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Original Article

Comparison of Anesthetic Effectiveness of Different Volumes of Articaine for Inferior Alveolar Nerve Block In Molar Teeth With Symptomatic Irreversible Pulpitis

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ABSTRACT

Objective: To compare the efficacy of different volumes of articaine in achieving Inferior Alveolar Nerve Block (IANB) anesthesia, in patients diagnosed with symptomatic irreversible pulpitis.

Study Design: Randomized controlled trial (NCT05840913).

Place and Duration of Study: Armed Forces Institute of Dentistry (AFID), Combined Military Hospital (CMH), Rawalpindi, Pakistan, from Dec 2023 to Jan 2024.

Methodology: A total of 78 patients with symptomatic irreversible pulpitis were enrolled in the clinical trial using a double-blind, randomized approach, to receive either 1.8 mL or 3.6 mL of articaine in an inferior alveolar nerve block. Pain levels were assessed using the Visual Analog Scale (VAS) before, during, and after the procedure. A successful anesthesia was defined by minimal or no pain; moderate to severe pain indicated anesthesia failure. Data was analyzed using chi-square and t-tests, with significance set at p-value ≤ 0.05.

Results: Significant differences were observed between the two groups during stages of dentin preparation and pulp chamber opening, with a p-value < 0.001, where Group 2, receiving 3.6 mL of articaine, had a final success rate of 79.49%, significantly higher than the 30.77% observed in Group 1, which received 1.8 mL (p < 0.001). Although there was no significant difference in pain levels 15 minutes after anesthesia (p = 0.387) or during root canal instrumentation (p= 0.185), severe pain was notably higher during the pulp exposure stage in Group 1 (17.95%).

Conclusion: The higher volume of articaine increased the IANB anesthesia effect in mandibular molars among patients with symptomatic irreversible pulpitis.

Keywords: Articaine Inferior alveolar nerve block, Local anesthesia

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INTRODUCTION

Root canal therapy is a procedure in which tissue, inorganic debris, and microorganisms are removed from the pulp chamber and root canals to eradicate infection and symptoms.[1] but providing adequate and profound anesthesia has always been a challenge for dentists, hindering patient satisfaction and comfort during the procedure.[2] Different studies have analyzed the efficacy of various anesthetic solutions during endodontic treatment.[3] but posterior teeth diagnosed with symptomatic irreversible pulpitis are difficult to anesthetize,[4] along with lower molar teeth.[5] The most commonly used technique for mandibular molar anesthesia is the inferior alveolar nerve block (IANB)[6] especially due to its efficacy and safety with Lidocaine, which is safe to use in medically compromised patients, and pregnancy[7]. Recently, articaine has also been approved for usage and various studies have compared the efficacy of lidocaine and articaine and found no significant difference between the two agents [8]. Once the block is administered, the pulpal anesthesia should be confirmed by either a cold test or electronic pulp testing (EPT).[9] as most dentists confuse soft tissue anesthesia with pulpal anesthesia, which merely indicates the correct location of deposition of anesthetic solution rather than pulpal anesthesia while pulpal anesthesia is achieved only if the patient feels no or mild discomfort during the root canal procedure, failing which, volume of anesthetic solution must be increased.[10] Although the majority of studies done in this regard have reported no significant improvement in achieving anesthesia by increasing the volume of solution, all of these studies used lidocaine as an anesthetic agent. This study aimed to compare the efficacy of IANB anesthesia with articaine in patients diagnosed with symptomatic irreversible pulpitis when two different volumes (1.8mL and 3.6mL) of anesthetic solution were used.

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METHODOLOGY

This prospective, randomized double-blind study's procedural and ethics approval was obtained from the Ethics Committee/Institutional Review Board (IRB) of the Armed Forces Institute of Dentistry (AFID), Rawalpindi, via letter no. 918/Trg, dated 13 May 2020 and was registered on clinicaltrials.gov with the name of "Articaine Efficacy for IANB" (NCT05840913) .The minimum sample size was established by using the World Health Organization (WHO) calculator and was estimated to be 78. It was divided into two groups, with 39 participants in each group, with a level of significance 5%, confidence 95%, and power of test 80%. The study enrolled 78 patients requiring endodontic therapy. All the participants received treatment at the Department of Operative Dentistry and Endodontics at AFID from December 1, 2023 to July 31, 2024. The procedure was explained and consent form was signed by each patient. Demographic details were recorded on data collection forms.

Inclusion Criteria: Healthy individuals belonging to either gender, aged 18 to 65 years, with a noncontributory medical history, diagnosis of symptomatic irreversible pulpitis in the 1st or 2nd mandibular molars, VAS pain scores in the range of 4-10, no pathology on periapical radiograph, and no allergy to drugs or dental materials used in the study were included.

Exclusion Criteria: Patients with an allergy to articaine or any other component of local anesthetic, history of medication 12 hours before treatment, pregnancy, lactation or immunocompromised health were excluded.

The patients were randomly divided into two groups of 39 patients each where randomization was done by writing serial numbers on paper in odd and even numbers (1–78), then each patient was handed over a sealed envelope. After opening the envelope, and based on the number (Group A: odd number, 1.8 mL articaine and Group B: even number, 3.6 mL articaine), the patient was allocated to one of the two groups. Before administration of the anesthetic solution, each patient was explained in detail about visual analog pain scale (VAS) and was asked to rate their pain on a self-report questionnaire. The VAS scores were designated as; 0= no pain, 1-3= mild pain, 4-7= moderate pain, and 8-10= severe pain. The principal investigator administered the first local anesthetic injection in both groups, each patient was administered one cartridge of the articaine solution plus a mock injection in Group A and two cartridges in Group B. At the start of procedure, a topical anesthetic gel (20% benzocaine) was passively placed at the injection site for 1 minute. Afterwards, a conventional inferior alveolar nerve block was administered using a self-aspirating syringe and a 27-G 31-mm needle. Ten minutes after the injection, the patients were asked about lower lip numbness. All patients reported experiencing numbness in the lower lip hence no exclusions were made at this stage. Subsequent stages of procedure including electric pulp testing, access cavity preparation and root canal instrumentation were done. The teeth were re-assessed with electric pulp testing fifteen minutes after the administration of the anesthetic solution. If the patients responded positively to testing before caries removal or if higher than mild pain VAS score >3 was recorded at any stage of treatment, then supplemental anesthesia was administered as intraligamentary injection in a fixed volume of 0.2 ml, in accordance with strict protocol, only if necessary, however, the volume used was too low to influence results and the standardized approach made sure that any variations in pain management or treatment outcomes were solely attributable to the main intervention. After rubber dam application, the carious lesion was excavated with a handpiece and burr followed by access cavity preparation. The participants were advised to stop the clinician at any step of the procedure (i.e., caries removal, access cavity preparation, pulp chamber opening, or root canal instrumentation) in case they felt moderate or severe pain. They were then advised to rate the pain they felt on the given VAS sheet. If the patients had not already indicated the occurrence of pain, the clinician stopped after each step of the procedure to inquire about it. If there was no pain or the symptoms were mild (weak, mild pain, or discomfort) anesthesia was considered successful whereas moderate to severe pain was marked as the failure of anesthesia. After the determination of working length during the procedure, root canal preparation was done with Protaper rotary endodontic files (Dentsply). All data was entered for analysis in Statistical Package for the Social Sciences (SPSS) Version 24.0. Descriptive numbers for age, namely, Mean±SD, and categorical variables like gender and pain scores were expressed in percentage. Chi-square test was used to compare categorical variables between the two groups, while an independent-samples t-test was done to compare

quantitative variables while a p-value ≤ 0.05 was considered statistically significant.

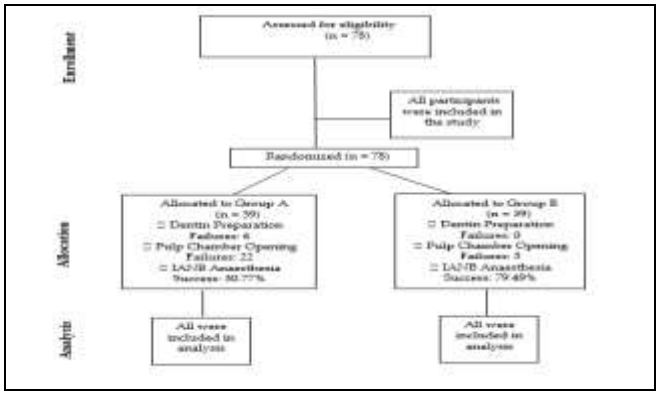

Figure 1: Patient Flow Diagram (n=78)

RESULTS

The mean age in Group 1 and Group 2 was 45.92 ± 9.8 and 46.21 ± 9.5 respectively, as shown in Table-I, with gender distribution across both groups being such that Group 1 constituted 20(51.28%) males and 19(48.72%) females while Group 2 constituted 21(53.85%) males and 18(46.15%) females. No significant difference in age and gender was observed between both groups (p = 0.0898 and p = 0.822 respectively). Side effects such as allergic reaction, cardiovascular reaction or central nervous system reaction, were not observed in any patient included in this study.

Table-I: Demographic Variables of Both Groups (n=78)

Variables	Group 1	Group 2	p-value (≤ 0.05)
Age (years)			
Mean ± SD	45.92±9.8	46.21±9.5	0.898
Range	25-65	30-65	
Gender n (%)			
Male	20(51.28)	21(53.85)	0.822
Female	19(48.72)	18(46.15)	

In Group 1, there were 6 failures in the dentin preparation stage and none in Group 2. During the stage of pulp chamber opening, 22 cases failed in Group 1 and only 5 failures occurred in Group 2. The difference between the groups regarding dentin preparation and pulp chamber opening was statistically significant (p<0.001), however, no significant differences were detected between the two groups 15 minutes after the injection of articaine (p=0.387) and the period of root canal instrumentation (p=0.185). The final result for IANB anesthesia was observed to be 79.49% in Group 2 and 30.77% in Group 1 with a significant difference (p<0.001), as seen in Table II, which provides an overview of the success rate of the anesthesia during different treatment stages.

Table-II: Frequency of Patients with Failed Anesthesia During Endodontic Treatment (n=78)

Treatment Stage	Failed cases n (%)		p-value (≤ 0.05)
	1.8 mL	3.6 mL	
15 minutes	0	0	-
Dentin	6(15.38)	0	<0.001
Pulp	22(56.41)	5(12.82)	<0.001
Instrumentation	7(17.95)	2(5.13)	0.185
Final Success	12(30.77)	31(79.49)	<0.001

Figure 2 shows the percentage of patients who reported different levels of pain during various stages of treatment after receiving anesthesia, where, fifteen minutes after the anesthesia was given, the reports of no pain and mild pain were similar in both groups. From those in Group 1, 48.72% experienced no pain while 51.28% suffered mild pain while Group 2 had 53.85% reporting no pain and 46.15% had mild pain. Majority of patients recorded mild pain during dentin, pulp and instrumentation stages with only Group 1 reporting severe pain during preparation of the access cavity when the pulp was exposed, affecting 17.95% of the patients.

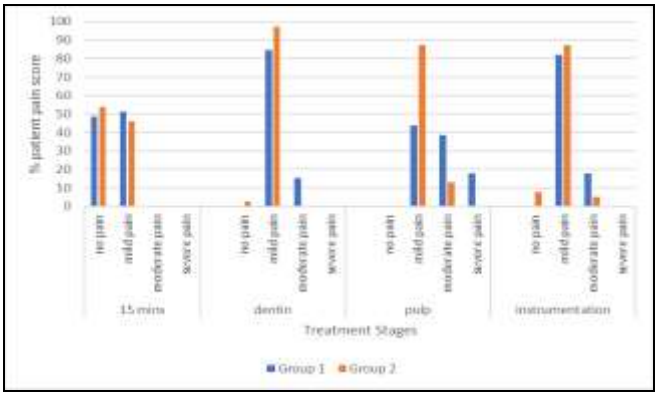

Figure 2: Frequency of Patients Experiencing Pain During Treatment (n=78)

DISCUSSION

The present study noted that the greater volume of articaine (3.6 mL compared to 1.8 mL) in IANB injection in molar teeth having symptomatic irreversible pulpitis, improved the success rate of anesthesia without increasing the risk of adverse effects, which corroborates with previously conducted studies.[11-14] where higher volume of IANB injection

enhanced the success rate of anesthesia. The results demonstrated in one study,[15] also mirror ours such that the overall success rate was nearly 70% for the group with 3.6 mL of articaine administered in comparison with 35% for the other group with 1.8 mL of articaine administered, as the success rate was slightly higher in our study with 79.49% in the 3.6 mL group and 30.77% in the 1.8 mL group. Similar volumes of articaine administered for patients with irreversible pulpitis in their mandibular molar teeth had comparable results, such that the rate of success was 65% in the 3.6 mL group (14.49% less than observed in Group 2 of our study) and 40% in the 1.8 mL group [16]. In comparison to cold testing used by another study[17], we employed the electric pulp test (EPT) which is the gold standard for assessing pulp anesthesia. Additionally, we waited for 15-minutes post-local anesthesia before testing, while other studies have also examined anesthesia success rate 20 minutes post-administration[18]. Our study re-affirms the ability of articaine to enhance anesthesia as compared with lidocaine in patients having symptomatic irreversible pulpitis, where articaine was more effective in comparison with lidocaine in enhancing the IANB injection's success rate [19]. Another study [20] also compared the efficacy of 4% articaine in 1:100,000 epinephrine to 2% lidocaine in 1:100,000 epinephrine for IANB, highlighting the increased efficacy of articaine to achieve successful anesthesia for mandibular molars with symptomatic irreversible pulpitis, which can be attributed to Articaine's ability to diffuse superiorly through the bone. Articaine is also proved to be a more efficient anesthetic agent in comparison with other local IANBs to achieve anesthesia in the mandibular region.[21]

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LIMITATIONS OF STUDY

This study's limitations include variability in mandibular anatomy, clinician injection techniques, subjective pain assessments, and restricted inclusion criteria focused on a specific age group and molars. Standardized training or computer-assisted delivery systems after utilizing advanced imaging modalities could minimize technique differences. Incorporating objective pain measures alongside subjective reports could improve data reliability and expanding the inclusion criteria to a broader age range and different types of teeth could improve generalizability.

CONCLUSION

Higher volume of articaine increases the IANB anesthesia effect in mandibular molars with symptomatic irreversible pulpitis.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

KZ & SMHS: Data acquisition, data analysis, critical review, approval of the final version to be published.

ZMK & HHA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

SH & HR: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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