ORIGINAL ARTICLE

COMPARISON OF ANAESTHETIC EFFICACY OF ARTICAINE AND LIDOCAINE IN NONSURGICAL ENDODONTIC TREATMENT OF PERMANENT MANDIBULAR MOLARS WITH SYMPTOMATIC IRREVERSIBLE PULPITIS. A RANDOMIZED CLINICAL TRIAL

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Background: Inferior Alveolar Nerve Block (IANB) with Buccal Infiltration (BI) anaesthesia is required to completely anesthetize the mandibular molars with symptomatic irreversible pulpitis. 4% Articaine and 2% Lidocaine provide local anaesthesia during the nonsurgical endodontic treatment of mandibular molars with symptomatic irreversible pulpitis. Objective of the study was to compare the effect of Articaine and Lidocaine in the combination of Inferior alveolar nerve block with buccal infiltration anaesthesia during the nonsurgical endodontic treatment of mandibular molars with symptomatic Irreversible Pulpitis. **Method:** One hundred and sixty participants with Symptomatic Irreversible Pulpitis of permanent mandibular molars were divided randomly in two groups. Group A was given Articaine 4% IANB along with BI whereas group B was given Lidocaine 2%. Pain was assessed after 15 minutes of administration of local anaesthesia. Anaesthetic success of the agents is defined as, absence of pain or mild pain first during the access cavity preparation then instrumentation of the canals of tooth. Chi-square test was applied to analyse data for statistical significance. **Results:** Anaesthetic success of Articaine was 96.2% during access cavity preparation compared to Lidocaine (86.2%). Success during instrumentation of canals was also found to be high in Articaine (90.2%) compared to Lidocaine (76.2%). This difference of anaesthetic efficacy between Articaine and Lidocaine was found statistically significant. (p=0.02) **Conclusion:** Articaine is found to be better than Lidocaine regarding anaesthetic efficacy and hence, it can be a safer alternative to Lidocaine.

Keywords: Lidocaine; Carticaine; Efficacy; Anaesthesia; Local; Nerve Block; Pulpitis

Citation: Khan Q, Noor N, Anayat N, Khan TS, Ahmed M. Comparison of anaesthetic efficacy of Articaine and lidocaine in nonsurgical endodontic treatment of permanent mandibular molars with symptomatic irreversible pulpitis. A randomized clinical trial. J Ayub Med Coll Abbottabad 2021;33(2):192–7.

INTRODUCTION

Inferior Alveolar Nerve Block (IANB) is a local anaesthetic technique, used worldwide to achieve pulpal anaesthesia in permanent mandibular molar in non-surgical endodontic treatment (root canal treatment), but it fails 10-81% of the times.[1] Pain control is necessary in endodontics to lessen anxiety during procedure. Failure rate of IANB is very high in patients with symptomatic irreversible (IR) pulpitis.[2,3] Irreversible pulpitis is that stage of inflammation of the dental pulp from which the pulp is not expected to recover. So, complete pulpal anaesthesia in symptomatic irreversible pulpitis is difficult to achieve in mandibular molars with IANB alone.[3] IANB even when administered properly, has a high chance of clinical failure.[1,4,5] A supplementary injection technique, i.e., buccal infiltration (BI) is usually used in conjunction with IANB to achieve profound pulpal anaesthesia.[6] Therefore, supplemental techniques, like buccal infiltration, intra-osseous, intra-ligamental, intra-pulpal for profound pulpal anaesthesia are recommended.[3]

Lidocaine is widely used standard local anaesthetic agent and considered to be a gold standard. Many investigators have compared Lidocaine with 4% Articaine due to its efficacy, minimal toxicity and short onset of action.[3,7] IANB with buccal infiltration (BI) either with Articaine or Lidocaine injections showed that Articaine was superior (71%) to Lidocaine (29%) in terms of anaesthetic efficacy, i.e., Articaine showed 4 times better results than Lidocaine.[1,8] Kanaa *et al.* also found Articaine to be more effective as compared to Lidocaine in Buccal Infiltration anaesthesia.[9]

Articaine has been recently introduced and used frequently. The success of Articaine might be due to small size of thiophene ring in place of benzene ring and presence of intramolecular hydrogen bond that makes easier penetration in bone.[10–12] Thiophene ring of Articaine has a lipophilic

segment and increased plasma protein binding capacity. This increases its clinical activity and causes it to penetrate the nerve membrane. When buccal infiltration in the mandibular first molar region administered with Articaine, it anesthetizes mental nerve and have a nerve block like effect due to its better penetration in bone and nerve membrane.[8] It has lesser systemic toxicity, i.e., wide therapeutic range than other amides and rapid metabolism about 90% into inactive metabolites.[10,11] It also has an ester ring so that plasma esterase hydrolyzes Articaine in plasma and hepatic microsomal enzymes in the liver. These properties make Articaine better hard and soft tissue diffusion potential than other local anaesthetics.[13]

The study conducted by Meechan also showed that Articaine infiltration produced more effective pulpal anaesthesia compared to mandibular inferior alveolar nerve block.[14,15] Anaesthetic success of Articaine reported by Argueta-Figueroa *et al* as IANB 64.2% in symptomatic irreversible pulpitis as compared to 86.9% in asymptomatic irreversible pulpitis.[16]

Articaine is the centre of heated discussions among dentists due to faster onset and higher anaesthetic efficacy, i.e., 1.5 times superior to that of Lidocaine and other amides used in dental local anaesthesia.[17]

In dental practice, Articaine is newer anaesthetic agent, and variability in its efficacy has been observed.[13] Despite the proven anaesthetic success of Articaine as IANB in irreversible pulpitis, its use is not so common in our region.

This study was planned to provide more profound awareness about Articaine as a local anaesthetic agent. This study was conducted to investigate the anaesthetic efficacy of 4% Articaine and 2% Lidocaine in IANB with BI during the nonsurgical endodontic treatment of mandibular molars with symptomatic irreversible pulpitis. It is expected that the efficacy revealed in this study would enhance the confidence of dentists in opting for a more effective and safer agent in treating Irreversible Pulpitis.

MATERIAL AND METHODS

One hundred and sixty participants with the complaint of pain in mandibular first or second permanent molar reported to Rawal Institute of Health Sciences Islamabad Pakistan, were randomly enrolled in this double-blind study. The CONSORT flow chart was used for the study design and study groups (Figure-1). This project was accepted and approved by the institutional ethical review committee. The study was completed in 6 months (September 2016 to February 2017). Informed verbal and written consent were obtained from all participants and the procedure was explained to them. All clinical steps of procedure performed in the study were in accordance with the ethical standards set by the Helsinki declaration.

Patients with allergy to local anaesthesia, active site of pathology in infected area, premedication (analgesics and antibiotics) during preceding 12 hours and lack of lower lip numbness after IANB were excluded from the study. Both males and females (18–65 years) clinically diagnosed with symptomatic irreversible pulpitis, active pain >54mm on pain scale of Heft-Parker Visual Analogue Scale (HP-VAS), Cold test (Endo-ice, Coltene-Roeko, Langenau, Germany) elicit moderate to severe pain with a prolonged response, positive response to electric pulp test (Denjoy, China) as well as the tooth with a normal periapical radiographic view were included in this study.

The WHO sample size calculator was used to determine sample size. Level of significance (*a*) was set at 5%, power of the test was kept at 80%, anticipated population proportion in Articaine arm of 71%, whereas anticipated population proportion in Lidocaine arm 29%.[1] The sample size in each group was 80 (total 160) with Irreversible Pulpitis were enrolled in the study.

All steps of the procedure were carried out by a single operator. Each patient in the study was requested to rate pain on Heft-Parker Visual Analog Scale. A 170-mm line divided into different categories of pain. Lack of pain corresponds to 0 mm. Faint or weak pain corresponds to >0 mm up to 54 mm categorized as mild pain. Moderate pain corresponds to >54 mm up to 114 mm. Strong or intense pain corresponds to >114 mm up to 170 mm categorized as severe pain. Patients were enquired categorized their pain experienced before the starting of the treatment, after the administration of local anaesthesia, during the preparation of access cavity of tooth and instrumentation of canals. Patients who categorized their pain as moderate to severe pain only were enrolled in the study.

The participants were allocated to Group A and Group B randomly, 1.7 ml of 4% Articaine 1:100,000 epinephrine (Septanest; Septodont, Lancaster, PA) and 1.8 ml of 2% Lidocaine 1:100,000 epinephrine (Huons Co., Ltd. Korea) by computer-generated random number table. Single blinded dental assistant registered all patients and allocated them for intervention. Articaine and Lidocaine anaesthetic cartridges offered to operator were in equal numbers. They had been covered with tape and given a code. Another dental assistant randomly provided the cartridges and was aware of the assigned code. Two cartridges packed together

because IANB and BI anaesthesia were to be administered by using the same anaesthetic cartridge with assigned code. All patients received one cartridge for IANB and one for BI. All anaesthetic injections were performed by using 27-gauge 0.4×42-inch mm (Septodont, France) needle. Before each anaesthetic injection, blood aspiration was performed. Patients with no numbness of lower lip were excluded. Their cartridges were replaced with same code. For patients who reported numbness of lips after 15 minutes of anaesthesia, cold-test was performed on test tooth. If the cold test negative then the tooth was included in the study. The electric pulp test was performed on the test tooth to confirm successful pulpal anaesthesia. Pulpal anaesthesia had been successful after the two-consecutive lack of response to the maximum pulp stimulus of 80 mA has been recorded. The reading of 80 is an endpoint that showed complete pulp anaesthesia for 1 hour.

After the application of the rubber dam (AMD Medicom Inc. Canada H9P2Z2), the clinical procedure was started with access cavity preparation in mandibular molars using round diamond bur #2 (Prima Dental Group GL2 2HA UK). After accessing the canals, the initial filing of canals of mandibular molars was performed with small hand K-file (ULTRA-RCT, NJ 07039 USA) of size #10 and #15 to full working length by watch-winding movement. Sodium hypochlorite irrigation was used. The patients included in our study were requested to categorize the pain on HP-VAS during the access cavity preparation and instrumentation of canals. Successful anaesthesia was defined as lack of pain or not more than mild pain on access cavity preparation of tooth and initial instrumentation of mandibular canals till 1 hour. The pulpectomy procedure was continued. The unsuccessful anaesthesia was classified if the pain was moderate or severe. (HP-VAS score ≥ 54mm)

Data were analysed using SPSS (version 22). Anaesthetic efficacy of Articaine and Lidocaine was compared by Chi-Square test between two study groups. *p*-value ≤0.05 was considered statistically significant.

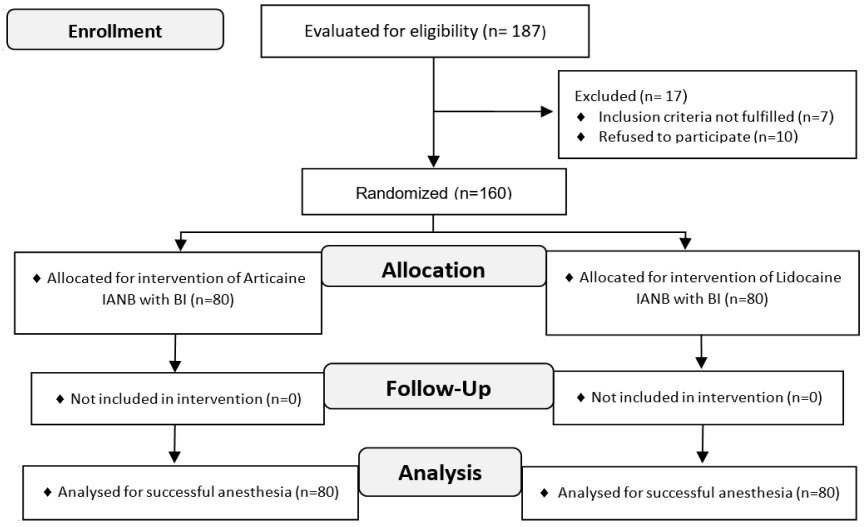

Figure-1: CONSORT flowchart of study design and study groups

RESULTS

The mean age and gender distribution were comparable between the two groups as tabulated in table-1. In group A, first molar 55 (68.8%) and second molar 25 (31.2%) while in group B, first molar 54 (67.5%) and second molar 25 (31.2%) were encountered.

Frequency of the pain observed between the two groups is given in Table 2. 4% Articaine showed successful anaesthesia in 77 (96.2%) cases, i.e., no or mild pain compared to 69 (86.2%) cases in 2% Lidocaine group during access cavity preparation of the tooth. In this way, during access cavity preparation of the tooth, 3 (3.8%) patients in group A and 11 (13.8%) in group B experienced pain and were considered a clinical failure. This difference in pain was statistically significant (*p*-value, 0.025).

During instrumentation of canals, i.e., filing of canals, 4% Articaine showed successful anaesthesia, i.e., no or mild pain (90.0%) as compared to 2% lidocaine (76.2%) group. In group A, during the instrumentation of canals, 8 patients (10.0%) felt pain compared to 19 (23.8%) in group B. This difference was statistically significant between the two groups (*p*-value, 0.020), table-3.

Table-1: Baseline characteristics comparison between two study groups

Variables	Articaine (n=80)	Lidocaine (n=80)	*p*-value
Mean (SD) Age (years)	34.70 (10.5)	33.08 (10.2)	0.32
Gender: number (%) Male Female	 42 (52.5%) 38 (47.5%)	 41 (51.2%) 39 (48.8%)	0.874
Tooth Number: number (%) First Molar Second Molar	 55 (68.8%) 25 (31.2%)	 54 (67.5%) 26 (32.5%)	0.865

Table-2: Comparison of pain on access cavity preparation between two study groups

Efficacy	Articaine (n=80)	Lidocaine (n=80)	*p*-value
Yes	77 (96.2%)	69 (86.2%)	0.025
No	3 (3.8%)	11 (13.8%)	

Table-3: Comparison of pain on the instrumentation of canals between two study groups

Efficacy	Articaine (n=80)	Lidocaine (n=80)	*p*-value
Yes	72 (90.0%)	61 (76.2%)	0.020
No	8 (10.0%)	19 (23.8%)	

DISCUSSION

The objective of this study was to assess anaesthetic success during access cavity preparation of tooth and filing of canals, i.e., instrumentation of canals during root canal treatment. Evaluation of anaesthetic success was carried out using HP-VAS pain scale.[18] The patients anesthetized with Articaine showed higher anaesthetic success compared to patients anesthetized with Lidocaine during access cavity preparation. Similarly, anaesthetic success during instrumentation of canals was found higher in Articaine than in Lidocaine. The difference was statistically significant between Articaine and Lidocaine during access cavity (*p*-0.025) preparation and instrumentation of canals (*p*-0.020).

Previous evidence shows that anaesthetic success of local anaesthesia in nonsurgical endodontic treatment in cases with irreversible pulpitis in mandibular molars was not 100%. Cortical plates of the mandibular bone are denser, thicker and less porous. This causes less amount of local anaesthesia to be penetrated the spongy bone. In local anaesthesia around the inferior alveolar nerve (IAN) before it enters the mandibular canal the anaesthetic efficacy is not 100% due to inferior alveolar nerve anatomical variation with respect to the ramus of the mandible.

In the current study buccal infiltration adjacent to the apices of the mandibular molars after IANB provides pulpal anaesthesia rapidly and effectively till one hour as observed in study carried out by Badr and Aps.[17] This was because the plasma protein binding of Articaine is 95% which is higher than that of lidocaine which is 65%. Higher the protein binding property longer will be the duration of action local anaesthesia.[19]

In the study by Rogers *et al*. Articaine showed higher anaesthetic success (62%) than Lidocaine (37%) in IANB with BI (*p*=0.036).[6] In another study by Ashraf *et al*, anaesthetic success of Articaine was 71% compared to 29% in Lidocaine which shows that Articaine is roughly 4 times more effective as compared to Lidocaine in terms of anaesthetic efficacy.[1]

Kanaa *et al*. in 2012 found that IANB alone does not always produce successful anaesthesia in irreversible pulpitis. Therefore, supplemental injection techniques must be employed. They stated that after the failure of successful anaesthesia, supplemental injections like buccal infiltration should be given. After failed IANB with Lidocaine, buccal infiltration of Articaine provided higher success than any other technique.[20] This proved that buccal infiltration anaesthesia as a supplemental injection after the failure of IANB increases the success of IANB.

Fowler *et al* stated that when IANB fails and buccal infiltration with Articaine administered, the anaesthetic success was 73% still not that successful to achieve complete pulpal anaesthesia so other supplemental injections must be considered.[21] However, a study conducted by Aggarwal et al in 2011 showed that Articaine BI increases the success rate of IANB of lidocaine, however its success was not 100%.[22]

Results of current study were in line with the findings of Jain and Jadhav et al. according to which Articaine is superior to Lidocaine in anaesthetic efficacy.8,16,23 Brandt et al found Articaine 3.8 times more effective than Lidocaine as BI. Kung et al. also found Articaine 3.5 times more successful than Lidocaine in obtaining pulpal anaesthesia after the failure of IANB. These findings are comparable to those of our study.24 Current study is different in that buccal

infiltration was administered immediately in addition to IANB whereas in the studies mentioned above BI and IANB alone were administered in maxilla and mandible respectively. So, it was difficult to draw a conclusive comparison with these studies. In this study IANB with BI provides profound pulpal anaesthesia before starting the procedure and the patient does not experience pain. This can also improve the patient-dentist relationship.

Our study has certain advantages, as it is a randomized clinical trial and a reasonable number of patients were registered in this study. Anaesthetic success was determined during the procedure and there was no need for follow up or recall visits also no specific tools required for testing the efficacy of the anaesthetic agent. Yet there was a certain limitation, as local and systemic adverse effects of Articaine was not examined in recall or follow up visits.

CONCLUSION

The anaesthetic success during access cavity preparation of tooth and instrumentation of canals was higher in the Articaine group compared to Lidocaine in this study. In future, further such studies are required to validate the findings of the current study. For the time being, we suggest that Articaine is a safe and successful as well as widely held anaesthetic agent for dental treatment.

Disclaimer: Information contained in our manuscript submitted for publication is correct. This is an original study and not submitted and published to any other journal at the same time. All co-author has seen, approved the final version of the manuscript and agreed to the submission of a manuscript.

Conflict of interest: There is no conflict of interest and no funding in this research project.

AUTHORS CONTRIBUTION

QK: Literature search, the conceptualization of study design, data collection, manuscript writing. NN: Proofreading, supervised the project. NA: Literature search. TSK: Data analysis and interpretation of results. MA: Critical review of the manuscript.

ACKNOWLEDGEMENT

The authors would like to thank Dr Abdul Samad Khan Associate Professor of Science of Dental Biomaterials, College of Dentistry/the University of Dammam KSA and Dr Muhammad Zubair Nasir Assistant Professor of Community Dentistry, Shifa College of Dentistry Islamabad, Pakistan for his expert advice and encouragement throughout this publication.

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Submitted: July 31, 2020	*Revised: December 13, 2020*	*Accepted: January 12, 2021*

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