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Original Article

Anesthetic Efficacy of Supplemental Buccal Infiltration as Compared to Intraligamentary Injection in Treating Mandibular Second Molars with Irreversible Pulpitis

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ABSTRACT

Objective: To compare the anesthetic efficacy of supplemental buccal infiltration (BI) and intraligamentary (IL) injections in treating mandibular second molars with irreversible pulpitis in the Pakistani population.

Study Design: Quasi experimental study.

Place and Duration: Department of Operative Dentistry and Endodontics, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from Apr 2024 to Oct 2024.

Methodology: This study included 100 participants (median age: 30 years) divided into two groups: IL group and BI group. Patients received standardized local anesthesia protocols, and pain levels were recorded using the Visual Analog Scale (VAS). Pain levels were classified as mild, moderate, or severe, and the success rate of anesthesia was evaluated.

Results: The IL group showed significantly lower pain levels (median VAS: 38.00(31.00–41.00)) compared to the BI group (median VAS: 65.50(40.00–87.00)). Severe pain was reported by 21(42.0%) participants in the BI group versus none in the IL group (p<0.001). The IL technique had a higher success rate of 45(90.0%) compared to 22(44.0%) in the BI group (p<0.001), indicating its superior efficacy.

Conclusion: Intraligamentary injections with 4% Articaine provide more effective anesthesia and higher success rates compared to buccal infiltrations for mandibular second molars with irreversible pulpitis. These findings suggest that IL injections are a preferable supplemental technique for profound anesthesia in such cases. Further studies are recommended to validate these findings.

Keywords: Anesthetic efficacy, Buccal infiltration, Intraligamentary injection, Irreversible pulpitis, Mandibular molars, Visual Analogue Scale.

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INTRODUCTION

Despite the significant strides made in endodontic therapy, achieving effective anesthesia in patients with irreversible pulpitis remains a challenge for many clinicians.[1] The ability to eliminate pulpal pain is crucial in alleviating patients' fear of undergoing endodontic procedures.[2] The primary goal of any endodontist is to relieve the acute pain experienced by patients, whether it stems from pulpal or periapical origins. Mastery of various local anesthetic techniques is essential in addressing this persistent issue.[3] Achieving profound anesthesia in teeth affected by irreversible pulpitis is notably more difficult compared to anesthetizing healthy mandibular molars.[4,5] Research indicates that block anesthesia alone tends to be less effective in providing adequate anesthesia for mandibular molars.[6] Several factors contribute to local anesthetic failure, including anatomical variations, decreased local pH, rapid desensitization of the anesthetic, and activation of nociceptors and associated central mechanisms.[7] Therefore, exploring alternative methods to achieve profound anesthesia in mandibular molars with irreversible pulpitis is crucial.

Numerous studies have proposed various alternative methods to alleviate the discomfort and pain experienced by patients during endodontic treatments. These methods include the use of supplementary injections, such as buccal infiltrations (BI), intraligamentary (IL), intraosseous (IO), and intrapulpal injections.[8,9]

Buccal infiltration is commonly employed as an adjunct to IANB in the mandibular region. While it achieves predictable results in maxillary teeth due to their thinner cortical plates, the same cannot be said for mandibular teeth. As a supplemental method, buccal infiltration can increase the success rate of anesthesia by delivering the anesthetic solution close to the apex of the tooth.[10]

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In contrast, intraligamentary injection involves delivering the anesthetic solution directly into the periodontal ligament, ensuring rapid diffusion into the surrounding cancellous bone. This method provides several advantages, including quick onset, minimal impact on adjacent soft tissues, and localized anesthesia without widespread numbness.

The aim of this study is to analyze the anesthetic efficacy of supplemental buccal infiltration compared to intraligamentary injection in treating mandibular second molars with irreversible pulpitis in the Pakistani population. Achieving anesthesia in second molars can be challenging due to the thick buccal cortical plate. Research on this specific topic is scarce within our population.

METHODOLOGY

This Quasi experimental study received approval from the Institutional Ethical Committee of Armed Forces Institute of Dentistry, Rawalpindi (letter no. 918/Trg dated 13 May 2020). Patients referred for nonsurgical root canal treatment at the Operative Dentistry and Endodontics department were chosen for this study. The study spanned six months, from April 2024 to October 2024. Sample size (n=24; 12 in each group) was calculated using the WHO sample size calculator. Parameters used were the mean pain scores of 41.56±3.88 and 51.67±7.41 in BL and IL groups respectively[11] power of study was kept at 90% and margin of error at 5%. However, we screened 120 participants and the final recruited sample was 110 (55 in each group).[10] participants were excluded from final analysis and 100 (50 in each group) participants were analysed for result.

Inclusion Criteria: Patients requiring primary root canal treatment for irreversible pulpitis with normal periodontium in mature mandibular second molars, with age ranging from 18 to 49 years, pulpal status was confirmed through cold and electrical pulp tests, along with bleeding in the pulp chamber.

Exclusion Criteria: Patients with diabetes, immunocompromised conditions, pregnancy, recent analgesic (within 3 days) or antibiotic (within a month) use, and teeth that were periodontally compromised, previously accessed, or unsuitable for rubber dam isolation.

After obtaining informed consent, patients were assigned by the assistant to one of two groups according to the supplemental injection technique, IL and BI group, Using a computer-generated sequence created in Microsoft Excel with the =RAND function to ensure equal allocation in each group and to control bias.

All treatments were conducted by a single operator (N.V.), a second-year resident at the Department of Operative Dentistry and Endodontics, who has two years of clinical experience. Patients received local anesthesia through an inferior alveolar nerve block using 1.8ml of 2% Lidocaine with 1:100,000 Epinephrine (Septodont, USA). In IL group 0.2 ml of 4% Articaine with 1:100,000 Epinephrine (Septodont, USA) in each mesial and distal part of the tooth using a 30-gauge short needle (Septodont, USA) was given. In BI Group injection of 1.7 ml 4% Articaine with 1:100,000 epinephrine (Septodont, USA) in the buccal vestibule alongside the second molar using a 30-gauge short needle (Septodont, USA) was administered. After isolating the tooth with a rubber dam, caries were removed, and the access cavity was prepared. The pulp chamber was cleaned, and the working length was determined using an electronic apex locator (Root ZX, J Morita, Tokyo) with a size 15 K-file. The file was advanced until "APEX" appeared, then retracted to the flashing bar between “APEX” and “1,” where the working length was recorded. The working length was subsequently confirmed with a periapical radiograph.

Root canal preparation was done using Protaper Gold rotary files (Dentsply, USA). An electric endomotor (X-Smart Dentsply, Switzerland) was used for rotary preparation with recommended speed (300 rpm), torque (2.5 Ncm), and motion (clockwise rotation) settings. 5 mL of 2% NaOCl (Cerkamed, Poland) was used for irrigation after each instrument change. Irrigation was performed with a 30-gauge side-vented irrigation needle (PD, Switzerland). After canal preparation, canals were irrigated with 5 mL of 17% EDTA (PD, Switzerland) for 1 minute, followed by Normal saline and a final rinse with 5 mL of 2% NaOCl for 1 minute. The canals were dried using absorbent paper points (Dentsply, USA) and obturated with the lateral condensation technique, employing gutta-percha (Dentsply, USA) and a resin-based sealer (Dentsply, USA) applied with a lentulo spiral (Dentsply, USA). Following obturation, the cavity was permanently restored with a composite resin restoration (Coltene, Switzerland), and a postoperative radiograph was obtained. Occlusion was checked with articulating paper (PD, Switzerland) to prevent postoperative pain due to high-spot.

In this study, the primary outcome assessed was the effectiveness of the supplemental anesthetic techniques in reducing pain during endodontic procedures of second mandibular molar with irreversible pulpitis. For pain assessment, patients recorded their perioperative pain levels using a visual analog scale-(VAS) following the procedure, where 0 indicated no pain and 10 indicated maximum pain. Patients returned the completed Data collection. Pain levels were classified into mild (1–3), moderate (4–6), and severe (7–10) to aid in clinical interpretation. No pain and mild pain during procedure was regarded as successful anaesthesia whereas moderate and severe pain where regarded as failed anaesthesia.

Data entry and analysis was done on statistical software, the Statistical Package for Social Sciences (SPSS) version 28:00. Categorized data was presented as frequency and percentage and based upon data normality, median and interquartile ranges were reported for age and VAS score. Chi-square was applied to compare the frequencies across IL and BI groups, while Mann Whitney U test was applied to compare age and VAS score with level of significance was kept as $p<0.05$.

RESULTS

The study involved 100 participants with a median age of 30 years (IQR: 24.00–38.75 years), comprising 60(60.0%) males and 40(40.0%) females. Two supplemental injection techniques, Buccal Infiltration and Intraligamentary, were used equally, each in 25(50%) of the cases. Pain levels varied, with the majority of participants 67(67.0%) reported no or mild pain, while 33(33.0%) experienced moderate or severe pain. The Visual Analogue Score (VAS) had a median value of 40.50 (IQR: 36.00–72.75), reflecting a range of pain intensities. The success rate of the procedure was observed in 67(67%) of the participants (Table-I).

Table I: Baseline Characteristics and Outcome of the Study Sample (n=100)

Variables		Median (IQR)
Age		30.00(24.00-38.75)
Visual Analogue Scale Score		40.50(36.00-72.75)
	Frequency (%)	
Gender	Male	60(60.0%)
	Female	40(40.0%)
Injection	Buccal Infiltration	50(50.0%)
	Intraligamentary	50(50.0%)
Pain	No and mild pain	67(67.0%)
	Moderate and Severe Pain	33(33.0%)
Outcome	Success Rate	67(67.0%)

The pain distribution is further depicted in the bar chart, which shows that most participants 64(64.0%) experienced mild pain, followed by 21(21%) with severe pain, 12(12%) with moderate pain, and only 3(3.0%) reporting no pain. These findings highlight that the majority of participants had low pain intensity, aligning with the overall success rate of the procedure (Figure-2).

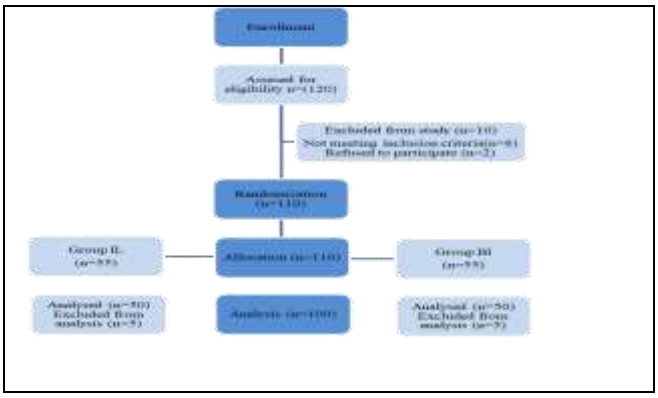

Figure-1: Flow Diagram of Participants' Allocation Process

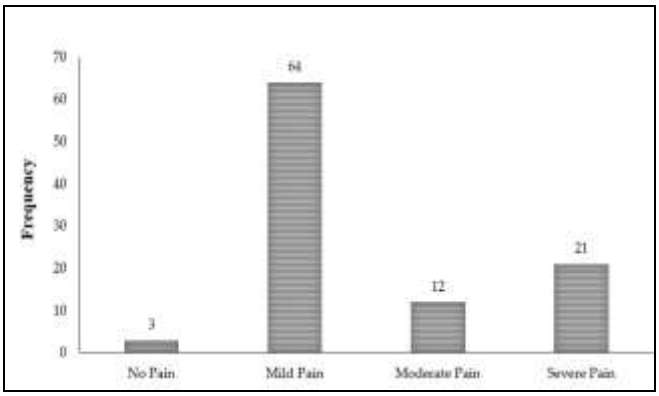

Figure 2: Distribution of Pain Intensity Levels in the Study Sample (n=100)

The table-II compares the characteristics, pain levels, and outcomes between the IL and BI groups. The median age was almost similar between the groups, with 30 years (IQR: 24.00–37.00 years) in the IL group and 31 years (IQR: 23.00–40.00 years) in the BI group ($p=0.521$). The Visual Analogue Score was significantly lower in the IL group compared to the BI group [median (IQR): 38.00(31.00–41.00) vs 65.50(40.00–87.00); $p<0.001$], indicating less pain in the IL group.

Gender distribution showed a higher percentage of males in the IL group [34(68.0%) vs. 26(52.0%)] compared to the BI group, while females comprised 16(32.0%) and 24(48.0%) in the respective groups

(p=0.153). Pain intensity levels revealed significant differences between the groups (p<0.001). In the IL group, 45(90.0%) experienced no/mild pain, with only 5(10.0%) experiencing moderate pain/severe. In contrast, in the BI group, 22(44.0%) reported no/mild pain, 28(56.0%) had moderate/severe pain. The success rate was significantly higher in the IL group, with 45(90.0%) achieved successful outcomes compared to 22(44.0%) in the BI group (p<0.001). These findings suggest that the Intraligamentary supplemental technique is associated with lower pain levels and a higher success rate compared to Buccal Infiltration.

Table-II: Comparison of Demographics, Pain Levels, and Outcome between Study Groups (n=100)

Variables		Group-IL (Total=50)	Group-BI (Total=50)	*p*-value
Age (years) Median(IQR)		30.00(24.00 -37.00)	31.0(23.00-40.00)	0.521
Visual Analogue Scale Score Median(IQR)		38.00(31.00 -41.00)	65.50(40.00 -87.00)	<0.001
Gender	Male	34(68.0%)	26(52.0%)	0.153
	Female	16(32.0%)	24(48.0%)	
Pain	No/Mild Pain (0-44)	45(90.0%)	22(44.0%)	<0.001
	Moderate/ Severe Pain (45-100)	5(10.0%)	28(56.0%)	
Outcome	Successful	45(90.0%)	22(44.0%)	<0.001
	Not Successful	5(10.0%)	28(56.0%)	

DISCUSSION

This study demonstrates that the intraligamentary (IL) injection technique is more effective than buccal infiltration (BI) for achieving anesthesia in mandibular second molars with irreversible pulpitis in a Pakistani population. Among the 100 participants (median age: 30 years, 60% male, 40% female), 67% experienced no or mild pain, and the IL group showed significantly lower Visual Analog Scale (VAS) scores (median: 38) compared to the BI group (median: 65.50). The IL technique had a success rate of 90%, notably higher than BI's 44%, confirming its superiority in providing profound anesthesia and reducing pain. These findings suggest that IL injection could be a more reliable technique for endodontic procedures requiring profound pulpal anesthesia in challenging cases.

Research indicates that the success rates of supplemental buccal infiltrations (BI) following inferior alveolar nerve block (IANB) vary between 42% and 88%.[12-14] The success rate of supplemental intra-ligamentary (IL) injections during endodontic treatments ranges from 50% to 96%.[15]

Our findings align with previous studies. Parirokh *et al*.[16] observed that a combination of IL + BI + IANB achieved a 58% success rate, significantly higher than the 22% success rate for standard IANB alone. Our study also found that combining techniques, such as IL, yielded a higher success rate, although our success rates for individual techniques (90% for IL) were higher than those reported by Parirokh et al.[16]

Shahi et al.[17] demonstrated success rates of 75% for IANB + IL and 65.6% for IANB + BI, compared to 28.1% for standard IANB. Our results corroborate the higher efficacy of IL (90%) over BI (44%) in achieving profound anesthesia, with the IL technique showing superior results in both studies.

Fan et al.[18] reported anesthetic success rates of 81.48% for IANB + BI and 83.33% for IANB + PDL, higher than our BI results but in line with the trend of achieving better outcomes with combination techniques. Our study, however, focuses on the isolated efficacy of IL and BI techniques rather than combinations, highlighting IL's superiority in our specific context.

Comparisons with Zargar *el al*.[19] study reveal some differences; while their study found no significant difference between IL (80%) and BI (74%) overall, they reported higher IL efficacy in second molars (92% vs. 64% for BI), which is consistent with our findings. Unlike Zargar's study, we did not assess physiological responses like pulse rate variations. However, our study provides a more focused analysis on second molars, strengthening the evidence for IL's effectiveness in achieving profound anesthesia in this specific context.

Dias Junior *et al*.[20] systematic review of fourteen anesthetic methods highlighted the superior effectiveness of the Vazirani-Akinosi nerve block (VANB) and intraosseous injection (IOI) compared to IANB. Additionally, their findings supported the enhanced efficacy of BI combined with IANB (BI+IANB). While our study did not evaluate VANB or IOI, the results align in emphasizing the need for supplementary techniques to improve anesthesia success rates. The review underscores that combination techniques improve outcomes, and our study further builds upon this premise by highlighting IL effectiveness in second molars.

However not all studies align with these findings Kanaa *et al*.[21] reported higher success rates with alternative techniques like accessory buccal infiltration (ABI) and intraosseous (IO) injections, anesthetic success was evaluated via electric pulp testing and not through pain scales whereas our study found IL to be more effective than BI and evaluated anesthetic success via pain scales. These conflicting findings highlight the need for further research on efficacy of supplemental anesthesia and teeth affected with irreversible pulpitis.

The clinical relevance of these findings is significant for practitioners managing cases of irreversible pulpitis in mandibular second molars. The higher success rate of IL injection suggests its potential as a primary technique, particularly in cases where conventional IANB proves insufficient. Moreover, considering previous reports of IL injection's safety and ease of administration, its broader application in endodontics should be further examined.

CONCLUSION

In conclusion, our study reinforces the superior efficacy of the IL injection technique for mandibular second molars with irreversible pulpitis, particularly in the Pakistani population. These findings contribute to the growing evidence that tailored anesthetic approaches are essential for optimizing clinical outcomes in endodontic treatments. Future research should focus on further comparing IL with other advanced anesthetic techniques, evaluating long-term patient outcomes, and exploring modifications to further enhance its efficacy and comfort.

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Authors' Contribution

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

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

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

TK & NA: 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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