots.[16] As the onset of pulpal anesthesia usually occurs within 5–7 min after the administration of local anesthesia,[17] therefore, in our study, there was a time lapse of 7 min before initiating the AO. Moreover, then within 30 min, procedure was completed in all the cases, from AO through removal of pulp from all the canals by inserting the file till apex using apex locator. None of the patient complained of any increase in pain/discomfort during the entire procedure, thus indicating that duration of pulpal anesthesia was more than 37 min (as there was a time lapse of 7 min and after that procedure was completed in 30 min). HP VAS was used to measure the pain as it provides a validated and meaningful measure of anesthetic efficacy.[4]

In the present study, no significant difference was found between the number of failed cases, which was 30% in the Group I (4% articaine with 1:100,000 epinephrine) and 37% in the Group II (2% lidocaine with 1:80,000 epinephrine) [Table 1]. This result is consistent with the findings of Evans *et al*.,[18] Sherman *et al*.,[11] and Kanaa *et al*.[19] However, none of these studies assessed the equal-milligram doses of 4% articaine and 2% lidocaine. Our results differ from the study done by Srinivasan *et al*.,[13] who found a significantly higher success rate with 4% articaine with 1:100,000 epinephrine as compared to 2% lidocaine with 1:100,000 epinephrine. This difference might be because, higher volume of 4% articaine with 1:100,000 epinephrine (1.7 ml) was used by Srinivasan *et al*.[13] as opposed to the present study, in which only 0.8 ml of 4% articaine with 1:100,000 epinephrine was used.

In the Group I (4% articaine with 1:100,000 epinephrine), 30% cases failed and 70% cases were successful [Table 1]. Our results differ from the study done by Srinivasan *et al*.,[13] who found the success rate of 100% for maxillary buccal infiltration to produce pulpal anesthesia using 4% articaine in maxillary first molar. This difference might be because, higher volume of 4% articaine with 1:100,000 epinephrine (1.7 ml) was used by Srinivasan *et al*.[13] as opposed to the present study, in which only 0.8 ml of 4% articaine with 1:100,000 epinephrine was used.

In Group II (2% lidocaine with 1:80,000 epinephrine), 37% cases failed and 63% cases were successful [Table 1]. Our results differ from the study done by Srinivasan *et al*.[13] and Aggarwal *et al*.,[20] who found the success rate of 30% and 54%, respectively, for maxillary buccal infiltration to produce pulpal anesthesia using 2% lidocaine in maxillary first molar. The reasons for this variability in the anesthetic success in different studies may be because of operator differences, individual variations in response to the drug administered and variations in their bone density, tooth morphology, tooth positions, and anesthetic techniques.[18,21] The result of this study also differ from the study done by Gross *et al*.,[22] Mikesell *et al*.,[23] Evans *et al*.,[18] Mason *et al*.,[24] and Guglielmo *et al*.,[25] who found 82%, 100%, 72%, 97%, and 88% success rates, respectively, for maxillary first molar with infiltration of 2% lidocaine. As compared to all of the above studies, the present study showed the lower success rate of 63%, because success was evaluated by endodontic procedure and not with the electric pulp tester as in the other research studies.

Of all the 30 patients in the Group I, and 37 patients in the Group II [Table 1], where anesthesia failed, they reported moderate-to-severe pain while negotiating palatal canals only (inadequate pulpal anesthesia of palatal canal). Therefore, the mean pain scores while inserting the file in palatal canals are of critical importance in both the genders, in both articaine (Group I) and lidocaine (Group II) groups. This finding is in agreement with Atasoy Ulusoy and Alaçam,[21] where they also reported failure in 38% of the cases (19 patients) while negotiating the palatal canals only. The reasons for inadequate pulpal anesthesia in the palatal canal may be because of:

i. Local acidosis because of localized inflammation[13,20]
ii. Less volume of articaine[21]
iii. Two percent lidocaine, which because of its lower diffusibility might not be able to diffuse until the area of palatal root[13,20]

Table 3: Comparison of failed cases in the male of both groups and female of both groups

Group	Total number of patients	Number of failed cases (%)	*P*
Male - Group IA (4% articaine with 1:100,000 epinephrine)	50	14 (28)	0.389
Male - Group IIA (2% lidocaine with 1:80,000 epinephrine)	50	18 (36)	
Female - Group IB (4% articaine with 1:100,000 epinephrine)	50	16 (32)	0.529
Female - Group IIB (2% lidocaine with 1:80,000 epinephrine)	50	19 (38)	

Two sample proportion test. $P<0.05$ taken as statistically significant

Table 4: Comparison of mean pain scores of failed cases while inserting the file in the palatal canal

	Group I (4% articaine with 1:100,000 epinephrine) (*n*=30: male - 14/female - 16)	Group II (2% lidocaine with 1:80,000 epinephrine) (*n*=37: male - 16/female - 19)	*P*
Males	Group IA: 82.00±22.79	Group IIA: 89.89±22.56	0.336
Females	Group IB: 88.31±16.79	Group IIB: 115.32±20.92	≤0.001*
P	0.391	0.001*	

Student's unpaired *t*-test. $P<0.05$ taken as statistically significant

Table 5: Comparison of mean pain scores of success cases while inserting the file in the palatal canal

	Group I (4% articaine with 1:100,000 epinephrine) (*n*=70: male - 36/female - 34)	Group II (2% lidocaine with 1:80,000 epinephrine) (*n*=65: male - 34/female - 31)	*P*
Males	Group IA: 2.75±4.60	Group IIA: 13.72±14.06	≤0.001*
Females	Group IB: 6.62±10.56	Group IIB: 16.09±14.27	0.003*
P	0.049*	0.508	

Student's unpaired *t*-test. $P<0.05$ taken as significant

iv. The buccopalatal width of alveolar bone considerable distance of the palatal root from the buccal cortical plate.[13,20]

In Group I (4% articaine with 1:100,000 epinephrine), no significant difference ($P = 0.662$) was found in the number of failure cases between male (Group IA) and female (Group IB) patients [Table 2]. Furthermore, in Group II (2% lidocaine with 1:80,000 epinephrine), no significant difference was found in the number of failure cases between male (Group IIA) and female (Group IIB) patients [Table 2]. This results are consistent with Sherman *et al*.[11] in which they found that anesthetic success was not influenced by gender when anesthetic agents were administered through maxillary infiltration in patients with irreversible pulpitis of posterior teeth.

In Group I (4% articaine with 1:100,000 epinephrine), in failed cases, no significant difference was found between the genders, when mean pain scores during file insertion in palatal canals were compared [Table 4]. However, in successful cases [Table 5], female patients showed significantly higher mean pain scores during instrumentation in the palatal canals ($P = 0.049$), though the readings were quite low, indicating the low pain threshold of females as compared to males.[26] In Group II (2% lidocaine with 1:80,000 epinephrine), in successful cases [Table 5], there was no significant difference found between the genders, when mean pain scores during file insertion in palatal canals were compared. While in the failed cases [Table 4], when mean pain scores were compared between the genders, female patients showed significant higher mean pain scores during file insertion into the palatal canals ($P = 0.001$), thus indicating the low pain threshold of females as compared to males. These findings are consistent with those obtained by Tófoli *et al*.,[26] who found that pain threshold is higher in males than females following buccal infiltration of 2% lidocaine with 1:100,000 epinephrine in maxillary right canine.

However, our finding is in disagreement with the findings of Ram and Amir,[27] where they did not find any significant difference between both the genders. This difference might be because they performed the study on pediatric patients and not the adult patients. Moreover, LeResche *et al*.[28] showed that the prevalence of one or more common pain complaints was same between girls and boys before puberty, but increased dramatically in girls as puberty progressed.

When male patients in both Group IA (4% articaine with 1:100,000 epinephrine) and Group IIA (2% lidocaine with 1:80,000 epinephrine) were compared, no significant difference was found between the number of failure cases in both the groups [Table 3]. Furthermore, when female patients in both Group IB (4% articaine with 1:100,000 epinephrine) and Group IIB (2% lidocaine with 1:80,000 epinephrine) were compared, no significant difference was found between the number of failed cases in both the groups [Table 3]. This result is in agreement with the results of Sherman *et al*.[11] and Kanaa *et al*.,[19] where they both found similar anesthetic effectiveness when 4% articaine and 2% lidocaine were compared for maxillary infiltration in patients with irreversible pulpitis of posterior teeth.

In failed cases, no significant difference was found between the males of both the groups (Group IA and IIA), when mean pain scores during file insertion in palatal canals were compared [Table 4]. However, in the successful cases [Table 5], a significant difference ($P \leq 0.001$) in the mean pain scores was found during inserting the file in the palatal canal with Group II (2% lidocaine with 1:80,000 epinephrine) showing more mean pain score as compared to Group I (4% articaine with 1:100,000 epinephrine), though the values were low. In both, failed and successful cases [Tables 4 and 5], as compare to Group IB (4% articaine with 1:100,000 epinephrine), significantly ($P \leq 0.001$ and 0.003, respectively) higher mean pain scores were found in Group IIB (2% lidocaine with 1:80,000 epinephrine) during file insertion in the palatal canal, which can be attributed to its low anesthetic efficacy as compared to 4% articaine.[13,18,29]

In the present study, in both failed and successful cases [Tables 4 and 5], mean pain scores while inserting the file in palatal canals is the lowest in Group IA (male patients infiltrated with 4% articaine with 1:100,000 epinephrine) and highest in Group IIB (female patients infiltrated with 2% lidocaine with 1:80,000 epinephrine) indicating that:

a. Female patients experienced more pain as compared to male patients, this finding being consistent with the findings of Fillingim *et al*.,[30] who found that females display enhanced sensitivity to experimentally induced pain and they report greater pain after invasive procedures as compared to males
b. Four percent articaine with 1:100,000 epinephrine provides better anesthetic efficacy as compared to 2% lidocaine with 1:80,000 epinephrine, though it was used in a volume (0.8 ml), which is half to that of 2% lidocaine (1.6 ml). This finding is consistent with the meta-analysis done by Xiao *et al*.[31] and Katyal.[32] They both found that articaine is superior to lidocaine in anesthetic efficacy[31,32] and is good at maxillary anesthesia.[31]

Two possible explanations related to the biological differences between genders, may explain this increased pain prevalence in females:[33]

i. Differences in pelvic and reproductive organs may provide an additional portal of entry of infection in females leading to possible local and distant hyperalgesia
ii. Fluctuating female hormonal levels may be associated with changing levels of serotonin and noradrenaline leading to increased pain prevalence during the menstrual period and in women receiving hormonal replacement therapy or oral contraceptives.

This superior anesthetic efficacy of articaine may be because of its unique property of containing lipophilic thiophene ring and an additional ester group.[34] Articaine, not only has a high power of diffusion in oral tissues,[35] but also because of presence of a thiophene ring instead of a benzene ring, it has increased lipid solubility which in turn determines to what degree the molecules penetrate the nerve membranes. Therefore, articaine diffuses better through soft tissues than do other amide local anesthetics,[36] thereby achieving higher intraneural concentration, more extensive spreading along the nerve, and better conduction blockade.[37] Furthermore, articaine has a longer duration of clinical activity, which is because of its high degree of protein binding, resulting in increased tendency of articaine to attach securely to the protein receptor site and thus increasing its duration for clinical activity.[38]

Along with its needed effects, articaine may cause some adverse effects also, like nausea or vomiting, sensory impairments, prolonged paraesthesia, and even neurotoxicity, to name a few.[34,39] In our study, no patient showed any adverse effects, which might be because the incidence of adverse effects are dose-related,[40] and in every patients, we have used very small dose (only 0.8 ml) of articaine.

The limitation of this study is that pain recorded on HP VAS is a qualitative analysis which varies from individual to individual, depending upon the pain threshold. However, this methodology is well documented in the literature and has been used for various researches involving pain. However, this limitation has been overcome to certain extent by including large sample size in the study.

Conclusion

Within the limitations of this study, it can be concluded that:

i. Irrespective of gender, the anesthetic efficacy of 2% lidocaine with 1:80,000 epinephrine (Group II) is less as compared to 4% articaine with 1:100,000 epinephrine (Group I)
ii. In anesthetic failure cases of both groups, female patients experienced more pain as compared to the male patients which was not significant in Group I (4% articaine with 1:100,000 epinephrine) but significant in Group II (2% lidocaine with 1:80,000 epinephrine)
iii. In all the anesthetic failure cases, patients had moderate-to-severe pain while inserting the file in palatal canals only.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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