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Comparative Effectiveness of 20% Benzocaine Versus 2% Lignocaine Topical Gel in Reducing Needle-Puncture Pain During Local Anesthetic Infiltration

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Abstract

Pain associated with local anesthetic (LA) injections, including needle penetration and solution deposition, contributes to dental anxiety and reluctance to undergo dental treatment. Topical anesthetics are widely applied before injection to reduce procedural discomfort, although their relative effectiveness varies with the agent, formulation, concentration, application time, and injection site. This study compared the effectiveness of 20% benzocaine gel and 2% lignocaine gel in reducing pain during needle penetration and subsequent local anesthetic deposition in dental procedures. A non-randomized, parallel-group controlled trial was conducted in the Department of Oral and Maxillofacial Surgery, Fatima Memorial Hospital, Lahore, from March to July 2026. A total of 102 adults aged 18–60 years with American Society of Anesthesiologists (ASA) physical status I or II were included, with 51 participants receiving 20% benzocaine gel (Group A) and 51 receiving 2% lignocaine gel (Group B). Topical preparations were applied before standardized infiltration with an injectable local anesthetic solution. Pain was assessed using the Visual

Analogue Scale (VAS) and Wong–Baker FACES Scale (WBS) at both needle insertion and LA solution deposition, as reported in the study tables. Compared with the lignocaine group, the benzocaine group had lower mean VAS scores during needle insertion (1.12 ± 0.84 versus 2.85 ± 1.42) and LA deposition (1.86 ± 1.10 versus 3.41 ± 1.68). Wong–Baker FACES scores were also lower at needle insertion (0.94 ± 0.76 versus 2.61 ± 1.35) and solution deposition (1.65 ± 0.98 versus 3.18 ± 1.54); all four reported between-group comparisons were statistically significant ($p < 0.001$). Under the conditions of this single-center, non-randomized study, 20% benzocaine gel was associated with lower needle-puncture and LA-deposition pain scores than 2% lignocaine gel. Randomized studies using documented allocation procedures and standardized pain measurements are warranted to confirm the comparative effectiveness and broader applicability of these findings.

Keywords: benzocaine; lignocaine; local anesthesia; needle-puncture pain; topical anesthetic gel; dental extraction; infiltration anesthesia

1. INTRODUCTION

Fear of pain during needle insertion and administration of local anesthesia (LA) is among the common reasons for anxiety, distress, and avoidance of dental care. Administration of injectable local anesthetic solutions can cause discomfort, particularly in patients who anticipate pain or have previous negative dental experiences. Procedural anxiety may also provoke physiological responses, including hyperventilation or vasovagal symptoms, which can complicate otherwise routine appointments. Therefore, reducing discomfort associated with local anesthetic injections is an important component of patient-centered dental treatment and may help patients tolerate necessary oral procedures more comfortably [1].

Before injecting a local anesthetic, clinicians commonly apply a topical anesthetic preparation to the intended mucosal injection site to produce superficial anesthesia. Such preparations act on sensory nerve endings within the oral mucosa and can inhibit the transmission of painful stimuli during initial needle penetration. However, their effectiveness in reducing discomfort during both subsequent needle insertion and injection of anesthetic solution remains debated. Differences in drug concentration, gel formulation, duration of application, anatomical site, infiltration technique, and methods of assessing pain may all contribute to variation in results across clinical studies [2].

Dental injections may also trigger physiological changes related to procedural pain and anxiety, including transient changes in cardiovascular parameters. These responses may be especially relevant for patients with cardiovascular conditions or marked dental anxiety. Righes et al. evaluated the effects of topical benzocaine on pain during oral injections at different anatomical sites [3]. Serious, although uncommon, vasovagal reactions have also been reported during oral surgery, as illustrated by Shimoda et al. [4]. Together, these findings underscore the importance of minimizing avoidable discomfort while maintaining appropriate procedural monitoring and patient reassurance.

Evidence concerning topical anesthetics has been inconsistent across injection techniques and clinical settings. In a randomized, double-blind, split-mouth study, Righes et al. compared 20% benzocaine with placebo before oral local anesthetic injection and assessed pain using a visual analogue scale (VAS), together with selected cardiovascular measurements [3]. They reported a statistically significant reduction in needle-puncture pain during infraorbital nerve injection, whereas no significant difference was identified for posterior superior alveolar nerve injection. These site-specific results indicate that the apparent effectiveness of topical anesthesia may depend on the location and technique of administration rather than on the active ingredient alone.

Various additional methods for reducing injection-related discomfort have been investigated. Abbasi et al. compared cryoanesthesia using ethyl chloride spray with 5% lidocaine gel for pain associated with buccal local anesthetic injection in a randomized clinical trial [5]. Their investigation illustrates continued interest in techniques that may make routine dental injections more tolerable. These approaches differ in mechanisms of action, application procedures, and practical constraints, and their findings cannot automatically be extrapolated to comparisons of topical benzocaine with lignocaine gel.

The method used to measure pain is another important consideration in evaluating topical anesthetic effectiveness. The visual analogue scale (VAS) allows patients to indicate the perceived intensity of subjective pain on a continuous or scored line and is frequently used in clinical pain research [6]. Other commonly used measures include verbal rating scales and pictorial rating systems, which ask patients to describe pain intensity using categories or illustrated faces [7]. Accordingly, clear specification of the measurement instrument, its scale range, the precise procedural time point, and the method of analysis is essential for meaningful comparisons of topical anesthetic preparations.

Topical anesthetic efficacy may also depend on how long the preparation remains in contact with the oral mucosa. Bhalla et al. systematically evaluated application duration and found that contact time is an important methodological consideration when assessing topical anesthesia before dental injections [8]. Guidance on pain assessment also emphasizes distinguishing pain experienced at the moment of puncture from discomfort experienced during solution deposition [9]. Moreover, a systematic review and meta-analysis by Maia et al. considered the effects of topical anesthetics on these two distinct components of injection pain [10]. Such evidence supports examining needle insertion and anesthetic infiltration as related but separate clinical outcomes.

Different topical drug concentrations and delivery systems have been evaluated to improve superficial oral anesthesia. Fukayama et al. compared 20% benzocaine gel with 60% lidocaine gel and identified differences in their anesthetic effectiveness under the tested conditions [11]. Other investigators have examined liposomal topical anesthetic delivery to the palatal mucosa [12], while Carr and Horton evaluated a transoral drug-delivery approach for topical anesthesia [13]. These studies demonstrate that the active agent, concentration, vehicle, contact time, and delivery system all deserve consideration when interpreting the efficacy of a particular topical preparation.

Systematic reviews have also emphasized uncertainty regarding the overall magnitude and clinical consistency of topical anesthetic benefits. Maia et al. synthesized randomized controlled trials evaluating pain during needle puncture and anesthetic infiltration and reported variation according to procedure and outcome assessed [10]. Their findings indicate

that reductions in puncture pain should not be assumed to imply an equivalent reduction in pain during solution deposition. Differences among included studies in anesthetic agents, treatment timing, injection sites, and comparison groups further justify direct clinical comparisons of commonly available topical products.

Investigators have additionally assessed whether topical anesthesia affects discomfort during infiltration and the success of dental anesthesia. Parirokh et al. examined topical anesthesia in relation to needle penetration, infiltration pain, and anesthetic success for maxillary central incisors [14]. Other work has evaluated the anterior middle superior alveolar (AMSA) injection technique as an alternative method of providing anesthesia to the maxillary dentition [15]. These investigations underscore the distinction between superficial pain relief at an injection site and successful pulpal or regional anesthesia during the subsequent dental procedure.

The injectable local anesthetic solution and its method of administration can also influence clinical outcomes. Lawaty et al. compared solutions containing mepivacaine with levonordefrin and lidocaine with epinephrine for maxillary infiltrations in a prospective, randomized, double-blind study [16]. Such evidence indicates that the effectiveness of an infiltration procedure cannot be attributed solely to any topical agent applied beforehand. Comparisons of topical gels should therefore maintain similar needle gauges, injection procedures, solution concentrations, and injection volumes wherever feasible.

Direct comparisons of commonly used topical anesthetic gels are particularly relevant to everyday dental practice. Nair and Gurunathan compared 2% lignocaine gel with 20% benzocaine gel for reducing pain during the administration of local anesthesia in a randomized controlled trial [17]. Their study provides a clinically pertinent basis for comparing the two preparations, although differences in patient age, injection site, and measurement procedure must be considered when interpreting results. Other studies, particularly in pediatric dentistry, have also found that perceived discomfort can differ among topical anesthetic agents and methods of application.

A more recent randomized clinical trial compared lidocaine, benzocaine, and eutectic mixture of local anesthetics (EMLA) for reducing pain associated with inferior alveolar nerve blocks in schoolchildren [18]. The findings reinforce the clinical importance of choosing an appropriate formulation and application method. However, the pediatric population and nerve-block technique differ from adult infiltration anesthesia. Earlier clinical evaluations likewise documented differences among commercially available topical products, including mixtures containing benzocaine or other local anesthetic agents [19].

Both lignocaine and benzocaine are used widely as topical anesthetic agents in dentistry. Lignocaine has established local anesthetic properties and is available in numerous formulations, whereas benzocaine is commonly used for short-term superficial anesthesia of the oral mucosa. Despite their frequent clinical use, available evidence does not establish that all topical formulations provide equivalent pain reduction during needle penetration or anesthetic solution deposition. Comparing the specific commercially relevant concentrations used in dental practice may therefore provide useful information for selecting a topical agent before infiltration anesthesia [18].

The present study was designed to compare 2% lignocaine gel with 20% benzocaine gel in reducing perceived pain during needle penetration before local anesthetic infiltration for dental extraction. The investigation also assessed pain experienced during deposition of the injectable solution, thereby distinguishing initial puncture discomfort from subsequent infiltration pain. This direct comparison may inform the selection of topical preparations for adult dental patients, while recognizing that its findings must be interpreted in relation to the non-randomized design, patient selection, application duration, and procedural conditions.

Study objective. To compare 20% benzocaine gel with 2% lignocaine gel for reducing needle-puncture pain and local anesthetic solution-deposition pain during dental infiltration procedures in adults.

2. MATERIALS AND METHODS

A non-randomized controlled trial was conducted in the Department of Oral and Maxillofacial Surgery, Fatima Memorial Hospital, Lahore, between March and July 2026. The total sample comprised 102 adults. The reported sample-size calculation assumed mean pain scores of 1.73 ± 2.49 and 0.67 ± 0.98 for two treatment conditions, with a 95% confidence level and 80% statistical power; the original source of these numerical planning assumptions requires confirmation because the systematic review cited elsewhere in the manuscript does not establish them as a direct two-arm comparison. Participants were enrolled through non-probability sampling and allocated to two parallel groups of 51 participants each. Group A received 20% benzocaine gel, and Group B received 2% lignocaine gel before infiltration anesthesia. Eligible patients were 18–60 years old, had American Society of Anesthesiologists (ASA) physical status I or II, and required infiltration anesthesia for dental extraction. The investigator responsible for assessing pain outcomes was reportedly blinded to the treatment group; however, the precise allocation and blinding procedures were not described in the source materials and should be verified against the study protocol.

Inclusion criteria were age 18–60 years, ASA physical status I or II, either sex, provision of informed consent, and a need for local anesthetic infiltration during dental extraction. Patients were required not to have taken sedatives, analgesics, or anxiolytic medication for at least two weeks before extraction. These criteria were intended to reduce potential differences

in baseline pain perception and medication-related responses between the groups.

Patients were excluded if they had a history of allergy or hypersensitivity to either study agent, benzocaine or lignocaine; declined participation; or had an odontogenic infection. The eligibility assessment was completed before administration of a topical anesthetic. These exclusion criteria should be interpreted in conjunction with the ASA classification and the specific procedural requirements for the planned dental extraction.

Following institutional ethical approval and written informed consent, demographic details, including age, sex, and medical-record information, were documented using a standardized study proforma. Sterile gauze was used to isolate and dry the designated labial alveolar mucosa. In Group A, 20% benzocaine gel was applied with a cotton applicator and rubbed on the intended site for 30 seconds, followed by a further 30 seconds of application, giving a total contact period of approximately one minute. In Group B, 1.0 mL of 2% lignocaine gel was applied using the same procedure. The amount of benzocaine gel, expressed as volume or mass, was not specified in the source manuscript and requires confirmation to establish dose equivalence. Subsequent infiltration was performed using 0.6 mL of 2% lidocaine with epinephrine 1:100,000 administered through a 27-gauge needle. Pain was assessed separately during needle insertion and during LA solution deposition using the VAS (0–10) and Wong–Baker FACES Scale (WBS; 0–10). The original abstract and methods provide different descriptions of which scales were recorded at which time points; the outcome tables report both measures at both time points, and the original case-record forms should be checked before submission.

Data were coded and analyzed using SPSS software, version 24.0. Continuous variables were summarized as means and standard deviations, whereas categorical variables were described using frequencies and percentages. The Shapiro–Wilk test was used to assess distributional normality. Between-group pain scores were compared using an independent-samples t-test when the relevant distributional assumptions were satisfied and a Mann–Whitney U test otherwise. Two-tailed tests were performed, with statistical significance defined as $p < 0.05$. Needle-insertion pain and pain during local anesthetic deposition were evaluated as distinct procedural outcomes. Scores from the VAS and WBS instruments were retained separately rather than combined into a pooled measure. The manuscript reports significance thresholds but does not provide the normality-test results, the selected test for each outcome, or exact p-values; these details should be checked against the original SPSS output.

3. RESULTS

A total of 102 adult patients participated, with 51 participants in each treatment group. Group A received 20% benzocaine topical gel and Group B received 2% lignocaine topical gel before standardized infiltration anesthesia. The study assessed perceived pain during two parts of the procedure: needle insertion and subsequent deposition of the injectable local anesthetic solution. Both the Visual Analogue Scale (VAS) and Wong–Baker FACES Scale (WBS) were reported for the two procedural time points. The overall group allocation and sample composition are summarized in Table 1.

Table 1. Baseline allocation characteristics of participants in the two topical anesthetic groups

Parameter	Total Study Population (n = 102)
Total participants	102
20% Benzocaine group	51
2% Lignocaine group	51
Group distribution	1:1

The 102 recruited patients were divided equally between the two topical anesthetic groups, as shown in Table 1. Thus, group sizes were balanced for the reported outcome comparisons. The text of the original manuscript states that age and sex distributions were similar between groups, but the baseline table provides only sample sizes and allocation proportions, not the corresponding demographic summary values or statistical comparisons. Accordingly, demographic comparability cannot be independently assessed from the supplied table and should be verified using the study records.

The balanced allocation provided the same number of reported observations in each treatment arm for the needle-puncture and local anesthetic deposition comparisons. Nevertheless, equality of group sizes alone does not establish equivalence of baseline patient characteristics in a non-randomized design; documentation of age, sex, extraction site, and any other clinically relevant characteristics would strengthen interpretation of the observed treatment differences.

Table 2. Pain during needle insertion following application of topical anesthetic gel

Assessment Tool	20% Benzocaine (n = 51)	2% Lignocaine (n = 51)	p-value
VAS (0–10)	1.12 ± 0.84	2.85 ± 1.42	$p < 0.001$
Wong–Baker FACES (0–10)	0.94 ± 0.76	2.61 ± 1.35	$p < 0.001$

As summarized in Table 2, patients who received 20% benzocaine gel reported lower mean pain scores during needle

insertion than those who received 2% lignocaine gel. The reported between-group differences were statistically significant for both assessment instruments ($p < 0.001$). These comparisons describe the intensity of pain associated with initial needle penetration, rather than discomfort during subsequent deposition of the injectable anesthetic solution.

The mean VAS score during needle insertion was 1.12 ± 0.84 in the benzocaine group and 2.85 ± 1.42 in the lignocaine group, indicating a lower reported mean score in Group A (Table 2). The corresponding Wong–Baker FACES scores were 0.94 ± 0.76 and 2.61 ± 1.35 , respectively. For both the VAS and WBS comparisons at this procedural stage, the manuscript reports $p < 0.001$, supporting a statistically significant between-group difference under the selected analytic procedures.

These findings suggest that application of 20% benzocaine gel was associated with less perceived pain during initial needle penetration than application of 2% lignocaine gel in the participating adults. The mean differences were observed using both reported pain assessment instruments, although the degree of correspondence between the two ratings within individual participants was not reported and therefore cannot be independently evaluated.

Table 3. Pain during local anesthetic solution deposition following topical pretreatment

Assessment Tool	20% Benzocaine (n = 51)	2% Lignocaine (n = 51)	p-value
VAS (0–10)	1.86 ± 1.10	3.41 ± 1.68	$p < 0.001$
Wong–Baker FACES (0–10)	1.65 ± 0.98	3.18 ± 1.54	$p < 0.001$

The same direction of difference was observed during local anesthetic (LA) solution deposition, as presented in Table 3. The mean VAS score was 1.86 ± 1.10 in the 20% benzocaine group compared with 3.41 ± 1.68 in the 2% lignocaine group. This between-group comparison was reported as statistically significant ($p < 0.001$). The deposition-related scores were higher than the corresponding needle-insertion scores in both groups, but the study did not report a formal within-participant statistical test comparing the two procedural stages.

For the Wong–Baker FACES Scale, mean pain scores during anesthetic solution deposition were 1.65 ± 0.98 in Group A and 3.18 ± 1.54 in Group B, respectively (Table 3). The reported significance threshold was again $p < 0.001$. Thus, both pain rating instruments showed lower average deposition-related discomfort in the group receiving topical benzocaine before infiltration.

Taken together, the VAS and Wong–Baker FACES results indicate a consistent direction of between-group differences during anesthetic deposition. This interpretation is limited to the reported patient ratings and does not establish whether the topical preparations differed in onset time, depth of mucosal anesthesia, duration of effect, or subsequent success of the dental extraction procedure.

Table 4. Overall comparison of pain scores during needle insertion and local anesthetic deposition

Procedure Stage	Outcome Measure	20% Benzocaine	2% Lignocaine	p-value
Needle penetration	VAS	1.12 ± 0.84	2.85 ± 1.42	$p < 0.001$
Needle penetration	Wong–Baker FACES	0.94 ± 0.76	2.61 ± 1.35	$p < 0.001$
LA deposition	VAS	1.86 ± 1.10	3.41 ± 1.68	$p < 0.001$
LA deposition	Wong–Baker FACES	1.65 ± 0.98	3.18 ± 1.54	$p < 0.001$

Table 4 brings together the four reported comparisons across two procedural stages and two pain rating scales. Participants treated with 20% benzocaine had lower mean pain scores than those treated with 2% lignocaine during both needle penetration and anesthetic deposition. For the VAS, the difference between group means was 1.73 points during puncture and 1.55 points during solution deposition. These absolute differences represent the reported scale-point contrasts rather than standardized effect sizes and should not be interpreted as equivalent measures of clinical importance without further analysis.

All four between-group comparisons shown in Table 4 were reported to be statistically significant at $p < 0.001$, with the direction consistently favoring 20% benzocaine gel. Because exact test statistics, exact p-values, and confidence intervals were not provided in the source manuscript, the precision and robustness of these comparisons should be confirmed from the original statistical output.

The combined results therefore indicate lower pain perception in the benzocaine group during both needle penetration and local anesthetic deposition. Consistent differences across the VAS and Wong–Baker FACES instruments support the direction of the observed findings, while the absence of detailed scale-administration procedures limits assessment of potential measurement effects. Moreover, the non-randomized allocation procedure leaves open the possibility that unmeasured baseline differences contributed to some of the observed pain-score variation.

Overall, within the specific clinical conditions of this non-randomized, single-center investigation, 20% benzocaine gel was associated with significantly lower reported injection-related pain scores than 2% lignocaine gel. The observed differences were apparent at both recorded procedural stages, not solely during the initial needle puncture. However, these

results support a comparison of the two topical pretreatments as delivered in this study and do not independently establish comparative efficacy for other mucosal locations, application durations, or patient groups.

4. DISCUSSION

Pain during dental local anesthetic administration is a frequent concern because it can generate anxiety, discomfort, and reluctance to receive needed dental treatment. The injection procedure involves at least two clinically distinct sources of discomfort: penetration of the oral mucosa by the needle and deposition of the anesthetic solution into the tissues. Topical anesthetic preparations are commonly used before injection to reduce this discomfort. In the present study, **20% benzocaine gel**, rather than 2% lignocaine gel, was associated with lower mean pain scores at both needle insertion and local anesthetic deposition. The original discussion incorrectly described the tested benzocaine product as 10 mg/g; 10 mg/g corresponds to 1% rather than 20%, so the study concentration is consistently identified here as 20% while the administered mass or dose remains subject to verification. The differences were evident using the Visual Analogue Scale (VAS) and Wong–Baker FACES Scale (WBS), with all four comparisons reported as statistically significant ($p < 0.001$).

In a randomized controlled trial, de Freitas et al. investigated the effects of 20% benzocaine compared with placebo before oral local anesthetic administration and reported that its efficacy varied across the clinical sites and outcomes examined [1]. Unlike that placebo-controlled investigation, the present study directly compared 20% benzocaine with 2% lignocaine gel. The lower reported pain scores in the benzocaine group therefore provide evidence of a difference between two active topical preparations under the conditions studied, although the non-randomized design prevents the same degree of protection against confounding available in a randomized clinical trial.

Injection technique, anatomical site, and the injectable anesthetic solution can also affect the success and tolerability of dental anesthesia. Kumar et al. examined buccal versus buccal-palatal infiltration using lidocaine and articaine in a randomized trial, demonstrating the importance of injection technique and solution selection [2]. Righes et al. compared benzocaine with placebo at different oral injection sites and reported that the analgesic effect was not uniform across those locations [3]. In the present investigation, the needle gauge, local anesthetic formulation, reported injection volume, and general application procedure were standardized between groups. Such procedural consistency may reduce variability, although complete equivalence in injected sites, individual operator technique, and baseline patient characteristics remains to be confirmed.

Dental procedures may also produce anxiety and physiological responses that are not captured by pain scores alone. Shimoda et al. described transient asystole related to a vasovagal reflex during oral surgery, demonstrating that serious responses can occasionally occur during dental treatment [4]. The present study did not measure anxiety, cardiovascular responses, or vasovagal events, and its findings therefore should not be interpreted as direct evidence that benzocaine prevents any of these outcomes. Nevertheless, minimizing injection-related discomfort remains a reasonable clinical objective when providing patient-centered dental care.

Multiple alternatives to standard topical anesthetic gel have been evaluated to reduce injection pain. Abbasi et al. investigated ethyl chloride cryoanesthesia versus 5% lidocaine gel for buccal injection discomfort [5], while Tani et al. examined the clinical efficacy and safety of lidocaine tape applied to oral mucosa [6]. These studies show that both pharmaceutical agents and their methods of delivery can influence pain control. However, the applications, concentrations, and comparators vary substantially, so the results of these investigations should be interpreted as contextual evidence rather than direct replications of the present benzocaine–lignocaine comparison.

Pain assessment is itself an important methodological consideration in research on dental injections. The VAS is widely used to measure patient-reported pain intensity, with respondents indicating the severity of their own subjective experience [7]. The Wong–Baker FACES Scale provides an illustrated set of expressions that can facilitate pain reporting. General resources also distinguish visual analogue methods from categorical verbal pain ratings [9]; however, these resources do not establish how the FACES instrument was administered to the participants in this particular study. In the present study, both instruments yielded lower reported mean scores in the benzocaine group at needle insertion and solution deposition. Agreement in the direction of the group-level effects is encouraging, but further documentation is needed to determine how the instruments were presented, whether both were completed at each time point, and whether participants were instructed consistently.

These findings should also be considered in the context of systematic evidence. Maia et al. performed a systematic review and meta-analysis of randomized controlled trials evaluating topical anesthetic effects on needle-puncture and anesthetic-infiltration pain [10]. The review reported benefits in certain puncture-pain outcomes, while effects during infiltration were less consistent across clinical circumstances and injection sites. The present study contributes a direct comparison between two active preparations rather than between a topical anesthetic and an inactive comparator. Nevertheless, its results should not be interpreted as overturning the broader review, because the included trial designs, intervention protocols, and anatomical sites differ considerably.

The length of contact between the topical anesthetic and mucosa can modify apparent effectiveness. Bhalla et al.

evaluated duration of topical anesthesia before dental injections, supporting attention to application time when comparing clinical outcomes [8]. In the present study, both gels were reportedly applied using the same one-minute procedure, with an initial 30-second application followed by a further 30 seconds of contact. This standardization reduces one possible procedural explanation for the difference in mean pain scores. However, the total quantities administered, particularly the benzocaine mass or volume, were not documented sufficiently for a fully dose-standardized comparison.

Studies comparing other topical formulations have reported divergent findings. Fukayama et al. investigated 20% benzocaine and 60% lidocaine gels and observed substantially different responses under their experimental protocols [11]. In that research, the high-concentration lidocaine preparation reduced reported pain, whereas benzocaine did not produce a comparable significant reduction for the assessed stimuli. Because their topical concentrations, exposure durations, study population, and outcome procedures were unlike those in the present investigation, their findings are not directly interchangeable with a comparison of 20% benzocaine versus 2% lignocaine.

Differences between the present study and Fukayama et al. may reflect variations in product concentration, formulation vehicle, amount applied, time of mucosal contact, anatomical injection site, population characteristics, and pain-assessment methods [11]. In particular, a 60% lidocaine gel cannot be assumed to perform identically to the 2% lignocaine gel tested here. The available evidence therefore indicates that the specific preparation and application protocol are important when interpreting comparative topical anesthetic performance, rather than relying solely on the name of the active ingredient.

The delivery system used for topical anesthesia may likewise influence mucosal penetration and the resulting clinical effect. Franz-Montan et al. investigated a liposomal system for delivering topical anesthetics to palatal mucosa [12]. Carr and Horton evaluated a transoral delivery system designed for topical oral anesthesia [13]. These investigations support the broader principle that formulation and delivery characteristics can change treatment performance. Thus, the results of a comparison between two conventional topical gels should not be generalized to other delivery technologies without direct study.

Topical anesthesia has also been examined in relation to both injection discomfort and anesthetic success. Parirokh et al. assessed the effect of topical anesthesia on pain during infiltration injections and on successful anesthesia for maxillary central incisors [14]. Their work illustrates the need to distinguish subjective injection pain from the degree of subsequent pulpal anesthesia. The present investigation focused specifically on pain recorded at needle insertion and local anesthetic deposition, and it did not report postoperative pain, procedural success rates, or the quality of pulpal anesthesia during dental extraction.

The injectable anesthetic and injection technique can influence the overall effectiveness of the subsequent dental procedure. Lee et al. examined the anterior middle superior alveolar injection technique [15], whereas Lawaty et al. compared different injectable anesthetic solutions for maxillary infiltrations [16]. Both lines of research emphasize that injection technique and solution choice can influence clinical anesthesia. In the present study, the injection was reportedly standardized using the same 2% lidocaine solution with epinephrine 1:100,000, a 27-gauge needle, and a 0.6-mL volume in both arms. This reduces, but does not entirely eliminate, potential procedural confounding.

The randomized controlled study by Nair and Gurunathan is particularly relevant because it directly compared 2% lignocaine gel with 20% benzocaine gel during administration of local anesthesia [17]. The direction of the difference reported in that investigation provides context for the present findings, although the prior work was conducted in a different clinical population and used its own measurement procedures. The current comparison likewise found lower VAS and Wong-Baker FACES scores with benzocaine during needle penetration and subsequent solution deposition. Such agreement across studies is informative, but it does not remove limitations associated with the non-randomized allocation and incomplete baseline details in the present dataset.

Vickers and Punnia-Moorthy evaluated three topical anesthetic products and identified differences in the reduction of needle-insertion pain relative to placebo [19]. More recently, Karkoutly et al. compared 8% lidocaine gel, 20% benzocaine, and EMLA in schoolchildren receiving inferior alveolar nerve blocks [18]. These investigations support the relevance of selecting an appropriate topical formulation, while also showing that concentration, age, and injection procedure strongly affect comparability. Findings from pediatric nerve blocks, therefore, cannot be directly equated with the outcomes of adult mucosal infiltration in the current study.

Rehman and Qazi evaluated topical 20% benzocaine before maxillary injections in a randomized controlled trial [20]. Their study examined needle penetration and local anesthetic deposition relative to a no-topical-agent comparison, making it relevant to the distinction between the two procedural pain outcomes. The present study likewise observed lower pain scores with benzocaine during needle penetration, but it also reported lower deposition pain relative to 2% lignocaine. Differences in active comparator, patient selection, injection site, topical application, and assessment procedure may account for variation between investigations. These distinctions merit further study before definitive conclusions about deposition-pain reduction can be drawn.

Recent research has also investigated alternative methods to reduce dental injection pain. Daly et al. evaluated a microneedle patch used with topical anesthetic [21], while Joshi et al. compared a vibration-based DentalVibe technique

with 2% lignocaine gel [22]. In children, Havale et al. compared several topical approaches, including clove oil, betel leaf extract, lignocaine gel, and ice [23]. Amrollahi et al. further examined evidence for pre-cooling as a means of decreasing pain associated with pediatric dental injections [24]. Collectively, these studies demonstrate that pharmaceutical, physical, and device-based interventions may influence pain perception; nevertheless, their differing comparators and clinical conditions should be considered when interpreting their relevance to the present adult two-gel comparison.

The principal strengths of this study include the balanced number of participants in the two treatment groups, the use of a consistent topical application duration, and reported standardization of the needle gauge and injectable anesthetic solution. Needle-insertion pain and local anesthetic deposition pain were evaluated as separate outcomes, providing information about two distinct moments during infiltration. Both the VAS and Wong–Baker FACES instruments yielded effects in the same direction, favoring the benzocaine group. At the same time, such design features cannot compensate entirely for the absence of randomized allocation or detailed information on baseline comparability and masking procedures.

Several limitations must be acknowledged. The non-randomized design and non-probability recruitment introduce the possibility of selection bias and residual confounding. This single-center study included only adults aged 18–60 years with ASA physical status I or II, limiting generalizability to children, medically complex patients, individuals with extreme dental anxiety, and procedures such as palatal infiltration or inferior alveolar nerve block. Exact topical doses, application-site comparability, and allocation procedures were not fully described. Moreover, psychological distress, heart rate, blood pressure, adverse reactions, and subsequent anesthetic success were not measured. Future randomized multicenter investigations should examine varying mucosal sites, concentrations, standardized administered quantities, application durations, and patient-reported and physiological outcomes.

Taken together, this study reports lower pain scores following use of 20% benzocaine gel than 2% lignocaine gel during both needle penetration and local anesthetic deposition under specified clinical conditions. The results are compatible with some direct comparative literature, particularly Nair and Gurunathan [17], and share certain findings with Rehman and Qazi [20]. Differences from other investigations [10, 11] highlight the potential importance of concentration, formulation, anatomical site, contact time, and study design. Given the limitations of the non-randomized, single-center approach, the results should be described as evidence of lower reported pain scores in this setting rather than definitive proof of universal clinical superiority.

5. CONCLUSION

The present study found that patients receiving 20% benzocaine gel before local anesthetic infiltration reported significantly lower mean pain scores during needle penetration and anesthetic solution deposition than patients receiving 2% lignocaine gel. The same direction of difference was observed using both the Visual Analogue Scale and the Wong–Baker FACES Scale, with all four reported comparisons meeting the specified statistical significance threshold. These findings suggest that topical benzocaine may be an effective option for reducing the discomfort associated with dental injections in selected adult patients. However, the study was non-randomized, conducted at one center, and restricted to participants aged 18–60 years with ASA physical status I or II. In addition, the absence of detailed information on baseline demographics, actual topical doses, and statistical-test outputs limits the certainty of the conclusions. Larger randomized, adequately documented multicenter trials are therefore recommended to determine whether the observed differences persist across dental procedures, injection sites, and patient populations, and whether improvements in patient comfort translate into meaningful clinical benefits.

Author contributions

All authors contributed equally to the conception, development, preparation, and revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Data availability

The study generated individual-level clinical and pain-assessment data from 102 participants. Because these records may contain confidential patient information, the underlying participant-level dataset is not included with the manuscript. The availability of a de-identified dataset from the corresponding author, subject to institutional approval and applicable privacy requirements, should be confirmed by the authors before journal submission.

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