ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 6, Issue – 1, January - 2023, Page No. : 57 - 70

Comparative evaluation of anesthetic efficacy of lidocaine and articaine during inferior alveolar nerve block anesthesia for symptomatic irreversible pulpitis - An in-vivo study

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Citation of this Article: Arshitha V, Anish Sebastian, Noushad M C, Mohammed Azharudheen P T, "Comparative evaluation of anesthetic efficacy of lidocaine and articaine during inferior alveolar nerve block anesthesia for symptomatic irreversible pulpitis - An in-vivo study", IJDSIR- January - 2023, Volume –6, Issue - 1, P. No.57– 70.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: The aim of the study is to compare the anesthetic efficacy of lidicaine and articaine by administering inferior alveolar nerve block in patients with symptomatic irreversible pulpitis.

Methodology: Patients were randomly allocated to two treatment groupsof 30 patients each. Participants then received Inferior alveolar nerve block injections. A total of 30 patients (lidocainegroup) received injections of 2.5 mL of 2% Lidocaine, 30 patients (articainegroup) received 2.5 mL of 4% Articaine. Endo-Frost cold sensitivity test and test cavity was used to evaluate anesthesia.

Result and discussion: Mean pain score assessed was significantly higher in lidocaine group than that ofarticaine group. Using cold sensitivity test, in lidocaine group 66.6% of IANB was successful whereas in articaine group 83.3% of IANB was successful. In the articaine group, 10 % of the patients experienced pain during the test cavity preparation, whereas the percentage of patients reporting pain was higher in the lidocaine group (16.7%).

Articaine due to its lipid solubility property which is enhanced by the presence of a thiophene ring was found more effective for achieving inferior alveolar nerve block anesthesia than lidocaine.

Conclusion: Articaine was more effective for achieving inferior alveolar nerve block anesthesia than lidocaine.

Keyword: lidocaine, alveolar, achieving

Introduction

The most common dental complaint is pain. It accounts for more than 80%of all dental visits.The International Association for the Study of Pain (IASP) has defined pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. It is difficult to determine the intensity of pain perceived because there is an emotional element , and each patient has a different threshold which involves both subjectivity and previous experiences[1], [2].

Symptomatic irreversible pulpitis is a clinical diagnosis based on subjective and objective findings indicating that the vital inflamed pulp is incapable of healing. Inflammation produces a significant increase in internal tissue pressure since pulp is not able to expand[3].In routine dental practice, pulpal pain is managed by giving local anesthetic agents.

Lidocaine is the most commonly used amide group local anesthetic agent in dentistry. Another frequently used anesthetic agent is 4% articaine combined with epinephrine. Articaine is an amide-group anesthetic agent and its lipid solubility property is enhanced by the presence of a thiophene ring[4][5].

The inferior alveolar nerve (IAN) block is the most used mandibular injection technique to achieve local anesthesia for dental treatments.

Pulp vitality tests (PVTs) such as the electric pulp test (EPT) and thermal tests using cold stimuli have been studied for testing anesthetic effect. A regular diagnostic aid for the detection of pulp sensibility is cold test [6]

Test cavity[7] is done by cutting dentine using a high or low speed bur.

Visual analogue scales (VAS) are psychometric response scales used to measure subjective characteristics or attitudes.

Purpose of this study is to compare the level of pulpal anesthesia using cold test and test cavity attained by 2% lidocaine with 1:100000 epinephrine and 4% articaine with 1:100000 epinephrine during inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. Level of pulpal anesthesia is recorded using visual analogue scale (VAS)

Aims and objectives

Aim

The aim of the study is to compare the anesthetic efficacy of various local anesthetic agents by administering inferior alveolar nerve block in patients with symptomatic irreversible pulpitis.

Objective

- To study and compare the level of pulpal anesthesia obtained by lidocaine and articaine using cold test
- To study and compare the level of pulpal anesthesia obtained by lidocaine and articaine using test cavity

Materials and methods

- Sixty adult patients (n = 60)
- Endo-Frost (coltene whale dent, propane/butane)
- 2.5 mL of 2% lidocaine with 1:100000 epinephrine(EASYCAINE 2 % ADRENALINE)
- 2.5ml of 4%articaine with 1:100000 epinephrine (SEPTOCAINE AND EPINEPHRINE 1:100000)
- Ai rotor handpiece
- (NSK Pana Air Hand Piece FX TB2)
- Dentsply Endo Access Bur
- 2.5 ml Dispo van single use syringe with needle size 0.55*25mm
- Standardized cotton pellet (ROEKO Cotton Pellets Size 00 (4 mm))
- Rubber dam kit

- Visual analogue scale ranging from 0-10

Study design

Randomized control trial

Setting

Kannur Dental college

Sampling

Sample size

- Total sample size: n= 60
- Lidocaine group: n=30
- Articaine group: n=30

Inclusion criteria

- Patients age 30-50
- Mandibular first and second molar tooth with symptomatic irreversible pulpitis

Exclusion criteria

- Patients with cardiac disease and other medically compromised patients.
- Tooth with periapical pathosis
- Recently traumatized tooth
- Tooth with internal and external root resorption
- Patients with allergy to any component of anesthetic solution

Sixty adult patients participated in this study. All were patients of the Dental college and were in good health as determined by a health history and oral questioning. The Institutional Ethics Committee of Kannur dental college, Kerala, India approved the study, and a written informed consent was obtained from each patient. Patients of age group 30-50 and with mandibular first or second molar tooth with symptomatic irreversible pulpitis were selected for the study.

An initial diagnosis of irreversible pulpitis wasmade based on standard endodontic criteria such as spontaneous pain, prolonged sensitivity to thermal changes, sensitivity to pressure or percussion and pulpal exposure

Participants were pre-operatively cold tested with endo-frost (coltene whale dent, propane/ butane). Adjacent and contralateral normal teeth were also tested in order to establish a baseline response.

Inferior alveolar nerve block injections

The patients were randomly allocated to two treatment groups (lidocaine, articaine) of 30 patients.

Groups	Number of participants
Lidocaine group	30
Articaine group	30

Participants then received Inferior alveolar nerve block injections. All injections were administered by one person. A total of 30 patients (lidocaine group) received injections of 2.5 mL of 2% Lidocaine, 30 patients (articaine group) received 2.5 mL of 4% Articaine. After 15 minutes of inferior alveolar nerve block injection, the lip numbness was evaluated by asking the patient whether his/her lip is numb.

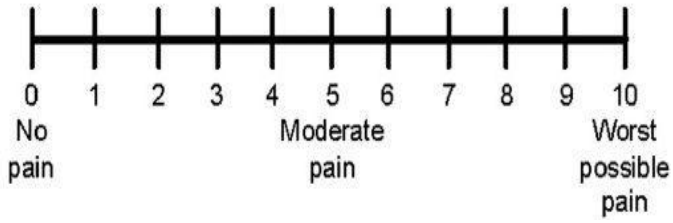
Cold test

To determine pulpal anesthesia, cold test using endo frost were first used. Standardized cotton pellet (ROEKO Cotton Pellets Size 00 (4 mm)) sprayed with the endo-Frost (COLTENE WHALEDENT, PROPANE/ BUTANE) were applied with care on the tooth in the junction of occlusal and cervical third in facial aspect. The patients were instructed to report any painful sensation.

If pain was experienced, patients were asked to point to their level of pain on a visual analogue scale (VAS). The subjects placed a mark on the scale where it best described their pain level.

To interpret the data, the VAS was divided into the following 4 categories: no pain corresponded to 0 mm on the scale; mild pain was defined as >0 and <4 cm, which included descriptors of faint, weak, and mild pain; moderate pain was defined as >4 cm and <7cm; severe

pain was defined as ≥7cm and included the descriptors of strong, intense, and maximum possible[75]. . Pain scores of 1 and 2 are considered as successful IANB and pain scores of 2 or 3 classified as IAN block unsuccessful[8]



Test cavity

The pulpal anesthesia was further determined by test cavity by cutting dentin using Ai rotor handpiece and Dentsply Endo access bur (NSK Pana Air Hand Piece FX TB2).

This may give some indication of whether the sensory element of the pulp is still functioning. The test cavity was made in the same position as an endodontic access cavity.

During the test cavity preparation patient was instructed to inform the clinician if pain is experienced.

Results

Table 1: Comparison of the level of pulpal anaesthesia obtained by lidocaine and articaine using cold sensitivity test with Visual Analogue Scale

	Mean Pain Score	**SD**	**P value**[Mann Whitney U test]
Lidocaine	2.36	2.39	
Articaine	1.16	2.11	0.04*

* p value <0.05 is statistically significant; ** <0.001 is statistically highly significant

Chart 1: Comparison of the mean pain score obtained by lidocaine and articaine using cold sensitivity test with Visual Analogue Scale

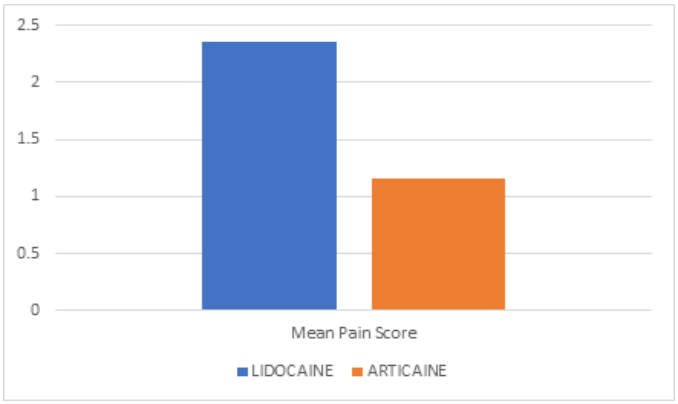


Table 2 & 3: Comparison of the level of pulpal anaesthesia obtained by lidocaine and articaine using cold sensitivity test with Visual Analogue Scale.

Cold test	Lidocaine n (%)	Articaine n (%)
No Pain	13(43.4)	22(73.3)
Mild	7(23.3)	3(10)
Moderate	10(33.3)	5(16.7)

Or

	Lidocaine n (%)	Articaine n (%)	P value[Chi-square test]
Successful Anesthesia	20 (66.6)	25 (83.3)	0.06
Unsuccessful Anesthesia	10 (33.3)	5 (16.7)	

* p value <0.05 is statistically significant; ** <0.001 is statistically highly significant

Chart 2: Comparison of the level of pulpal anaesthesia obtained by lidocaine and articaine using cold sensitivity test with Visual Analogue Scale.

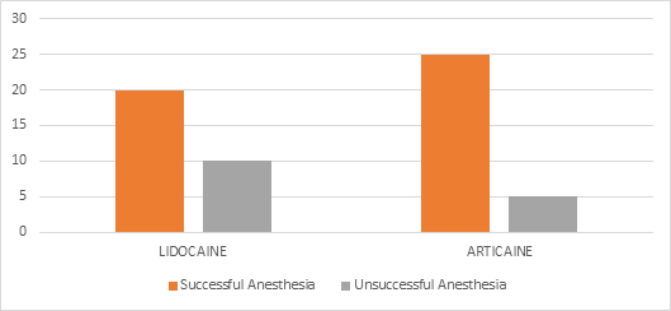
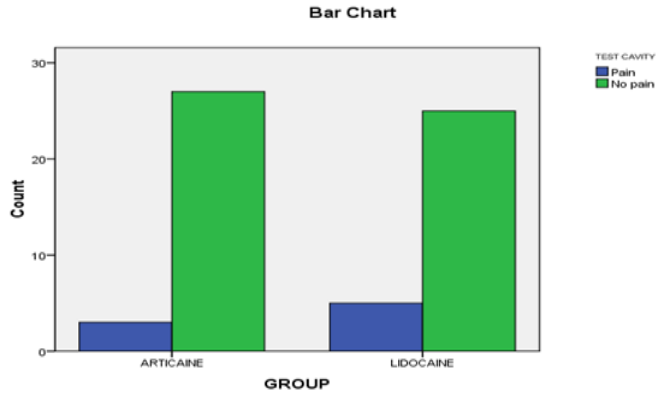


Table 3: Comparison of the level of pulpal anaesthesia obtained by lidocaine and articaine using test cavity

Test Cavity	Pain n (%)	No pain n (%)	P value [Chi- square test]
Lidocaine	5 (16.7)	25 (83.3)	0.57
Articaine	3 (10)	27 (90)	

chart 3: Comparison of the level of pulpal anaesthesia obtained by lidocaine and articaine using test cavity



Statistical analysis

The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data. Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean ± SD. Mann Whitney U test and chi square was used to find the significance of study parameters between the groups. Level of significance was fixed at $p<0.05$ and any value less than or equal to 0.05 was considered to be statistically significant.

Discussion

Local anaesthetic solution blocks the nerve impulses transmission by reversibly blocking the fast voltage-gated sodium channels, thereby inducing analgesia and anaesthesia. Physicochemically, local anaesthetics are weak bases that are formulated in an acidic milieu, hence containing a larger proportion of the drug in the ionised state.

The inferior alveolar nerve (IAN) block is the most used mandibular injection technique to achieve local anesthesia for dental treatments. However, clinical studies have demonstrated significant failure rates of this technique [9][10],which indicates that IAN blocks, even if applied appropriately, do not always result in successful pulpal anesthesia [9]This failure rate of IAN blocks is a common clinical problem for the treatment of mandibular posterior teeth with irreversible pulpitis.

Lidocaine is the most commonly used local anesthetic agent in dentistry. It has a short onset of action. It belongs to amide having intermediate duration of action[11].

Another frequently used anesthetic agent is 4% articaine combined with epinephrine.

Pulp vitality tests (PVTs) such as the electric pulp test (EPT) and thermal tests using cold stimuli have been studied for testing anesthetic effect. A regular diagnostic aid for the detection of pulp sensibility is cold test [6]. The cold test has various forms of delivery, such as ice sticks, ethyl chloride, carbon dioxide snow, dichlorodifluoromethane (DDM), 1,1,1,2-tetrafluoroethane (TFE) etc.Endo frost is propane/butane/isobutane gas mixture stored in a pressurized can (Endo Frost, Roeko, Lange Nau, Germany). Cold thermal testing results in contraction of the dentinal fluid within the dentinal tubules, resulting in a rapid outward flow of fluid within the patent tubules.

This rapid movement of fluid results in 'hydrodynamic forces' acting on the nerve fibres within the pulp–dentin complex, leading to a sharp sensation lasting only till the duration of the thermal test[12]

Test cavity[13] is done by cutting dentine using a high or low speed bur.This may give some indication of whether the sensory element of the pulp is still functioning

Visual analogue scales (VAS) are psychometric response scales used to measure subjective characteristics or attitudes.Failure of local anesthetic usually occurs in endodontic patients with a hot tooth [14]. The term "hot" tooth generallyrefers to a pulp that has been diagnosed with irreversible pulpitis, with spontaneous, moderate-to-severe pain.

Management of hot tooth in endodontics is always challenging for clinician. Different anesthetic solution like 4% Articaine and supplemental injection techniques has been found use full.

Oertel et al[15] concluded that because of the shorter half-life of articaine it can be given safely at higher concentrations; [15]however, Paxton and Thorne [16]argue that lipid solubility may not determine the speed of diffusion across the cell membrane. [16] Other studies have proposed that anaesthetic binding to plasma proteins has greater association with ionic channel action than lipid solubility[15]. Articaine has a higher affinity to plasma proteins as compared to lidocaine[17].Articaine anaesthetise by blocking nerve conduction similar to other local anesthetic agents. Another property to consider for diffusion is the molecular configuration.[18] Articaine contains a thiophene ring instead of benzene like lidocaine. This gives the molecule better diffusion properties compared with lidocaine [18]

Malamed et al. (2001)[19] compared the efficacy of 4 % articaine with adrenaline 1:100 000 with 2 % lidocaine with adrenaline 1:100 000. A total of 882 subjects received articaine, and 443 received lidocaine. The efficacy was determined by both subject and investigators using a visual analog scale, or VAS. They concluded that there were no significant differences between subjects receiving articaine and those receiving lidocaine, either for subjects or investigator ratings. This finding is similar to that obtained by Vehetalo et al. (1993).[20]

A study by Ruprecht et al. (1991)[21] compared equimolar concentrations of articaine and lidocaine. It concluded that articaine had a significantly longer duration of pulpal anesthesia, regardless of the Vaso constrictor content.

Winther & Nathalang[22] showed that articaine was significantly superior to lidocaine with respect to frequency, extent and duration of analgesia .

Another important issue is the concentration of adrenaline. The effectiveness of 4 % articaine associated with 1:100 000 or 1:200 000 adrenaline for inferior alveolar nerve blocks are found to be the same (Tofoli & al. 2003)[23]. This is why 1:200 000 is the recommended concentration of adrenaline for dental procedures (Jacob 1989)[24]In this study mean pain score assessed using cold sensitivity test after administration of local anesthesia was significantly higher ($p = 0.04$) in lidocaine group than that of articaine group.

Using cold sensitivity test, 43.4% of patients experienced no pain, 23.3 % of patients experienced mild pain and 33.3 % of patients experienced moderate pain in Lidocaine group. Whereas in Articaine group 73.3% of patients experienced no pain, 10 % of patients experienced mild pain and 16.7 % of patients

experienced moderate pain. In lidocaine group 66.6% of IANB was successful whereas in articaine group 83.3% of IANB was successful, but this difference was not statistically significant.

In the articaine group, 10 % of the patients experienced pain during the test cavity preparation, whereas the percentage of patients reporting pain during the test cavity preparation was higher in the lidocaine group (16.7 %). This difference was also not found to be statistically significant. The results of our study point to the fact that neither of the local anesthetic solutions used assures a complete absence of pain during endodontic treatment. However the success rate seemed bigger with the articaine solution than with the lidocaine solution.

In a study by Nusstein et al[25], he demonstrated that pulpal anesthesia is not a confident indicator for actual analgesia. In this study although 42% of all assessed posterior teeth had responded negatively to the electric pulp test, the patients reported pain during the subsequent endodontic treatment [25]. Our results agree with those by Reisman et al. [26], who found that mandibular posterior teeth with irreversible pulpitis frequently had not been anesthetized by IAN blocks. Therefore, these authors confirmed that a negative electric pulp test is no guarantee for pulpal anesthesia in irreversible pulpitis.

In this study when tested using cold sensitivity testing, Articaine group showed successful anesthesia of 83.3% and Lidocine group showed successful anesthesia of 66.6%. Study performed by Claffey et al[27] compared the efficacy of IAN blocks containing 4% articaine with 1:100,000 epinephrine with those containing 2% lidocaine with 1:100,000 epinephrine in patients with irreversible pulpitis. In this case, the success rates were 24% (9 of 37 patients) for IAN blocks with articaine solution and 23% (8 of 35 patients) for lidocaine solution [27]. However, the success rates observed in our study were far higher than those found by Claffey et al., reaching 83% (compared with 24%) with articaine solutions and 66% (compared with 23%) with lidocaine solutions.In a study by Tort Amano et al[28] in which anesthetic efficacy of Articaine and Lidocaine was compared in patients with irreversible pulpitis, pulpal anesthesia was measured through electric pulp stimulation, and the absence/presence of pain was recorded through a verbal analogue scale.Regarding pulpal anesthesia success as measured with the pulp tester, the lidocaine solution had a higher success rate (70%) than the articaine solution (65%). For patients reporting none or mild pain during pulpectomy, the success rate of the articaine solution (65%) was higher than that of the lidocaine solution (45%)According to Claffey E et al and Tort Amano IP et al[27][28], there was no statistically significant difference in the success rates of Articaine and Lidocaine after IANB. Ashraf H et al [29] reported that Articaine seems to raise anesthetic success more effectively compared with lidocaine.

Another study by Nagendra Abu et al[30] to find the efficacy of articaine over lidocaine in patients with irreversible pulpitis concluded that articaine is more effective than lidocaine for local anaesthesia of teeth with irreversible pulpitis undergoing root canal treatment. Other systematic reviews (Kung et al. 2015[31], St George et al. 2018[32] also concluded that articaine was more effective than lidocaine, whereas Brandt et al. (2011) [33]reported no difference, probably due to the small number of clinical trials included

Earlier studies have also shown that articaine provided a longer duration of pulpal anesthesia than lidocaine[34][35]Comparison the anesthetic efficacy of 4% articaine, 2% lidocaine and 2% mepivacaine, all in

combination with 1:100,000 epinephrine, in patients with irreversible pulpitis of permanent mandibular molars was done in a randomized clinical trial by Carlos et al [36] . subjective signal of lip numbness, pulpal anesthesia and absence of pain during the pulpectomy procedure were evaluated respectively. Evaluation was done by questioning the patient, electric pulp tester and a verbal analogue scale. All patients reported the subjective signal of lip numbness. Regarding pulpal anesthesia success as measured with the electric pulp tester, the success rate was respectively 68.2% for mepivacaine, 63.6% for articaine and 63.6% for lidocaine. Regarding patients who reported no pain or mild pain during the pulpectomy, the success rate was, respectively 72.7% for mepivacaine, 63.6% for articaine and 54.5% for lidocaine. These differences were not statistically significant. Neither of the solutions resulted in 100% anesthetic success in patients with irreversible pulpitis of mandibular molars

Authors of a recent systematic review with meta-analysis investigated and compared the efficacy and safety of articaine with lidocaine [37]. They found out that 4% articaine with 1:100.000 epinephrine showed a higher success rate in anaesthesia, lower VAS scores during injection phase and treatment phase, shorter onset time of pulpal anaesthesia and a lower percentage of patients experiencing adverse events. This study also confirmed other advantages with the use of articaine described in literature, such as less painful injection, faster onset of effect, with fewer adverse events.

Potocnik et al.[38]studied the in vitroeffects of lidocaine and articaine, both at concentrations of 2% and 4%, in addition to 3% mepivacaine. In these experiments, 2% articaine was more effective than 2% or 4% lidocaine or 3% mepivacaine, and articaine at 4% was even more effective.However, due to the risk of accidental intravenous injection during IANB and the possibility of anincidenceof paresthesia,the authors suggested replacing 4% articaine with a concentration of 2%. Articaine hydrochloride is a superior anesthetic agent, mainly due to its enhanced anesthetic potency, which is 1.5 times greater than that of lidocaine, with faster onset and increased success rate[39]

Investigators has used different methods in terms of assessing the success of pulpal anesthesia. Achieving the soft-tissue signs of local anesthesia is a poor predictor for the presence of profound pulpal anesthesia.[40]Few studies used a cold test or an electric pulp test followed by lip numbness to validate the first pulpal anaesthetic success [41][42] .Bjorn was the first to link a negative response to the maximal output of electrical pulp stimulation for painless dental treatment.

Dreven examined the reaction to an electric pulp tester as a measure of pulpal anaesthetic prior to endodontic treatment in teeth with normal pulp, reversible pulpitis, and irreversible pulpitis. In irreversible pulpitis, however, a lack of reaction to cold or electric pulp tests does not always imply pulpal anaesthesia[43] . This might be because in teeth with irreversible pulpitis, the reactions to electric pulp tests and cold testing are linked to rapid and slow silent A-delta fibres. It is assumed that if the tetrodotoxin-resistant sodium channels appear on deeper nociceptive C fibres, then neither negative nor positive responses to EPT and cold tests indicate the success of anaesthesia as the C fibres might be accountable for the pain response[41][33]Electric testing or VAS are the commonly used methods to assess pulpal anesthesia. VAS is a psychometric response scale that has been used as a measurement instrument for subjective characteristics such as dental pain, and it has been used successfully in dentistry primarily for patients who are symptom matic preoperatively[44][28][45]

Conclusion

According to the findings and within the limitations of the study it wasconcluded thatArticaine was more effective for achieving inferior alveolar nerve block anesthesia than lidocaine.

In our study mean pain score assessed using cold sensitivity test after administration of local anesthesia was significantly higher (p = 0.04) in lidocaine group than that of articaine group.In our study anesthetic efficacy assessed using cold sensitivity test after administration of Inferior alveolar nerve block was higher in articaine group than that of lidocaine group.The percentage of patients reporting pain during the test cavity preparation was higher in the lidocaine group (16.7 %) when comparing with articaine group (10%).

However, both the results are not found to be statistically significant. We suggest that the sample should be increased to improve these results

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Figures Legends

Figure 1: Endo Frost (coltene whale dent, propane/ butane)

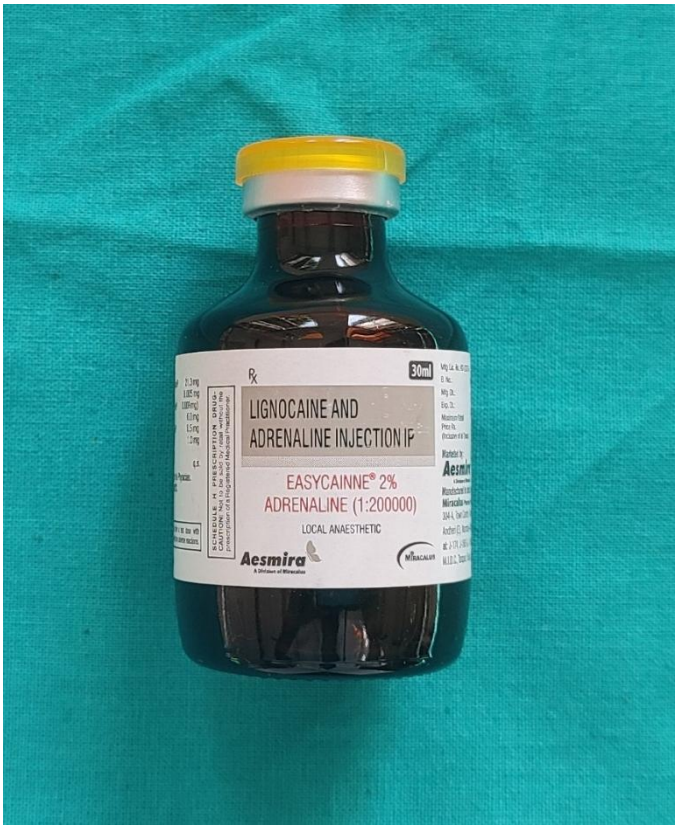

Figure 2: 2% lidocaine with 1:100000 epinephrine (EASYCAINE 2 % ADRENALINE)

Figure 3: 4%articaine with 1:100000 epinephrine (septonest and adrenaline 1:100000)

Figure 4: 2.5 ml Dispo van single use syringe with needle size 0.55*25mm

Figure 5: Rubber dam kit

Figure 6: Ai rotor handpiece (NSK Pana Air Hand Piece FX TB2)

Figure 7: Dentsply Endo Access Bur

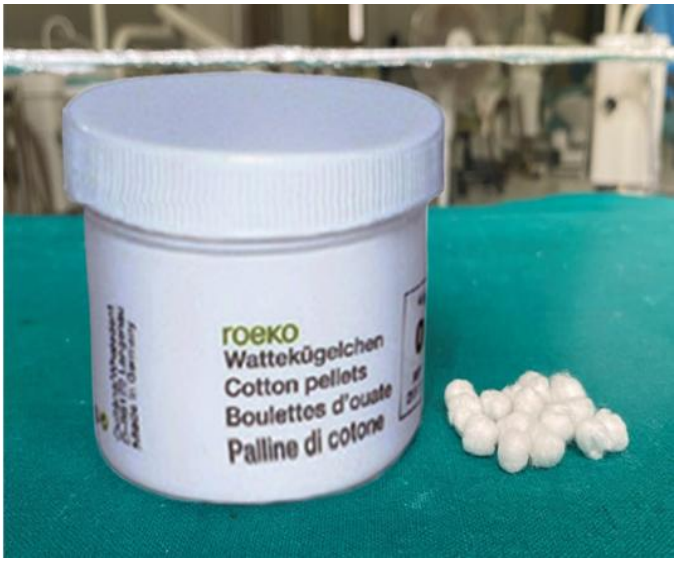

Figure 8: Standardized cotton pellet (ROEKO Cotton Pellets Size 00 (4 mm))

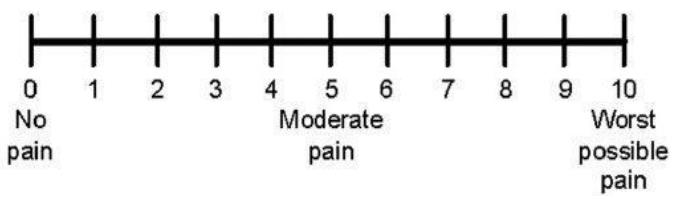

Figure 9: Visual analogue scale ranging from 0-10

Figure 10: Radiograph showing chronic irreversible pulpitisirt 47

Figure 11: Preoperative testing of 47 with endofrost

Figure 12: Loading of articaine in 2.5ml dispovan syringe

Figure 13: Inferior alveolar nerve block injection

Figure 14: Cotton pellet sprayed with the endo-Frost

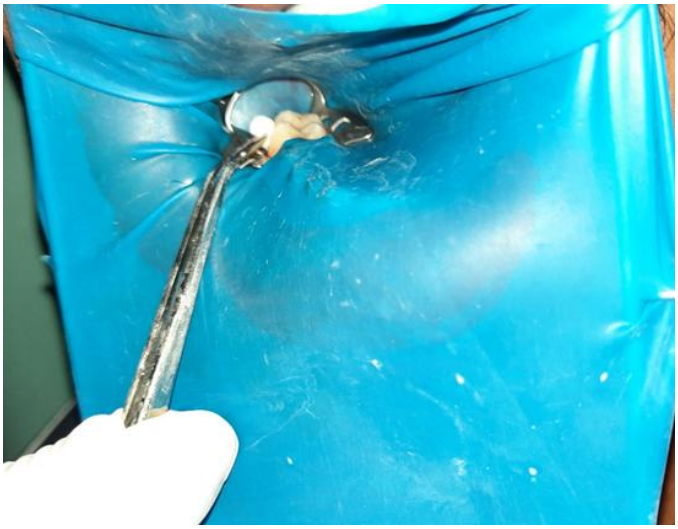

Figure 15: Application of cotton pellet on the tooth in the junction of occlusal and cervical third in facial aspect

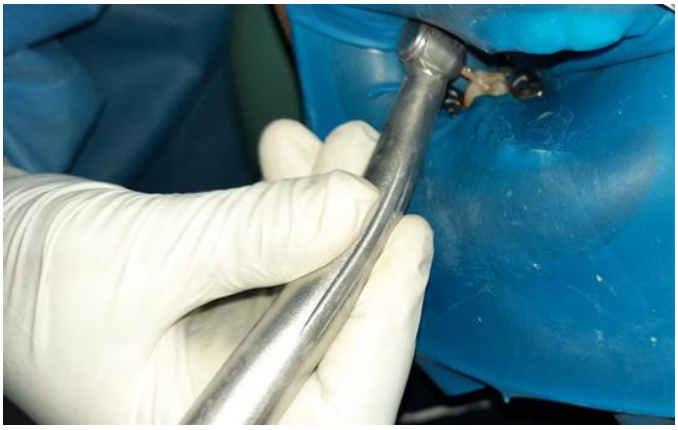

Figure 16: Performing test cavity by cutting dentin using Ai rotor handpiece and Dentsply Endo access bur.