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COMPARATIVE CLINICAL EVALUATION OF EMLA, BENZOCAINE AND LIGNOCAINE GEL AS TOPICAL ANAESTHETIC AGENTS PRIOR TO ADMINISTRATION OF LOCAL ANAESTHESIA FOR THERAPEUTIC EXTRACTIONS.

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Abstract:
Introduction: Topical anesthetics are routinely used in dentistry to minimize pain during needle insertion prior to local anesthetic administration. Their clinical efficacy varies depending on formulation, concentration, and tissue penetration. This study compared the anesthetic effectiveness of 5% lignocaine gel, 20% benzocaine gel, and 5% EMLA cream in patients undergoing orthodontic extractions.
Materials and Methods: A randomized controlled trial was conducted from December 2023 to June 2024 in the Department of Oral and Maxillofacial Surgery after obtaining institutional ethical clearance and informed consent. Forty-five patients aged 12–35 years requiring extraction of premolars for orthodontic treatment were randomly assigned into three groups (n=15 each) using a lottery method: Group A – 5% lignocaine gel (LIGNOSPAN-O), Group B – 20% benzocaine gel (MUCOPAIN), and Group C – 5% EMLA cream (EMLA, AstraZeneca). ASA I and II patients with malocclusion and severe crowding were included. Exclusion criteria comprised hypersensitivity to anesthetics, systemic illness, immunocompromised state, periodontitis, mutilated dentition, and mentally challenged individuals. The agents were applied to the palatal mucosa, mucobuccal fold, and pterygomandibular raphe. Pain perception was assessed at 30 seconds, 1 minute, and 5 minutes using the Visual Analog Scale (VAS). Data were analyzed using SPSS version 23.3 with independent t-tests ($p < 0.05$).
Results: The mean ages of Groups A, B, and C were 25.2, 25.5, and 22.73 years, respectively. In the maxilla, EMLA showed significantly lower VAS scores at 1 and 5 minutes compared to benzocaine and lignocaine ($p < 0.05$). In the mandible, no statistically significant differences were observed. At 30 seconds, all groups showed comparable pain scores.
Conclusion: Within the limitations of this study, 5% EMLA cream demonstrated superior surface anesthetic efficacy, particularly in the maxilla, followed by 20% benzocaine and 5% lignocaine gel. These findings are clinically relevant not only for improving procedural comfort but also for promoting overall human health and psychological well-being by reducing pain perception, anxiety, and patient distress during dental procedures. Larger studies assessing depth of penetration and additional clinical parameters are recommended.

Keywords: Health, Human, Pain Perception, Visual Analogue Scale

Introduction:

A topical anesthetic is a local anesthetic designed to numb the surface of a body part, providing relief from pain or discomfort.(1) These anesthetics work by inhibiting the transmission of pain signals from the area where they are applied, usually by blocking nerve conduction. (1,2)The active ingredients in topical anesthetics, such as benzocaine, lidocaine (lignocaine), and prilocaine, achieve this effect by interfering with sodium channels on nerve membranes, preventing the initiation and propagation of nerve impulses. By blocking these channels, the anesthetic prevents the nerves from transmitting pain signals to the brain, resulting in temporary numbness in the treated area. (3)Topical anesthetics are commonly used to relieve pain, itching, and irritation caused by conditions such as sunburns, minor burns, insect bites, poison ivy, poison oak, and minor cuts and scratches. (4)They are also used to manage discomfort from mouth ulcers, denture irritation, and anal or rectal conditions. These products are available in several forms, including creams, ointments, gels, sprays, and aerosols, making them versatile for treating a wide range of areas, from skin to mucous membranes.(5) Their effectiveness makes them a popular choice for providing localized pain relief, especially for superficial injuries or irritations.(6)In dentistry, topical anesthetics are routinely used to numb the oral tissues before administering a local anesthetic injection. (7)Prior to giving an injection, a topical anesthetic gel or cream is applied to the gingiva or other areas

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in the oral cavity to reduce the discomfort associated with the needle. By numbing the surface tissues, the patient experiences less pain when the needle is inserted, improving the overall experience during procedures such as fillings, cleanings, or extractions. (8)In some cases, the topical anesthetic may be sufficient to alleviate discomfort for minor procedures, such as taking dental impressions or removing a small piece of tissue.
The mechanism of action in dentistry is similar to other applications, where the topical anesthetic works by blocking the conduction of nerve impulses at the site of application. Benzocaine and lidocaine are the most commonly used agents in dental practice. Benzocaine is often used in gels or ointments, while lidocaine is available in various formulations, including sprays and gels.(9) The numbing effect typically lasts from several minutes to about an hour, depending on the specific product and the amount applied.
Benzocaine is a local anesthetic belonging to the amino ester class, widely used in dentistry and other medical settings for surface-level pain relief. (10) It works by blocking sodium channels on nerve membranes, preventing the transmission of pain signals from the site of application to the brain. This numbing effect is localized to the surface tissues, making benzocaine ideal for managing conditions like minor oral irritations, mouth ulcers, or denture-related discomfort.(11) It is also commonly used to relieve pain caused by minor cuts, scrapes, and insect bites on the skin or mucous membranes.
In dentistry, benzocaine is primarily applied topically to the gums or other areas of the oral cavity before administering a local anesthetic injection. This helps reduce the pain and discomfort associated with the needle insertion during procedures like fillings, tooth extractions, or root planing.(9,12) By numbing the surface tissue, benzocaine ensures a more comfortable experience for the patient during the injection, which can sometimes be the most uncomfortable part of dental procedures. Benzocaine is also used before minor procedures like taking impressions or removing small pieces of tissue in the mouth.(13) However, it should be used with caution, as prolonged or excessive application can lead to systemic absorption and potential side effects such as methemoglobinemia, a rare condition that affects oxygen delivery in the body.(13,14)
Lidocaine Hydrochloride gel is a local anesthetic that works by blocking the transmission of pain signals along peripheral nerves.(15) It accomplishes this by inhibiting the flow of sodium ions through nerve membranes, which prevents the initiation and propagation of nerve impulses, thereby reducing the sensation of pain. Lidocaine, a member of the amino amide class of anesthetics, is highly effective for providing temporary relief from localized pain or discomfort. (16)It is often used for conditions affecting the skin or mucous membranes, as it only numbs the surface tissues where it is applied. Lidocaine Hydrochloride Gel is commonly used in medical and dental settings for a variety of purposes. It is frequently used to alleviate pain associated with anal or rectal problems, such as hemorrhoids or fissures, by numbing the affected area.(16,17) It is also effective for managing discomfort from mouth ulcers and denture irritation. In addition, lidocaine gel is applied topically before minor surgeries, biopsy procedures, or dental procedures to numb the skin or mucosal tissues and reduce pain during interventions. The gel formulation is particularly useful in providing localized anesthesia for these applications, offering rapid and effective relief without affecting deeper tissues.(16–18)
EMLA (Eutectic Mixture of Local Anesthetics) is a topical anesthetic that combines lidocaine and prilocaine, two local anesthetics that work synergistically to numb the skin by blocking sodium channels on nerve membranes. This prevents the transmission of pain signals from the site of application, providing effective and localized pain relief. EMLA is typically applied as a cream or ointment and requires about 30 to 60 minutes to reach full effectiveness, numbing the skin's surface layers.(16–19)
In dentistry, EMLA is often used to numb the gums or oral mucosa before certain procedures that involve needle insertion, such as injections for local anesthesia. By applying EMLA to the area to be injected, dentists can help reduce the pain or discomfort caused by the needle prick, making the experience more comfortable for the patient.(16–20) It is particularly useful for procedures such as fillings, cleanings, or minor oral surgeries where the administration of a local anesthetic injection is necessary. Additionally, EMLA is used in pediatric dentistry to ease the process for young patients, making them feel more at ease during treatments that involve needles. EMLA is also effective for numbing the skin prior to dental impressions or other minor procedures that may cause discomfort in the mouth.(16–21)

Aim of the study: To evaluate the efficiency of Benzocaine,Lignocaine and EMLA topical anaesthetics for application in dentistry prior to therapeutic extractions.

Materials and methods:
This study is a randomized controlled trial (RCT) designed to assess and compare the efficacy of three different topical anaesthetic agents—5% lignocaine gel (LIGNOSPAN-O), 20% benzocaine gel (MUCOPAIN), and 5% EMLA gel (EMLA ASTRA ZENICA)—in patients undergoing orthodontic extractions. The objective of the study was to determine which of the three anaesthetics provides the most effective pain relief during the procedure. The study was conducted in the Department of Oral and Maxillofacial Surgery over a time frame from December 2023 to June 2024. Ethical clearance for the study was obtained from the institutional Ethical Committee, ensuring that the research adhered to ethical standards for patient care and confidentiality. Informed written consent was obtained from all participants, and the randomization of patients into three groups (A, B, and C) was done using the lottery method, ensuring unbiased treatment allocation. The effectiveness of the anaesthetics was assessed at multiple time points—30 seconds, 1 minute, and 5 minutes—using the

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Visual Analog Scale (VAS) to record pain perception, with data analyzed using SPSS software version 23.3.

Inclusion Criteria:

The study enrolled patients aged between 12 and 35 years, as this age group typically undergoes orthodontic treatment requiring extractions of the first premolars. Participants had to be diagnosed with malocclusion or severe crowding, making them candidates for orthodontic extractions of all four first premolars in both the maxilla and mandible. Additionally, patients needed to be classified as ASA (American Society of Anesthesiologists) Class 1 or Class 2, which indicates healthy individuals or those with mild systemic disease who would not face significant risk from local anaesthesia. The inclusion criteria focused on individuals who required routine orthodontic extractions, ensuring that the study population reflected a typical patient demographic in an orthodontic setting.

Exclusion Criteria:

To ensure the safety of participants and the accuracy of the study results, certain exclusion criteria were applied. Patients with periodontitis or significant periodontal disease were excluded, as such conditions could alter the anaesthetic response and potentially complicate the extraction procedure. Individuals with multiple missing or mutilated teeth were also excluded, as these factors could interfere with the proper application of the anaesthetic and affect the assessment of its efficacy. Further, participants with a history of hypersensitivity to local anaesthetic agents were excluded to prevent any adverse reactions. The study also excluded individuals who were mentally challenged, had systemic illnesses, or were immunocompromised, as these conditions might increase the risk of complications during the procedure. By excluding these groups, the study ensured that the sample consisted of individuals who were both appropriate for the procedure and less likely to experience confounding factors that could impact the anaesthetic's effectiveness.

Sample Size Calculation:

A total of 45 participants were enrolled in the study, with 15 participants randomly assigned to each of the three anaesthetic treatment groups: Group A (5% lignocaine gel), Group B (20% benzocaine gel), and Group C (5% EMLA gel). The sample size was determined based on a power analysis designed to achieve 80% statistical power and a sampling error of 5%. These parameters were chosen to ensure that the study could reliably detect significant differences in the effectiveness of the topical anaesthetics. The randomization was done using a lottery method, ensuring that each participant had an equal chance of being assigned to one of the three treatment groups. This methodology provided a robust framework for comparing the anaesthetic agents and ensuring unbiased results. The sample size was calculated to achieve sufficient power, allowing the study to draw meaningful conclusions about the relative efficacy of the anaesthetics.

Experimental Procedure and Statistical Analysis:

The experimental procedure involved the application of the three topical anaesthetics (lignocaine, benzocaine, and EMLA) to patients undergoing orthodontic extractions. The anaesthetic agents were applied to three different sites: the palatal mucosa, the area adjacent to the mucobuccal fold of the upper premolar, and the midpoint of the pterygomandibular raphe (for the block anaesthesia site). The effectiveness of the anaesthetics was evaluated at three time points: 30 seconds, 1 minute, and 5 minutes after application, using a Visual Analog Scale (VAS) to assess pain perception. The data collected were analyzed using SPSS software version 23.3, and for inter-group comparisons, an independent t-test was applied. A p-value of less than 0.05 was considered statistically significant, which allowed for the identification of any significant differences in the efficacy of the three anaesthetic agents. This statistical approach ensured that the results were reliable and that any observed differences could be attributed to the anaesthetic treatments rather than random chance.

Results:

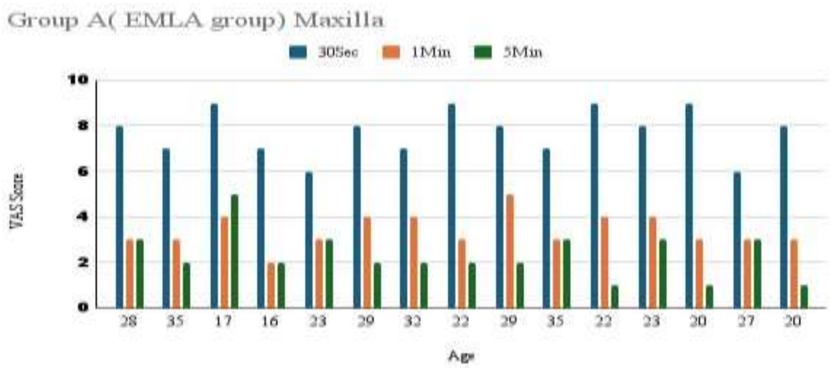

Figure 1: (Maxilla – Group A, EMLA group)

VAS scores at 30 seconds, 1 minute, and 5 minutes following EMLA application in the maxillary region.
A progressive reduction in pain scores is observed, indicating effective and sustained surface anesthesia.

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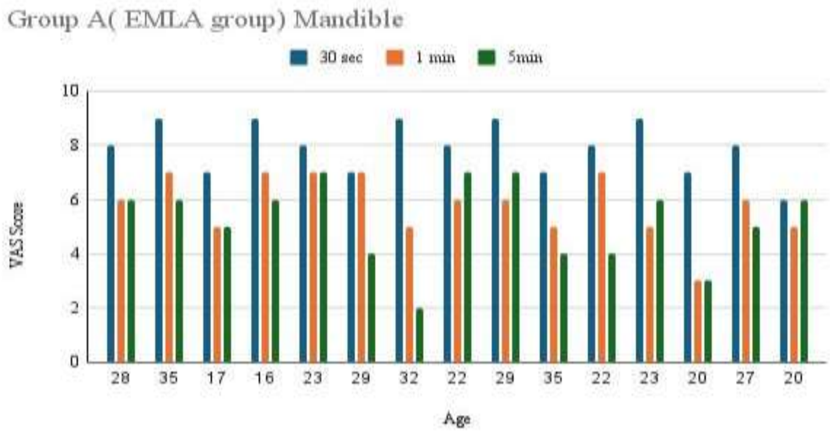

Figure 2: (Mandible – Group A, EMLA group)

VAS scores at 30 seconds, 1 minute, and 5 minutes following EMLA application in the mandibular region. Minimal reduction in pain scores over time suggests limited anesthetic efficacy in the mandible.

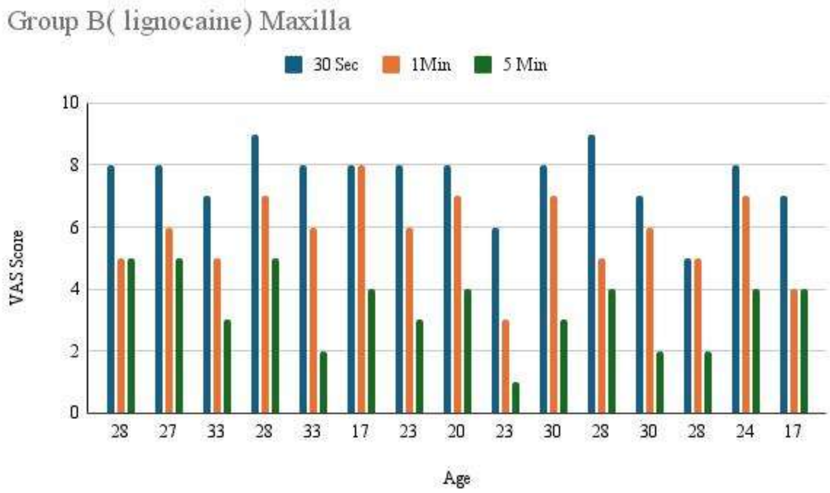

Figure 3: (Maxilla – Group B, Lignocaine group)

Bar graph showing VAS scores at 30 seconds, 1 minute, and 5 minutes following lignocaine application in the maxillary region. A consistent decline in pain scores indicates effective anesthetic action over time.

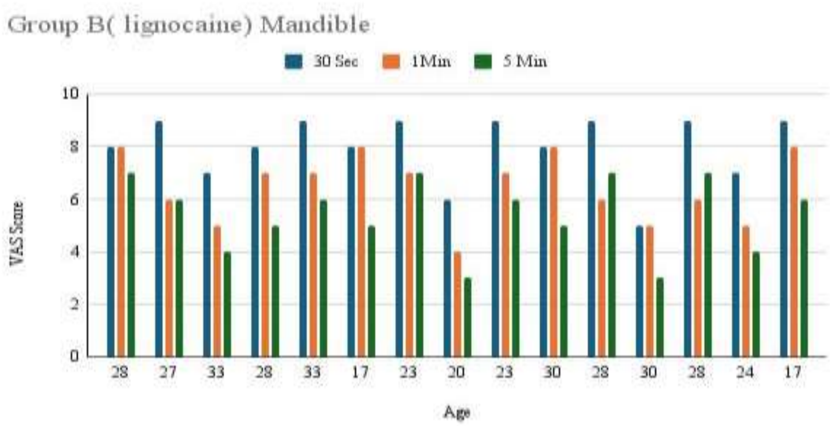

Figure 4 : (Mandible – Group B, Lignocaine group)

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Bar graph depicting VAS scores at 30 seconds, 1 minute, and 5 minutes following lignocaine application in the mandibular region. A moderate reduction in pain scores suggests comparatively lower efficacy than in the maxilla

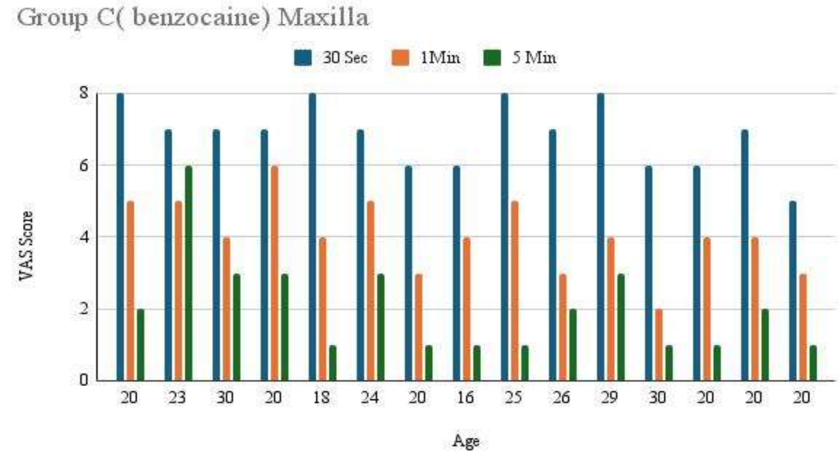

Figure 5 : (Maxilla – Group C, Benzocaine group)

Bar graph showing VAS scores at 30 seconds, 1 minute, and 5 minutes following benzocaine application in the maxillary region. A gradual decline in pain scores indicates effective onset of topical anesthesia.

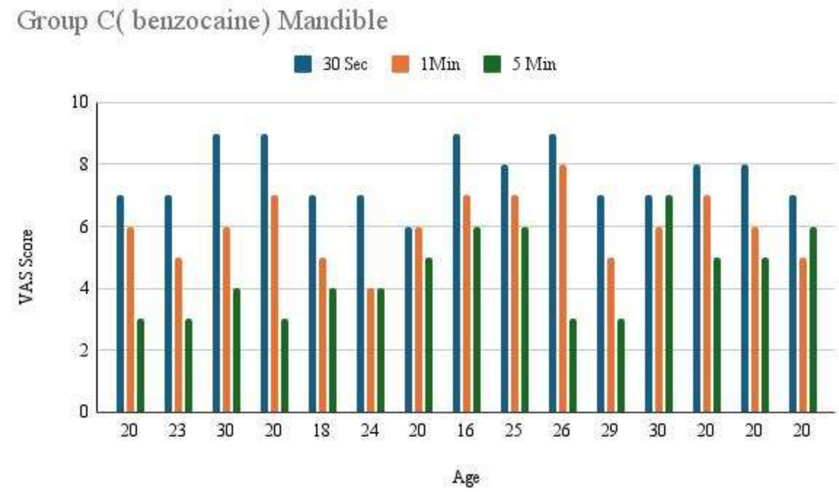

Figure 6: (Mandible – Group C, Benzocaine group)

Bar graph depicting VAS scores at 30 seconds, 1 minute, and 5 minutes following benzocaine application in the mandibular region. A moderate reduction in pain scores suggests comparatively lower efficacy than in the maxilla.

Discussion:

In the present study, three topical anaesthetics—5% lignocaine, 20% benzocaine, and 5% EMLA—were evaluated for their efficacy in reducing pain during orthodontic extractions. The findings demonstrated clear variations in efficacy depending on both the anatomical site and the time elapsed after application. Among the three agents, EMLA cream showed the most consistent and superior performance, particularly in the maxillary region, followed by benzocaine and lignocaine. These findings are clinically relevant, as effective surface anaesthesia plays a crucial role in improving patient comfort during orthodontic procedures.The superior performance of EMLA observed in this study is strongly supported by existing literature. Previous studies have consistently demonstrated that the eutectic mixture of lidocaine and prilocaine provides enhanced mucosal penetration and deeper anaesthetic action compared to conventional topical agents. Studies by Al-Melh et al. reported that EMLA was significantly more effective than benzocaine in reducing pain during palatal injections (22) , while other investigations have also shown that EMLA outperforms multiple topical agents, including benzocaine and lidocaine, in reducing procedural pain . Similarly, Nayak et al. concluded that although EMLA has a slower onset, it provides superior pain reduction compared to both benzocaine and lignocaine (23). These findings align closely with the present study, where EMLA demonstrated the lowest VAS scores at both 1 and 5 minutes, indicating not only rapid onset but also sustained anaesthetic efficacy in the maxilla.

Benzocaine showed moderate effectiveness in the present study, performing better than lignocaine but inferior to EMLA. This is consistent with previous research suggesting that benzocaine, although widely used due to its rapid onset, has limited depth of penetration and shorter duration of action. While some studies have reported benzocaine to be comparable to or slightly better than lignocaine in reducing needle insertion pain , others have indicated that its effect on pain reduction is not always significant when compared to control conditions (24) . Furthermore, comparative trials have demonstrated that EMLA consistently provides better analgesia than benzocaine, especially in maxillary and palatal regions . The present findings reinforce this perspective, as benzocaine showed a reduction in VAS scores over time but failed to achieve the same level of analgesic depth and duration as EMLA.

Lignocaine, despite being a widely used injectable anaesthetic, exhibited the least effectiveness when used topically in this study. This observation is supported by literature indicating that lignocaine's efficacy as a topical agent is limited due to its relatively lower mucosal permeability compared to eutectic formulations. Some studies have shown lignocaine and benzocaine to be equally effective in reducing pain , while others suggest that lignocaine may even be less effective than benzocaine in topical applications (25) . In contrast, studies comparing lignocaine with EMLA consistently demonstrate the superior analgesic effect of EMLA . The higher VAS scores observed with lignocaine in the present study further support its limited role as an effective surface anaesthetic in orthodontic procedures.

An important observation in this study was the difference in efficacy between the maxilla and mandible. In the maxillary region, all three agents demonstrated better performance, with EMLA showing statistically superior results. This can be attributed to the relatively thinner cortical bone and more vascular mucosa, which facilitate better diffusion of topical agents. In contrast, the mandibular region showed no statistically significant differences among the three anaesthetics.(12)Similar findings have been reported in previous studies evaluating topical anaesthetics for inferior alveolar nerve block, where all agents demonstrated comparable effectiveness due to the dense cortical bone and thicker soft tissue limiting drug penetration . This highlights the inherent limitation of topical anaesthesia in achieving adequate depth in the mandible, regardless of the agent used.(26)

Overall, the results of the present study are in strong agreement with the majority of existing literature, particularly in demonstrating the superior efficacy of EMLA over benzocaine and lignocaine for surface anaesthesia in the maxilla. The findings also reinforce the understanding that while benzocaine and lignocaine remain useful agents, their effectiveness is comparatively limited, especially in achieving sustained analgesia. Clinically, this suggests that EMLA may be considered the preferred topical anaesthetic for orthodontic extractions involving maxillary regions, while alternative or adjunctive techniques may be necessary to achieve adequate anaesthesia in the mandible

Group	Maxilla (VAS Score at 1 min)	Maxilla (VAS Score at 5 min)	Mandible (VAS Score at 1 min)	Mandible (VAS Score at 5 min)
Benzocaine	5.8	5.4	5.4	5.4
Lidocaine	4.06	2.6	4.46	4.46
EMLA	3.2	2.3	5.2	5.4

Limitations of the study :

The study provides valuable insights into the efficacy of different topical anaesthetics, there are several limitations that should be acknowledged. One major limitation is the small sample size, with only 15 participants per group, which may limit the generalizability of the findings. A larger sample size would have enhanced the statistical power of the study, potentially providing more robust conclusions and reducing the potential for sampling bias. Furthermore, the study's reliance on the Visual Analog Scale (VAS) to measure pain perception introduces a degree of subjectivity in the assessment. VAS scores can vary significantly from patient to patient, depending on their individual pain thresholds, anxiety levels, and emotional states, which could influence the accuracy and consistency of the results.

Conclusion:

This study concludes that 5% EMLA cream provides the most effective surface anaesthesia with adequate depth of penetration compared to the other two topical anaesthetics tested—20% benzocaine and 5% lignocaine. The results clearly demonstrated that EMLA cream not only provided superior pain relief in the maxilla, but also showed better overall performance in terms of duration and effectiveness of anaesthesia. While benzocaine was moderately effective, particularly for the maxillary mucosa, it was outperformed by EMLA in terms of both onset time and sustained pain relief.

Lignocaine was the least effective, especially in surface anaesthesia, which underscores the need for more targeted choices of anaesthetic agents based on their specific properties and clinical applications.
The study also highlights that EMLA cream's effectiveness is likely due to its balanced formulation, which provides adequate depth of penetration while maintaining a rapid onset of action, making it particularly suitable for surface anaesthesia in the oral cavity. On the other hand, benzocaine was found to be more effective than lignocaine in providing surface anaesthesia, but its action was shorter in duration and less effective than EMLA, particularly in deeper tissues. These findings suggest that, while benzocaine can be an acceptable alternative in certain situations, EMLA should be considered the first-line choice for topical anaesthesia in procedures such as orthodontic extractions where longer-lasting, effective surface anaesthesia is needed.

Future scope:
The promising results of this study, further research is recommended to refine and validate these findings. Future studies could expand on the current work by incorporating a larger sample size, which would increase the statistical power of the results and improve the generalizability of the findings across different patient populations. Additionally, advanced tools for measuring anaesthetic depth (such as sensory testing or measurement of tissue penetration depth in millimeters) could provide more objective data on how far the topical agents penetrate into the tissues and how this correlates with pain relief. Furthermore, assessing surface pH changes before and after the application of these anaesthetics could provide insight into how the pH levels influence the effectiveness of local anaesthesia. A comprehensive understanding of these factors could lead to the development of even more effective and tailored topical anaesthetic formulations for dental and orthodontic procedures in the future.

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