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Comparative Evaluation of Pain Perception with Various Topical Anesthetic Agents: A Randomized Control Trial

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Abstract

Background and Aim: Effective pain control during local anesthetic (LA) procedures is essential to enhance patient comfort and reduce procedural pain and anxiety. This study compared the effectiveness of different topical anesthetics—5% EMLA gel, Ice sticks, 2% Lignocaine gel, clove oil and lavender oil—in reducing pain and stress during LA administration.

Method: Study involving 120 children aged 7 to 9 years were divided into 6 groups, each receiving a different topical anesthesia before insertion of needle for LA. Pain was measured using the Visual Analog Scale (VAS) and Sound, Eye, Motor (SEM) scores. Pulse rate and oxygen levels (SpO_2) were recorded before and after the injection.

Results: Children who received 5% EMLA gel reported the least pain, followed by those treated with ice stick, 2% Lignocaine, Clove oil and lavender oil respectively, while the control group experienced the highest pain. EMLA gel and ice also showed lower pulse rates and improved oxygen saturation levels, depicting less stress during the procedure.

Conclusion: 5% EMLA gel and ice sticks were most effective in reducing pain and stress in children during LA procedures. Use of effective topical anesthetics can greatly improve patient comfort and outcomes.

Keywords: Topical anesthesia, Pain Perception, Visual Analogue Scale, Sound Eye Motor Scale.

Introduction

Pain prevention in pediatric dentistry is essential for creating a positive dental experience for children. It helps to build trust and cooperation, making future visits more comfortable and stress-free.

One of the primary causes of fear and anxiety in children during dental appointments is the pain associated with local anesthesia (LA) injections. To minimize this

discomfort, topical anesthetics are commonly applied before administering LA injections. Among the commercially available agents 2% lignocaine is widely used due to its rapid onset of action and making it suitable for short dental procedures. Another effective agent is EMLA gel, which contains a combination of 2.5% lidocaine and 2.5% prilocaine. This formulation acts synergistically by providing a longer-lasting anesthetic effect and in some cases may eliminate the need for injectable anesthesia (Kushner et al[1]). In addition to conventional agents, herbal alternatives such as clove oil (containing eugenol) and lavender oil have demonstrated mild anesthetic and calming properties, they are being explored as potential topical anesthetic agents in managing mild to moderate pain during dental procedures.

Cryoanesthesia a simple and non-invasive form of pain management leads to vasoconstriction, believed to stimulate myelinated A fibers, activating inhibitory pain pathway works by numbing the area through cold, thereby reducing pain. The composition, concentration, and duration of application significantly influence the effectiveness and safety of topical anesthetics adults (Johannsen et al[2]). Hence, this study was conducted to evaluate the efficacy of different topical anesthetic agents in reducing pain perception during local anesthetic injections in children.

Materials and Methodology

The study was conducted on One hundred and twenty children aged 7-9 years, who attended Department of Pediatric and Preventive Dentistry, Bangalore Institute of Dental Science and Hospital. Informed written consent in English and regional language was obtained from parents or legal guardians prior to their participation. Ethical committee clearance was obtained.

Inclusion Criteria

- Healthy co-operative children.
- Children aged between 7-9 years.
- Children with no history of allergies to local anesthesia and topical anesthetic agents.
- First exposure to local anesthesia.
- Informed parental consent.

Exclusion Criteria

- Children with special health care needs.
- Presence of abscess in the mucobuccal fold area.
- Extremely anxious and fearful subjects.
- Hypersensitivity to local anesthesia and topical anesthetic agents.

A simple random sampling method was employed to divide the study participants into 6 groups consisting of 20 in each.

1. Group A: Control group - without any topical anesthetic agent.
2. Group B: Application of 2% Lignocaine as a topical anesthetic agent.
3. Group C: Application of 5% EMLA gel as a topical anesthetic agent.
4. Group D: Application of clove oil as a topical anesthetic agent.
5. Group E: Application of an ice stick as a topical anesthetic agent.
6. Group F: Application of lavender oil as a topical anesthetic agent.

The participants were comfortably positioned on the dental chair and the site of application was chosen based on the patient's treatment needs. The site of application for the topical anesthetic agent was isolated with sterile cotton rolls, suction tip and the mucosa was air-dried before material application.

This test material was applied based on the respective groups:

- Group A: Control group - without any topical anesthetic agent
- Group B - 2% Lignocaine gel (Lignox 2% gel, A Indoco Remedies Ltd, India.) was applied using cotton applicator for 5 min.
- Group C - 5% Eutectic Mixture of Local Anesthetic gel was (Toplap cream ,Prilocaine (2.5% w/w) + Lidocaine (2.5% w/w) Torrent Pharmaceuticals Ltd) was applied using cotton applicator for 5 min.
- Group D - Clove oil (Pure Clove Oil, 5 ml) was applied using cotton swabs 5 min.
- Group E - Ice sticks were customized by filling water the in little plastic tubes and freezing at -40 Degree Celsius. The ice sticks were placed for 3 min
- Group F -Lavender oil (Khadi Natural Lavender Essential Oil) was applied using cotton swabs for 5 min.

All test materials were applied gently, on mucobuccal fold over the apex of teeth covering an area of approximately 1.5 cm in diameter on the gingiva, prior to the buccal infiltration.

Local anesthesia was then administered by a single operator using a 27-gauge needle, gently inserted 3mm superior to the mucogingival border on the mucobuccal fold to the required depth of penetration. The local anesthesia was slowly deposited after aspiration to prevent intravascular delivery and minimize adverse reactions at the injection site. Subsequently, the required dental procedure was carried out.

The pain perception during the insertion of the needle was recorded using the Visual Analogue Scale (VAS) and Sound Eye Motor Scale (SEM). Additionally, vital parameters such as Oxygen saturation level (Spo2) and Pulse rate (PR) were measured before and after administration of local anesthesia using a Pulse oximeter (Pulse -Finger Pulse Oximeter With TFT Display, Indian)

Data obtained was tabulated and subjected to statistical analysis using Kruskal Wallis Test and One way Anova test.

Results

Table 1:

Table no. 1 Comparison of mean VAS scores for pain perception during Needle Insertion between different groups using Kruskal Wallis Test

Groups	N	Mean	SD	Min	Max	p-value
Group A	20	7.95	0.76	7	9	<0.001*
Group B	20	4.50	0.51	4	5	
Group C	20	1.30	0.47	1	2	
Group D	20	6.60	0.50	6	7	
Group E	20	3.50	0.51	3	4	
Group F	20	7.30	0.57	6	8	

Table 2:

Table no. 2 Comparison of mean Sound, Eye & Motor Scale (SEM Scale) Scores during Needle Insertion between different groups using Kruskal Wallis Test

Groups	N	Mean	SD	Min	Max	p-value
Group A	20	7.30	0.66	6	8	
Group B	20	4.40	0.60	3	5	
Group C	20	2.00	0.80	1	3	<0.001*
Group D	20	5.30	0.57	4	6	
Group E	20	3.55	0.69	3	5	
Group F	20	6.35	0.67	5	7	

Table 1 and 2 Compares mean value of VAS and SEM scores of pain perception during needle insertion. **Group** C presented the lowest score (1.30 ± 0.47 and 2.00 ± 0.80), followed by Group E (3.50 ± 0.51 and 3.55 ± 0.69). Group A demonstrated the highest score (7.95 ± 0.76 and 7.30 ± 0.66). A Statistical significant difference was seen between the groups.

Table 3: Comparison of Mean Pulse Rate Before and After LA Procedure using One way Anova test

Group	Pulse rate Mean Before (bpm)	Mean After(bpm)	Mean difference	ANOVA p-value
A	95.80	92.20	3.60	
B	93.10	82.70	10.40	
C	93.10	71.40	21.70	< 0.001 (Significant)
D	95.05	85.95	9.10	
E	93.10	74.30	18.80	
F	95.10	88.95	6.15	

Table 3 Compares Pulse Rate Before and After LA Procedure using One way Anova test. Group C demonstrated highest mean difference of (21.70), followed by Group E (18.80). Group A presented lowest mean difference of (3.60). A Statistical significant difference was seen between the groups**.**

Table 4: Comparison of Mean Spo2 Before and After LA Procedure using One way Anova test

Group	Spo2 Mean Before (bpm)	Spo2 Mean After(bpm)	Mean difference	ANOVA p-value
A	94.65	95.35	0.70	
B	94.55	98.15	3.60	
C	94.85	99.65	4.80	< 0.001 (Significant)
D	94.50	97.00	2.50	
E	94.65	98.90	4.25	
F	94.40	96.15	1.75	

Table 4 Compares Spo2 Before and After LA Procedure using One way Anova test. Group C demonstrated highest mean difference of (4.80), followed by Group E (4.25). Group A presented lowest mean difference of (0.70). A Statistical significant difference was seen between the groups.

Discussion

Topical anesthetics are widely used as a pre-injection protocol to minimize the discomfort associated with needle penetration and thereby improve patients positive experience. The present study evaluated the effectiveness of various topical anesthetic agents in reducing pain during LA administration in children aged 7–9 years. Among the six groups, 5% EMLA gel showed the highest efficacy in reducing pain during LA injection. Studies by (Bhalla et al[3]**)** and **(**Ganesh et al[4]**)** too reported that EMLA gel significantly reduced pain perception due to its deeper mucosal penetration and longer duration of action. It acts by blocking the voltage-gated sodium channels in neuronal cell membranes. This prevents sodium influx, which is essential for the generation and conduction of action potential nerve signals (Galinkin & Koh[5]). Cryoanesthesia is a simple and non-invasive form of pain management which acts by vasoconstriction and slowing down the nerve conduction (Kosaraju et al[6]). Our study observed that ice stick application effectively reduced pain perception during local anesthesia procedures as depicted in the VAS and SEM scales. The Sp02 and Pulse rate also showed significant improvement. (Harbert et al[7]), (Aminabadi et al[8]), (Kuwahara et al[9]) and (Kosaraju et al[6]), also found similar results in their studies. Lidocaine**,** commonly known as lignocaine, is an amide-type local anesthetic. It works by inhibiting sodium ion influx through voltage-gated sodium channels in neuronal cell membranes, thereby stabilizing the neuronal membrane and preventing the initiation and conduction of nerve impulses. This blockade leads to a reversible loss of sensation in the targeted area. Ligocaine gel is widely used for topical anesthesia due to its rapid onset (typically within 2-5 minutes) and intermediate duration of action (15-45 minutes). It effectively numbs mucosal surfaces, making it suitable for procedures like intraoral injections in pediatric patients (Maged et al[10]). Its ease of application and effectiveness make it a standard choice for managing pain in children. (Gupta et al [11]) compared 2% Lignocaine and 20% Benzocaine and found benzocaine to be more effective, although Lignocaine still provided significant pain relief. Similarly, the current study shows that Lignocaine is useful but less effective than 5% EMLA or ice. Clove (Syzygium aromaticum) is one of the most valuable spices, rich in phenolic compounds. The commercial use of clove is for the production of clove oil, which contains active constituents such as eugenol, eugenyl acetate, and gallic acid, which have antimicrobial, anti-inflammatory, analgesic, and anesthetic action. The mechanism involved in analgesic activity has been attributed to the activation of calcium and chloride channels in ganglionar cells. Raghavendra et al[12] stated that the analgesic effect of eugenol is attributed to its ability to inhibit prostaglandins and other inflammatory mediators. Studies conducted by (Grollman[13]), (Curtis[14]) and (Keene[15]) suggest that clove oil can be used as a potent topical anesthetic agent. The present study found that clove oil provided moderate pain relief, however less effective than 2% Lignocaine, Cryotherapy and 5% EMLA. Lavender oil is another natural remedy that is known for its analgesic and calming properties. It is usually derived by stem distillation of Lavandula angustifolia flowers (Family: Lamiaceae). It has been traditionally used to alleviate anxiety and pain in dental settings. It is believed

that topical application of lavender oil may have a calming effect on the central nervous system, thereby reducing pain perception and anxiety (Bessa et al.[16]). However, In current study, Lavender oil exhibited the least anesthetic effect but may have contributed to a calming influence through its anxiolytic properties. **(**Uthaiah et al[17]) and **(**Miraj[18]) noted lavender's aromatherapeutic benefits, can reduce anxiety but not necessarily pain at the injection site. The significant reduction in pulse rate and increase in SpO_2 observed in the EMLA and ice groups reflect reduced anxiety and pain, confirming the utility of these objective parameters in pediatric pain studies. The results of the present study highlight the effectiveness of 5% EMLA gel and ice stick in providing significant pain relief and improving physiological parameters. However, these findings needs to be substantiated in a larger sample size and in a wider age group.

Conclusion

The study shows that 5% EMLA gel exhibited a significant lower pain score along with improved pulse rate and Spo2 followed by cryotherapy. 2% Lignocaine and clove oil showed moderate pain relief, whereas Lavender oil showed the least pain reduction during Local anesthesia administration.

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