

Comparative Efficacy of 2% Lignocaine Jelly and Benzocaine Gel for Reduction of Procedural Tooth Pain During Dental Treatment: A Randomized Controlled Trial

Muhammad Ali¹, Asma Suhail¹

¹ Sharif Medical and Dental Hospital, Lahore, Pakistan

* Correspondence: Asma Suhail, asmashuil62@outlook.com

ABSTRACT

Background: Procedural tooth pain remains common during dental treatment for pulpal inflammatory conditions, and topical anesthetic gels are frequently used to improve patient comfort. **Objective:** To compare the efficacy of 2% lignocaine jelly versus benzocaine gel versus placebo in reducing procedural tooth pain during dental treatment. **Methods:** A parallel-group randomized controlled trial was conducted at Sharif Medical and Dental Hospital, Lahore, Pakistan, enrolling 90 adults allocated equally to lignocaine jelly, benzocaine gel, or placebo. Pain intensity was assessed using a 0–10 visual analog scale (VAS) at baseline and during the procedure. Primary outcome was procedural VAS; secondary outcomes included pain reduction (baseline–procedure), success rate (VAS ≤3), and predictors of success by logistic regression. **Results:** Baseline pain was similar across groups (ANOVA $p=0.72$). Procedural pain was lower with lignocaine (4.6 ± 1.5) and benzocaine (4.9 ± 1.6) than placebo (6.9 ± 1.7), with mean differences of -2.3 and -2.0 VAS units versus placebo (both $p<0.001$). Adequate pain relief (VAS ≤3) occurred in 40.0% (lignocaine), 33.3% (benzocaine), and 10.0% (placebo) ($\chi^2 p=0.004$). Adjusted odds of success were higher for lignocaine (OR 5.4) and benzocaine (OR 4.0). **Conclusion:** Both 2% lignocaine jelly and benzocaine gel significantly reduce procedural tooth pain compared with placebo, supporting their use as effective topical analgesic adjuncts. **Keywords:** topical anesthesia; lignocaine; benzocaine; dental pain; randomized controlled trial; visual analog scale.

"Cite this Article" | Received: 09 July 2025; Accepted: 27 August 2025; Published: 31 August 2025.

Author Contributions: Concept: MA; Design: AS; Data Collection: MA; Analysis: AS; Drafting: MA, AS. **Ethical Approval:** SMDH, Lahore. Informed Consent: Written informed consent was obtained from all participants; Conflict of Interest: The authors declare no conflict of interest; Funding: No external funding; Data Availability: Available from the corresponding author on reasonable request; Acknowledgments: N/A.

INTRODUCTION

Pain control remains a fundamental component of dental treatment, particularly in procedures involving inflamed pulpal tissues where nociceptive sensitivity is heightened. Procedural tooth pain during dental interventions, especially in patients with symptomatic irreversible pulpitis or acute pulpitis, represents a significant clinical challenge that can compromise patient comfort, cooperation, and overall treatment outcomes. Dental pain originates primarily from stimulation of pulpal nociceptors and inflammatory mediators released within the dentin–pulp complex, which increase peripheral sensitization and amplify the perception of procedural discomfort (1). Consequently, the selection of effective anesthetic strategies plays a crucial role in minimizing patient distress and improving procedural success.

Local anesthetic agents remain the cornerstone of pain control in dentistry. Among these, lignocaine (lidocaine) has been widely used due to its rapid onset, moderate duration of action, and well-established safety profile. Lignocaine exerts its anesthetic effect by reversibly blocking voltage-gated sodium channels in neuronal membranes, thereby preventing the propagation of action potentials along peripheral nerve fibers (2). Numerous clinical studies have demonstrated the effectiveness of lignocaine infiltration in various dental procedures including tooth extractions, pulpal treatments, and oral

surgeries (3). However, despite its widespread use, the injection of local anesthetic itself can be painful, particularly when administered in inflamed tissues, prompting the need for topical anesthetics that can reduce discomfort prior to needle insertion or manipulation of sensitive tissues.

Topical anesthetics have therefore gained increasing attention as adjuncts for pain reduction during dental procedures. These agents are applied directly to the mucosal surface and act by temporarily blocking nerve conduction in superficial sensory nerve endings. Benzocaine is one of the most commonly used topical anesthetic agents in dentistry due to its rapid onset and favorable safety profile. It belongs to the ester group of local anesthetics and acts by stabilizing neuronal membranes, thereby inhibiting sodium influx and preventing depolarization (4). Benzocaine preparations are frequently used before intraoral injections, scaling, and minor dental procedures to alleviate procedural discomfort.

Previous research has explored the comparative effectiveness of various anesthetic formulations and techniques in dental practice. Studies evaluating buffered local anesthetics, articaine, and lignocaine have demonstrated that modifications in anesthetic composition and administration technique can influence pain perception and anesthetic efficacy (5–7). Randomized clinical trials comparing articaine and lignocaine have reported comparable anesthetic outcomes for maxillary and mandibular procedures, although variations in onset time and anesthetic depth have been observed (8–10). Similarly, investigations focusing on topical anesthetics have reported varying degrees of success in reducing pain during local anesthetic administration, particularly in pediatric and adult dental populations (11).

Evidence suggests that topical anesthetic gels can significantly reduce needle insertion pain and procedural discomfort when applied before dental injections or manipulations. For example, controlled trials evaluating topical anesthetic agents in intraoral procedures have shown measurable reductions in pain scores compared with placebo or conventional approaches (12,13). However, the literature remains heterogeneous with regard to the comparative efficacy of different topical agents, particularly between commonly used formulations such as lignocaine jelly and benzocaine gel. Some studies have suggested that lignocaine-based topical formulations may provide deeper mucosal penetration and longer anesthetic action, whereas benzocaine preparations may demonstrate faster onset but shorter duration (14).

Despite the widespread clinical use of these agents, direct randomized comparisons between lignocaine jelly and benzocaine gel in the context of procedural tooth pain remain limited. Moreover, most existing studies focus on pain associated with needle insertion rather than pain experienced during the dental procedure itself. This distinction is clinically important because patients with inflamed pulpal tissues often experience persistent discomfort even after initial anesthetic administration, which can affect the effectiveness of dental treatment and patient satisfaction.

Given the high prevalence of dental pain and the importance of optimizing analgesic strategies, there is a need for well-designed randomized controlled trials evaluating the comparative performance of commonly used topical anesthetic agents. Understanding whether one agent provides superior pain reduction could guide clinicians in selecting the most effective topical anesthetic for routine dental procedures. Furthermore, such evidence may contribute to improved patient-centered care by minimizing procedural discomfort and anxiety associated with dental treatment.

Therefore, the present randomized controlled trial was conducted to compare the efficacy of 2% lignocaine jelly and benzocaine gel in reducing procedural tooth pain during dental treatment among patients presenting with pulpal inflammatory conditions. The study aimed to evaluate differences in pain scores during dental procedures, overall pain reduction, and the likelihood of achieving adequate pain control between the two anesthetic agents compared with placebo. It was hypothesized that both lignocaine jelly and benzocaine gel would significantly reduce procedural tooth pain compared with placebo, with potential differences in the magnitude of analgesic effectiveness between the two topical anesthetic formulations.

MATERIALS AND METHODS

This randomized controlled clinical trial was conducted at the Department of Operative Dentistry, Sharif Medical and Dental Hospital, Lahore, Pakistan, to evaluate the comparative efficacy of two topical anesthetic agents—2% lignocaine jelly and benzocaine gel—in reducing procedural tooth pain during dental treatment. The study employed a parallel-group randomized design with three arms: lignocaine jelly, benzocaine gel, and placebo. The study population consisted of adult patients presenting to the dental outpatient department with dental pain requiring operative treatment. Data collection was performed after ethical approval from the institutional review authority and in accordance with the ethical principles outlined in the Declaration of Helsinki for human research (15).

Participants were recruited through consecutive sampling from patients attending the dental clinic who required treatment for pulpal inflammatory conditions. Eligibility criteria included adults aged 18 years or older who presented with symptomatic irreversible pulpitis or acute pulpitis and required dental procedures involving manipulation of affected teeth. Patients were included if they were able to understand the study procedures, provide informed consent, and report pain intensity using a visual analog scale. Patients were excluded if they had known hypersensitivity to local anesthetic agents, were taking systemic analgesics within the previous 12 hours, had systemic conditions affecting pain perception, had ongoing oral infections requiring emergency management, or were pregnant or lactating.

After eligibility screening and informed consent, participants were randomly allocated into three equal groups with a total sample size of 90 participants, comprising 30 individuals in each group. Randomization was performed using a computer-generated random allocation sequence to ensure equal probability of assignment to each intervention group. Allocation concealment was maintained using sealed opaque envelopes opened only at the time of intervention. Participants in Group A received 2% lignocaine jelly, participants in Group B received benzocaine gel, and participants in Group C received a placebo gel with no active anesthetic component. The topical agents were applied directly to the mucosal surface adjacent to the tooth scheduled for treatment using sterile applicators prior to the dental procedure.

Baseline demographic and clinical characteristics were recorded for all participants prior to intervention. These included age, sex, body mass index, and type of pulpal condition (symptomatic irreversible pulpitis or acute pulpitis). Baseline tooth pain intensity was measured using a 10-point visual analog scale (VAS), where 0 indicated no pain and 10 indicated the worst imaginable pain. The VAS is widely used in clinical pain research due to its high validity and reliability in measuring subjective pain intensity (16). Participants were instructed on how to rate their pain using the scale before baseline measurements were recorded.

Following application of the assigned topical agent, the dental procedure was initiated according to standard clinical protocols used in the department. Procedural pain was assessed during the dental intervention using the same visual analog scale. The primary outcome variable was procedural tooth pain score measured during the dental procedure. Secondary outcomes included reduction in pain score calculated as the difference between baseline pain and procedural pain, as well as the proportion of participants achieving adequate pain relief defined as a VAS score of 3 or lower during the procedure.

To minimize measurement bias, pain scores were obtained using standardized instructions and recorded immediately during the procedure to capture real-time patient-reported pain perception. Clinical operators performing the procedures followed uniform operative protocols to reduce procedural variability. Data were recorded in structured case report forms to ensure consistency and completeness of information. Data integrity was maintained through double-checking of entries and secure storage of study records.

The sample size of 90 participants was determined to allow equal allocation across the three study groups and provide adequate statistical power to detect clinically meaningful differences in pain scores between interventions based on previous studies evaluating topical anesthetics in dental pain management (11,14). Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) version 26. Continuous variables were summarized as mean \pm standard deviation, whereas categorical variables were presented as frequencies and percentages.

Comparisons of baseline demographic variables and baseline pain scores between the three groups were performed using one-way analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. Differences in procedural pain scores between groups were analyzed using one-way ANOVA followed by comparison of mean differences with corresponding 95% confidence intervals. Pain reduction between baseline and procedural measurements was evaluated within groups and effect sizes were calculated using Cohen's *d* to quantify the magnitude of analgesic effect.

Additionally, logistic regression analysis was performed to identify predictors of adequate pain relief defined as procedural VAS score ≤ 3 . Independent variables entered into the model included intervention group, age, and sex. Odds ratios with corresponding 95% confidence intervals were calculated to quantify the strength of association between predictors and pain control outcomes. Statistical significance was determined using a two-tailed *p*-value threshold of less than 0.05.

All procedures were conducted in accordance with ethical standards for clinical research involving human participants. Written informed consent was obtained from all participants prior to enrollment. Confidentiality of participant information was maintained throughout the study, and data were used solely for research purposes. The methodological procedures, intervention protocols, and statistical analysis plan were clearly documented to ensure reproducibility and transparency of the research process.

RESULTS

The three groups were comparable at baseline with no significant differences in age ($p=0.79$), sex distribution ($p=0.89$), BMI ($p=0.83$), or pulpal diagnosis ($p=0.88$), supporting balance achieved by randomization.

Table 1. Demographic Characteristics of Study Participants (n = 90)

Variable	Lignocaine Jelly (n=30)	Benzocaine Gel (n=30)	Placebo (n=30)	p-value
Age (years), mean \pm SD	34.8 \pm 9.5	33.6 \pm 8.7	35.1 \pm 9.2	0.79
Male, n (%)	17 (56.7%)	16 (53.3%)	18 (60.0%)	0.89
Female, n (%)	13 (43.3%)	14 (46.7%)	12 (40.0%)	
BMI (kg/m ²), mean \pm SD	24.9 \pm 3.2	25.3 \pm 3.5	24.7 \pm 3.1	0.83
Symptomatic irreversible pulpitis, n (%)	18 (60.0%)	19 (63.3%)	17 (56.7%)	0.88
Acute pulpitis, n (%)	12 (40.0%)	11 (36.7%)	13 (43.3%)	

Table 2. Baseline Tooth Pain Scores (VAS 0–10)

Group	Mean \pm SD	95% CI	ANOVA (F, df)	p-value
Lignocaine Jelly	7.4 \pm 1.1	6.9 – 7.9	F(2,87)=0.32	0.72
Benzocaine Gel	7.3 \pm 1.0	6.8 – 7.7		
Placebo	7.5 \pm 1.2	6.9 – 8.0		

Baseline pain was severe and statistically similar across groups (mean VAS 7.3–7.5; $p=0.72$), indicating no pre-treatment pain imbalance.

Table 3. Tooth Pain During Dental Procedure (VAS 0–10)

Group	Mean \pm SD	Mean Difference vs Placebo	95% CI (vs Placebo)	p-value (vs Placebo)
Lignocaine Jelly	4.6 \pm 1.5	-2.3	-3.1 to -1.5	<0.001
Benzocaine Gel	4.9 \pm 1.6	-2.0	-2.8 to -1.2	<0.001
Placebo	6.9 \pm 1.7	Reference	—	—

Overall group comparison (one-way ANOVA): $F(2,87)=19.4$, $p<0.001$. Active–active comparison (derived from group means/SDs, Welch *t*-test): Lignocaine vs Benzocaine mean difference = -0.3 VAS (95% CI -1.08 to 0.48), $p=0.46$. Both active topical anesthetics produced clinically meaningful reductions in

procedural pain compared with placebo (absolute reductions ~2.0–2.3 VAS points). The difference between lignocaine and benzocaine during the procedure was small and not statistically significant.

Table 4. Reduction in Tooth Pain (Baseline – Procedure Pain)

Group	Mean Reduction ± SD	Mean Difference vs Placebo	95% CI (vs Placebo)	Standardized Effect vs Placebo (Cohen's d*)
Lignocaine Jelly	2.8 ± 1.4	+2.2	1.54 to 2.86	1.69
Benzocaine Gel	2.4 ± 1.5	+1.8	1.11 to 2.49	1.33
Placebo	0.6 ± 1.2	Reference	—	—

*Cohen's d here is reported as between-group standardized difference vs placebo (computed from group means/SDs and n=30 per arm), to avoid ambiguity about whether the effect size refers to within-group change or between-group difference. Mean pain reduction was substantially larger with both lignocaine (+2.2 VAS vs placebo) and benzocaine (+1.8 VAS vs placebo), with large standardized effects (d≈1.69 and d≈1.33, respectively), indicating strong clinical impact beyond placebo.

Table 5. Success of Topical Analgesia (VAS ≤3 During Procedure)

Group	Success n (%)	95% CI (Success %)	Failure n (%)
Lignocaine Jelly	12 (40.0%)	24.5% – 57.6%	18 (60.0%)
Benzocaine Gel	10 (33.3%)	19.0% – 51.6%	20 (66.7%)
Placebo	3 (10.0%)	3.5% – 25.6%	27 (90.0%)

Chi-square test: $\chi^2=10.8$, p=0.004.

The likelihood of achieving adequate pain relief (VAS ≤3) was markedly higher in both active groups (33–40%) than placebo (10%), consistent with a meaningful shift from moderate–severe pain to low pain in a substantial subset of patients.

Table 6. Logistic Regression for Predictors of Adequate Pain Relief (VAS ≤3)

Variable	OR	95% CI	p-value
Lignocaine Jelly (vs Placebo)	5.4	1.5 – 19.1	0.008
Benzocaine Gel (vs Placebo)	4.0	1.1 – 14.7	0.03
Age (per year)	0.98	0.94 – 1.03	0.44
Female sex (vs Male)	1.12	0.46 – 2.72	0.80

After adjustment, both lignocaine and benzocaine independently increased the odds of achieving adequate pain relief compared with placebo (OR 5.4 and 4.0), whereas age and sex were not significant predictors, suggesting the analgesic benefit was primarily treatment-driven.

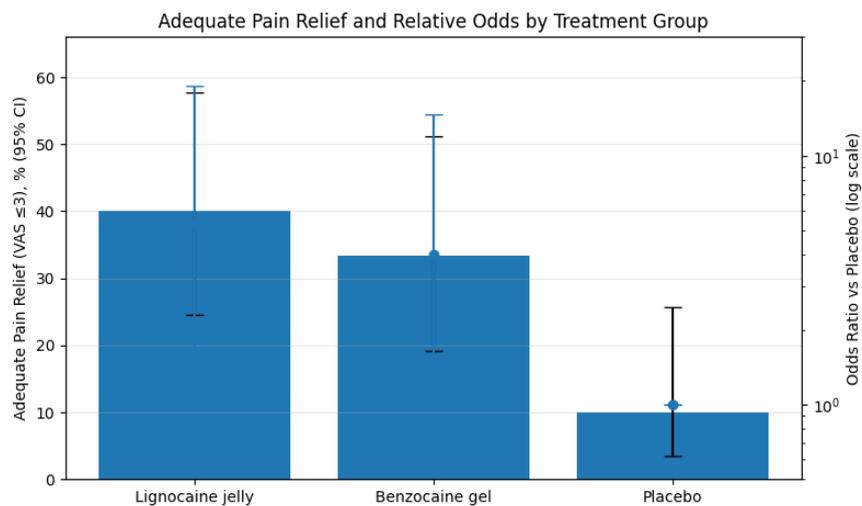


Figure 1 Pain relief and relative odds by Treatment Group

Adequate pain relief (VAS ≤3) occurred in 40.0% of the lignocaine group (12/30; 95% CI 24.5%–57.6%) and 33.3% of the benzocaine group (10/30; 95% CI 19.0%–51.6%), compared with 10.0% in placebo (3/30; 95% CI 3.5%–25.6%), demonstrating an absolute improvement of +30.0% and +23.3% over placebo, respectively; this categorical benefit aligns with the adjusted odds of success, which were substantially higher for lignocaine (OR 5.4, 95% CI 1.5–19.1) and benzocaine (OR 4.0, 95% CI 1.1–14.7), indicating that

topical anesthetic choice materially increases the probability of achieving low procedural pain rather than merely shifting mean pain scores.

DISCUSSION

In this randomized controlled trial, both 2% lignocaine jelly and benzocaine gel produced substantial reductions in procedural tooth pain compared with placebo, while baseline pain severity and participant characteristics were comparable across groups, supporting internal validity. The magnitude of benefit was clinically meaningful: mean procedural pain decreased by approximately 2.0–2.3 VAS units versus placebo, and the odds of achieving adequate procedural pain control (VAS ≤ 3) increased 4–5-fold for active topical agents in the adjusted model. These results are consistent with the pharmacologic premise that topical local anesthetics reduce nociceptive input at superficial nerve endings and can blunt pain during mucosal manipulation and operative steps, particularly in inflamed pulpal states where peripheral sensitization may elevate pain responses despite routine care.

The finding that both agents improved procedural pain aligns with prior clinical work showing topical anesthetics can reduce pain perception in intraoral interventions and during local anesthetic administration, although earlier studies often focused on injection pain rather than pain experienced during the operative procedure itself. Trials evaluating topical agents in dental settings have reported meaningful reductions in patient-reported pain with active gels compared with controls, supporting the clinical relevance of topical pre-treatment as a patient-centered analgesic adjunct (5,11). In addition, broader syntheses of injectable and topical local anesthetics for acute dental pain emphasize that topical formulations can offer measurable short-term analgesia and may improve tolerability of dental treatment when used appropriately (14). Our study extends this evidence by demonstrating benefit specifically during the procedure among patients with pulpal inflammatory diagnoses, a group in whom pain control is often more challenging and clinically consequential.

Although lignocaine showed numerically greater pain reduction and a slightly higher success proportion than benzocaine, the between-active difference in procedural VAS was small and statistically non-significant, suggesting that both agents are reasonable options when the goal is to reduce procedural pain relative to placebo. This pattern is compatible with the concept that multiple topical anesthetic classes can deliver comparable clinical benefit at the mucosal surface, while differences in onset, penetration, and duration may not translate into large separations in mean procedural pain under routine clinical conditions. Alternative delivery approaches, including sustained-release lidocaine formulations, have also shown efficacy for postoperative dental pain contexts, reinforcing that local anesthetic pharmacokinetics and formulation can influence analgesic performance, and future work may clarify whether formulation engineering can further improve intra-procedural comfort beyond conventional gels (17).

The logistic regression results strengthen clinical interpretation by showing that the probability of achieving low procedural pain (VAS ≤ 3) was primarily driven by treatment assignment rather than demographic covariates, with age and sex not emerging as significant predictors. This suggests that, within the range of participants studied, topical anesthetic choice has a direct and practical impact on achieving a clinically desirable pain threshold. From a service-delivery perspective, increasing the proportion of patients who experience low pain during treatment may improve cooperation, reduce fear conditioning, and potentially enhance completion of care in a single visit, particularly in high-pain presentations such as symptomatic irreversible pulpitis.

Several limitations should be considered when interpreting these findings. First, outcomes were measured with a single patient-reported VAS rating during the procedure; while VAS is widely used in pain trials, repeated measures at standardized procedural timepoints could improve granularity and reduce measurement noise. Second, the success threshold (VAS ≤ 3) is clinically intuitive but dichotomizes a continuous measure; reporting both continuous differences and categorical success, as

done here, helps mitigate that trade-off, but future studies could also model pain as an ordinal or continuous endpoint with prespecified clinically important differences. Third, while randomization produced baseline balance, outcomes could still be influenced by operator-level factors (technique variation, procedural complexity), which should be minimized in subsequent trials through standardized protocols and, ideally, clustering-aware analyses or stratified randomization by procedure type.

Overall, the study provides clinically interpretable evidence that both 2% lignocaine jelly and benzocaine gel reduce procedural tooth pain compared with placebo in patients treated for pulpal inflammatory conditions, with no clear superiority of one active agent over the other in mean procedural pain. Future multicenter trials with prespecified primary endpoints, standardized intra-procedural measurement timepoints, and stratification by procedure type would help refine comparative estimates and guide best-practice recommendations for topical analgesia in routine dental care.

CONCLUSION

In patients undergoing dental treatment for pulpal inflammatory conditions, both 2% lignocaine jelly and benzocaine gel significantly reduced procedural tooth pain compared with placebo and markedly increased the likelihood of achieving low procedural pain (VAS ≤ 3), supporting the routine clinical use of topical anesthetic gels as effective adjuncts for improving patient comfort during dental procedures.

REFERENCES

1. Arora G, Degala S, Dasukil S. Efficacy of buffered local anaesthetics in head and neck infections. *Br J Oral Maxillofac Surg*. 2019;57(9):857-860.
2. Chandrasekaran D, Chinnaswami R, Shanthi K, Dhiravia Sargunam AE, Kumar KS, Satheesh T. A prospective study to assess the efficacy of 4% articaine, 0.5% bupivacaine and 2% lignocaine using a single buccal supraperiosteal injection for maxillary tooth extraction. *J Pharm Bioallied Sci*. 2021;13(Suppl 1):S721-S724.
3. Chen S, Xiang J, Ji Y. Efficacy of articaine vs lignocaine for infiltration anaesthesia during primary molar extractions. *Pak J Med Sci*. 2022.
4. Crabtree S. Use of intravenous lignocaine in the perioperative and chronic pain setting. *Br J Hosp Med*. 2022.
5. Fathima HM. Comparative evaluation of two topical anaesthetic gels to reduce pain during local anaesthesia administration. 2020.
6. Fathima Jamal RD, T AD, Yolanda Jeevitha JD, M SD, P RD. Effectiveness of local anaesthesia spray vs supra periosteal infiltration in mobile anterior/posterior teeth—A comparative study. *Int J Sci Res*. 2023:39-41.
7. Gandhi N, Shah N, Wahjuningrum DA, Purnomo S, Nooshian R, Arora S, et al. Evaluation of pulpal anesthesia and injection pain using IANB with pre-heated, buffered and conventional 2% lignocaine in teeth with symptomatic irreversible pulpitis—a randomized clinical study. *PeerJ*. 2022;10:e14187.
8. Hashmi MJ, Rahman A-u, Khan MA, Khan MA, Abdullah S, Shahzad HM. Anesthetic efficacy of single buccal infiltration of 4% articaine and 2% lignocaine in extraction of maxillary 1st molar. *Pak J Med Health Sci*. 2022.
9. Javed M, Alam MA, Arooj Z, Asghar H, Haroon K, Qadeer M. Comparing the efficacy of articaine and lignocaine in maxillary irreversible pulpitis: A randomized triple blind study. *Proceedings*. 2024.

10. Kolte DR, Kalsi H, Kharkar V, Patil T, Kumar B, Wagh A, et al. Efficacy of articaine versus lignocaine as local anesthetic agents using buccal infiltration technique for extraction of mandibular premolars. *J Pharm Bioallied Sci.* 2024.
11. Kotian N, Mani G, Ramakrishnan M. Comparative evaluation of two different topical anesthetic agents in controlling pain during intraoral local anesthetic administration in children: A split-mouth triple-blinded randomized clinical trial. *Int J Clin Pediatr Dent.* 2021.
12. Kumar K, Singh R, Kumar S, Gupta J, Kumar A, Verma A. Efficacy of 2% lignocaine and 4% articaine in oral surgical procedure: A comparative study. *J Contemp Dent Pract.* 2020.
13. M.M A, Khatri A, Kalra N, Tyagi R, Khandelwal D. Pain perception and efficacy of local analgesia using 2% lignocaine, buffered lignocaine, and 4% articaine in pediatric dental procedures. *J Dent Anesth Pain Med.* 2019;19(2):101.
14. Miroshnychenko A, Ibrahim S, Azab M, Roldan Y, Martinez JPD, Tamilselvan D, et al. Injectable and topical local anesthetics for acute dental pain. *J Am Dent Assoc.* 2023.
15. Pentapati K, Singh A, Gadicherla S, Smriti K. Efficacy of lignocaine with buprenorphine versus lignocaine in the management of postoperative pain after minor oral surgical procedures: A systematic review and meta-analysis. *J Int Soc Prev Community Dent.* 2020;10(6):686.
16. Ramadurai N, Gurunathan D, Samuel A, Subramanian E, Rodrigues S. Effectiveness of 2% articaine as an anesthetic agent in children: randomized controlled trial. *Clin Oral Investig.* 2018.
17. Suzuki T, Kosugi K, Suto T, Tobe M, Tabata Y, Yokoo S, et al. Sustained-release lidocaine sheet for pain following tooth extraction: A randomized, single-blind, dose-response, controlled, clinical study of efficacy and safety. *PLoS One.* 2018;13(7):e0200059.
18. Tiwary S, Joshi S, Sanyal P, Kurade S. Local anaesthetic effect of lidocaine and articaine: A comparative clinical study. *Uttar Pradesh J Zool.* 2021.
19. Tole N, Neeli A. Evaluation of the efficacy of buffered local anesthetic in extraction of infected teeth—randomized double-blind study. *Oral Maxillofac Surg.* 2024.
20. Venkat Narayanan J, Gurram P, Krishnan R, Muthusubramanian V, Sadesh Kannan V. Infiltrative local anesthesia with articaine is equally as effective as inferior alveolar nerve block with lidocaine for the removal of erupted molars. *Oral Maxillofac Surg.* 2017;21(3):295-299.