



ORIGINAL RESEARCH PAPER

Paediatric Dentistry

TO COMPARE THE EFFECTIVENESS OF TOPICAL LOCAL ANAESTHETIC GEL, CRYOTHERAPY AND VIBRATORY TOOTHBRUSH IN PAIN CONTROL OF LOCAL ANAESTHETIC INJECTION IN CHILDREN OF AGE 7-9 YEARS

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ABSTRACT

Aim-The aim of the study was to compare the effectiveness of topical local anaesthetic solution, cryotherapy and vibratory toothbrush in pain control of local anaesthetic injection in children aged 7 to 9 years. **Material and Method-**A number of 60 children reporting to the department of Paediatric and Preventive dentistry, aged 7-9 years were selected for the study. The children were randomized into three groups, Group 1 (topical anaesthetic gel), Group 2 (cryotherapy) and Group 3 (vibratory toothbrush). Before commencing the procedure, the site of needle penetration was dried with the sterile gauge. In Group 1, the topical local anaesthetic gel was applied with the help of applicator tip at the injection site before administering the local anaesthesia injection. In Group 2, cryotherapy was done using refrigerated cartridges filled with water at the injection site. In Group 3, vibratory toothbrush was applied at the injection site. The children were then evaluated for pain during administration of local anaesthesia using Wong-baker's faces pain scale and FLACC pain scale, physiological parameters using pulse oximeter, both before and after local anaesthesia administration. **Result-** Pulse rate and oxygen saturation shows no statistically significant result. Wong Baker Faces pain rating scale shows no statistically significant differences. FLACC shows statistically significant difference as Group 1 shows higher pain compared to Group 2 and Group 3. **Conclusion-** Based on subjective and objective pain assessment, vibratory toothbrush showed better pain reduction followed by cryotherapy and topical LA gel, suggesting that both vibration and cryotherapy can be used as effective alternatives to topical anaesthetic gel.

INTRODUCTION

Dental procedures are commonly associated with pain and discomfort, making pain control an essential part of dental practice. Procedures such as tooth extractions, root canal treatments, and minor oral surgeries can produce varying degrees of pain.¹ Modern dentistry therefore relies greatly on local anaesthesia for effective pain management.² According to Peter G. Covino and Stephen J. Vassallo (1976), local anaesthetic agents temporarily block nerve conduction at the site of administration, preventing painful stimuli without loss of consciousness.³

Although local anaesthetic injections are routinely used, they often create fear and anxiety, especially in children. Nikhil Kalra reported that children frequently perceive the dental syringe as frightening due to needle fear.⁴ This anxiety can negatively affect dental treatment and may eventually lead to avoidance of dental care.

To reduce pain during injections, several methods have been introduced, including topical anaesthetics, warming the solution, slow injection techniques, finer needles, cryotherapy, vibratory stimulation, and buffering of local anaesthetics. Among these, topical anaesthesia is the most commonly used method to reduce needle prick pain.⁵ Topical anaesthetics provide temporary loss of sensation at the application site and can reduce discomfort during needle insertion.⁶ However, they are less effective on keratinized tissues such as the palate and may have limitations like unpleasant taste, inconsistent action, or allergic reactions.

Because topical anaesthetics may not completely eliminate pain, newer adjunctive techniques such as cryotherapy and vibratory stimulation are increasingly being used. These methods act as distraction techniques and work on the "Gate Control Theory" proposed by Ronald Melzack and Patrick Wall in 1965, which states that non-painful stimuli can reduce pain perception. Ice application decreases nerve conduction

and produces a local anaesthetic effect, while vibratory stimulation reduces pain by blocking pain signals, making both methods useful in paediatric patients and anxious individuals.^{7,8}

The main aim behind the study is to compare and evaluate the effectiveness of three different methods- Topical local anaesthetic gel, and the newer techniques that is Cryotherapy and Vibratory Toothbrush in pain control of local anaesthetic injection in children.

MATERIAL AND METHODS

The present study was carried out in the Department of Paediatric and Preventive Dentistry, Mahatma Gandhi Dental College and Hospital, MGUMST, Jaipur.

An ethical clearance was obtained from the Ethical Committee, Mahatma Gandhi Dental College and Hospital, MGUMST, Jaipur, before initiation of the study. (MGDC/IEC/1458/JPR/2024/418)

The sample size was calculated using Openepi software (v3.0) at 95% confidence interval and 80% power. With reference to study conducted by Dhingra N et al. The calculated sample size 20 samples per group that is total 60 children.

Children aged 7 to 9 year with positive or definitely positive behaviour ratings (Frankl scores 3 or 4), whose parents provided informed consent, with no history of allergy to local anaesthetic agents and no previous experience of intraoral local anaesthetic injections were included. Children presenting with abscess, erythema, or fistula at the injection site, systemic illness, or special health care needs were excluded from the study.

Children meeting the inclusion criteria were randomly divided into three groups with 20 participants each: Group 1 –

Topical LA Gel, Group 2 – Cryotherapy, and Group 3 – Vibratory Toothbrush. Pain and anxiety were assessed using the Pulse Oximeter, Wong-Baker FACES Pain Rating Scale, and FLACC Behavioural Pain Assessment Scale.

Each child was seated comfortably in the dental chair and allowed to relax for five minutes. Baseline pulse rate, oxygen saturation, and FLACC scores were recorded using a pulse oximeter placed on the index finger, and the child selected a face on the Wong-Baker scale to indicate baseline pain perception.

In Group 1 (Topical LA Gel), the injection site was dried with gauze and suction, followed by application of topical anaesthetic gel for one minute and left for two minutes before administration of 2 ml local anaesthesia using a 25-gauge needle. During injection, pulse oximeter and FLACC scores were recorded, and post-injection pain was assessed using the Wong-Baker scale.

In Group 2 (Cryotherapy), a frozen cartridge filled with distilled water was prepared and applied to the injection site for one minute before injection. Without removing the cartridge completely, 2 ml of local anaesthetic was administered with a 25-gauge needle adjacent to the cooled area. Readings were recorded during the procedure.

In Group 3 (Vibratory Toothbrush), a battery-operated vibratory toothbrush covered with a latex glove was used. The vibrating head was placed at the injection site for one minute prior to injection and maintained near the site during administration of 2 ml local anaesthesia using a 25-gauge needle. Readings were recorded during the procedure.

FLACC scores and pulse oximeter readings were assessed before and during injection, while Wong-Baker FACES scores were recorded after injection. All findings were documented individually for each child in a customized data chart.

The values obtained from each group were sent for statistical analysis.



Figure 1- Application of Topical LA Gel



Figure 2 Administration of LA with Cryotherapy



Figure 3 Administration of LA with Vibratory Toothbrush

RESULTS

The age and gender distribution were comparable among the three groups. The mean age was 8.20 ± 0.95 years in Group 1, 7.65 ± 0.93 years in Group 2, and 8.30 ± 0.86 years in Group 3, with no statistically significant difference ($p = 0.062$). Out of 60 participants, 26 (43.3%) were females and 34 (56.7%) were males, with no significant difference in gender distribution among the groups ($p = 0.622$).

The mean pulse rate before local anaesthesia was comparable among the groups: Group 1 (102.40 ± 15.88 beats/min), Group 2 (102.55 ± 19.58 beats/min), and Group 3 (104.30 ± 10.66 beats/min). During local anaesthesia, Group 2 showed a relatively higher pulse rate (109.10 ± 17.91 beats/min), while Group 3 showed lower values (101.15 ± 8.47 beats/min). Mean SpO_2 levels were also comparable before the procedure, whereas during local anaesthesia, Group 1 showed relatively higher oxygen saturation ($94.40 \pm 8.42\%$) compared to Group 2 ($91.45 \pm 6.88\%$) and Group 3 ($91.95 \pm 7.06\%$). However, no statistically significant difference was observed in pulse rate or SpO_2 levels among the groups (Table-1, Table-2).

Wong-Baker scores before local anaesthesia were lowest in Group 1 (2.20 ± 2.33) compared to Group 2 (3.70 ± 2.45) and Group 3 (3.80 ± 1.70), showing a statistically significant difference ($p = 0.042$). During local anaesthesia, Group 1 showed higher pain scores (4.40 ± 3.59) than Group 2 (3.10 ± 2.47) and Group 3 (2.30 ± 1.98), although the difference was not statistically significant ($p = 0.061$) (Table-3).

Mean total FLACC scores before local anaesthesia showed a significant difference among the groups ($p = 0.003$), with Group 2 showing higher scores and Group 1 the lowest. During local anaesthesia, Group 1 showed the highest FLACC scores, while Group 3 showed the lowest, with a highly significant difference among the groups ($p < 0.001$) (Table-4).

Table-1 Comparison of Pulse Rate between Group 1, Group2, Group3

Pulse Rate	Group	N	Mean	Std. Deviation	Minimum	Maximum	P value
Before LA	Group 1	20	102.40	15.882	77.00	130.00	0.915
	Group 2	20	102.55	19.589	68.00	144.00	
	Group 3	20	104.30	10.667	81.00	117.00	
During LA	Group 1	20	104.60	9.615	86.00	121.00	0.149
	Group 2	20	109.10	17.914	80.00	150.00	
	Group 3	20	101.15	8.468	82.00	113.00	

Table-2 Comparison of SpO2 Between Group 1, Group2, Group3

	N	Mean	Std. Deviation	Minimum	Maximum	P value
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Before LA	Group 1	20	95.05	4.850	84.00	99.00	0.520
	Group 2	20	94.05	5.576	82.00	99.00	
	Group 3	20	95.95	5.236	83.00	99.00	
During LA	Group 1	20	94.40	8.419	62.00	99.00	0.416
	Group 2	20	91.45	6.878	79.00	99.00	
	Group 3	20	91.95	7.059	80.00	100.00	

Table-3 Comparison of Wong Baker Scale Score Between Group 1, Group 2 and Group 3

		N	Mean	Std. Deviation	Minimum	Maximum	P value
Before LA	Group 1	20	2.20	2.330	.00	8.00	0.042
	Group 2	20	3.70	2.451	.00	8.00	
	Group 3	20	3.80	1.704	.00	6.00	
During LA	Group 1	20	2.40	3.589	.00	10.00	0.061
	Group 2	20	3.10	2.468	.00	8.00	
	Group 3	20	2.30	1.976	.00	8.00	

Table-4 Comparison of Total FLACC Score Before and During LA Between Group 1, Group 2 and Group 3

		N	Mean	Std. Deviation	Minimum	Maximum	P value
Before LA	Group 1	20	.45	.944	.00	3.00	0.003
	Group 2	20	2.05	1.820	.00	5.00	
	Group 3	20	1.45	1.356	.00	5.00	
	Total	60	1.31	1.545	.00	5.00	
During LA	Group 1	20	2.75	2.314	.00	9.00	<0.001
	Group 2	20	1.00	1.256	.00	5.00	
	Group 3	20	.40	.680	.00	2.00	
	Total	60	1.38	1.841	.00	9.00	

DISCUSSION

Pain during dental procedures and local anaesthetic administration is a common concern in paediatric dentistry.² Needle prick pain often produces fear and anxiety in children, making pain control an important part of behaviour management.⁸ Various methods such as topical anaesthetics, slow injection techniques, distraction, cryotherapy, and vibratory stimulation have been introduced to reduce pain during local anaesthetic administration.¹¹

Topical anaesthetic gels are widely used in paediatric dentistry. Lidocaine is commonly preferred because of its effectiveness and lower incidence of allergic reactions compared to benzocaine.^{12,13} Hindocha N. et al.¹⁴ reported that 5% lidocaine gel provides effective topical anaesthesia when applied for one minute. However, topical gels have limitations such as unpleasant taste, short duration of action, and spread beyond the application site.¹⁵

Cryotherapy has gained popularity as an alternative pain reduction technique. Cooling the injection site reduces nerve conduction and increases the pain threshold through the gate control mechanism.¹⁶ Sapci et al.¹⁷ found that cold therapy can help limit edema, swelling, and muscle spasms and thus indirectly alleviates pain. Harbert¹⁸ performed the first study in 1989 using ice in dentistry he found cooling of palatal area before injection relieved pain perception. Studies done by Amrutha Varshini I et al.,¹⁰ Faezeh Ghaderi et al.,¹⁶ Lakshmi Lakshmanan et al.,¹⁹ Chilakamuri S et al.,²⁰ suggested that precooling the injection site can reduce the pain in paediatric patients. For direct application of ice-pack the empty local anaesthesia cartridges (Septodont, Lignospan special, solution for injection) were used as they are easily acceptable by the child, small in size suitable for child mouth, and ease of placement by the operator."

Whelan et al. (2014)²¹ suggested that distraction can play an important role in diverting the attention, especially among children. For delivering vibrations various systems were developed like Buzzy®, dental vibe which have been evaluated in earlier studies done by Al Hareky M et al.,²² K. J. Alanazi et al.²³ and shown to lower perceived pain levels during needle administration. While Tondon S et al.,⁸ Nameeda K S et al.²⁴ used a mucosal vibrator that is electric toothbrush in

their study and showed that mucosal vibration can be used as an effective means to reduce the intensity of pain during local anaesthetic injection in dental patients. In the present study, an electric toothbrush was selected as the vibration source. The Colgate Kids Barbie battery-powered electric toothbrush was selected for this study because its cartoon-themed design is attractive and appealing to children, making them more comfortable and willing to accept its placement.

The results showed no significant difference in pulse rate and oxygen saturation among the groups. However, FLACC scores during local anaesthetic administration showed significant differences, with the topical gel group showing higher pain scores and the vibration group showing lower pain perception. Similar findings were reported by Magunur PC et al.,¹⁵ Banka A et al.,²⁵ and Tatiya N et al.²⁶ M Aminah et al.²⁷ reported contrasting findings, where precooling reduced more pain than vibration. Shetty A et al.²⁸ observed that both cryotherapy and vibratory stimulation effectively reduced pain, with no statistically significant difference between them.

Overall, both cryotherapy and vibratory stimulation were found to be effective, simple, and safe non-pharmacological methods for reducing pain during local anaesthetic administration in paediatric dental patients.

CONCLUSION

Based on subjective and objective pain assessment, vibratory toothbrush showed better pain reduction followed by cryotherapy and topical LA gel, suggesting that both vibration and cryotherapy can be used as effective alternatives to topical anaesthetic gel.

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