RESEARCH ARTICLE

Effectiveness of Pre-cooling the Injection Site, Laser Biostimulation, and Topical Local Anesthetic Gel in Reduction of Local Anesthesia Injection Pain in Children

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Abstract

Aim and objective: Evaluation of the effectiveness of laser biostimulation (LBS), ice, and local anesthetic (LA) gel in reducing the injection pain during administration of local anesthesia in children.

Materials and methods: A 3-arm, crossover randomized controlled trial included 30 children of age 9–12 years requiring extraction of primary maxillary posterior teeth. Children were randomly allocated to 3 groups of 10 each. After proper isolation and drying of the buccal mucosa, one of the three techniques, i.e., either LBS or ice or LA gel was applied for 1 minute followed by administration of the LA solution. The pain response was assessed using Wong-Baker Faces Pain Rating Scale and the Sound Eyes Motor scale (SEM). Kruskal–Wallis ANOVA and Mann–Whitney *U* tests were performed for intragroup and intergroup comparisons, respectively.

Results: Lower pain score of zero suggesting no hurt was given by more children in the ice group, followed by LA gel and LBS groups in both the scales. The differences in pain scores recorded were found to be statistically significant.

Conclusion: Ice is found to be equally effective as LA gel, whereas low-level laser therapy is less effective compared to the other two techniques in reducing the injection pain during administration of maxillary posterior buccal infiltration in children.

Clinical significance: Pain management during LA injection is a critical step in gaining initial trust and during the subsequent treatment visits. The present study suggests that simple methods like pre-cooling the injection site with ice can be used as an effective non-pharmacological technique to reduce injection pain.

Keywords: Ice, Local anesthetic gel, Local anesthesia, Low-level laser therapy, Pain perception, Randomized controlled trial.

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Introduction

Local anesthetic (LA) injections are usually the most scary and anxiety-provoking stimuli in pediatric dental practice.[1] The fear of pain caused during injection of anesthetic agents is definitely a hurdle for delivering appropriate dental care.[2] Proper local anesthesia is essential for the successful treatment of children which alleviates the anxiety and pain during various treatment procedures.[3]

To lessen the pain during administration of the LA injection, several pharmacological and non-pharmacological methods such as the utilization of topical anesthetics, slowing down the rate of infiltration, distracting the children, vibrating the tissue around the injection site during injection, heat and cold application before the injection have been tested. Application of flavored topical anesthetic gel is most commonly practiced in pediatric dentistry.[4]

The application of ice is a common practice to reduce signs of inflammation. This technique is being used as first aid in the management of sprain injuries, fractures of bones, and bruises of soft tissues.[5] Cooling with ice causes vasoconstriction, reduces the tissue metabolism, slows down the inpouring of inflammatory mediators, and activates inhibitory pain pathways which in turn suppresses the pain perception.[6]

Low-level lasers are being used in pain management in dentistry. They have been used for reducing pain during intradermal and intramuscular injections.[7] Biostimulation with low-level lasers provides analgesia. It stimulates the production of beta-endorphins which are considered as body's natural pain killers. It decreases the activity of c-fibers and inhibits the conduction of nerve fibers, thereby alters the pain threshold.[8]

The available literature on the use of ice and low-level laser for reducing injection pain in pediatric dental practice is sparse. Hence, the present clinical trial was carried out to test the effectiveness of laser biostimulation (LBS), ice, and LA gel in reducing pain during administration of LA injection in children.

Materials and Methods

A 3-arm, crossover randomized controlled trial was carried out in 30 children aged 9–12 years attending the outpatient Department of Paediatric Dentistry. The non-probability proportional quota

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sampling technique was followed. Ethical clearance was received from the institutional ethical committee (VDC/IEC/2016/30), and the trial was enrolled in Clinical Trials Registry—India (CTRI/2018/05/014298).

Children with cooperative behavior, without any confounding medical history, and who required the extraction of primary maxillary posterior teeth were included. The procedural details were explained to all the children according to their cognitive levels and also to their parents. Written informed consent was taken from the parents or guardians of all the children participating in the study.

Sample Size

Based on the previous studies, setting the significance level at 5%, power 80% and difference 25%, the required sample size was derived as 24 using the formula $n = [(Z_{\alpha/2} + Z_{\beta})^2 \times \{(p_1 (1 - p_1)) + (p_2 (1 - p_2))\}]/(p_1 - p_2)^2$. However, assuming the sample drop-out rate of 20%, the final sample size taken was 30 per group.

Children were randomly assigned to three groups by lottery method. The allocation sequence concealment was done by using sequentially numbered, opaque, and sealed envelopes. Random allocation sequence generation and assignment of participants were done by a doctor who is not associated with the study.

All the injections were administered by the principal investigator. After proper isolation and drying of buccal mucosa, one of the three techniques was used, i.e., Technique 1—LA gel application (Vishalcare gel, Vishal dentocare Pvt. Ltd., Ahmedabad); Technique 2—Ice application (Ice was made by filling the finger part of gloves with water which was then looped and freezed); and Technique 3—Laser biostimulation (Diode Laser, DenLase, China Daheng Group, Inc.) with 0.3 W power at a wavelength of 810 nm and probe tip kept 2 mm away from the surface in pulsed mode for 1 minute. Then, an injection of LA solution (Lignox 2% A, Kilitch Drugs India Ltd., Navi Mumbai) was carried out at a rate of 1 mL/minute.

The subjective and objective assessments of pain response were carried out during the administration of local anesthesia using Wong-Baker Faces Pain Rating Scale[9] and Sound Eyes Motor scale (SEM),[10] respectively.

Statistical Analysis

The obtained data were statistically analyzed using non-parametric tests. Since the data are ordinal, intragroup comparisons were done using Kruskal–Wallis ANOVA and intergroup comparisons with the Mann–Whitney *U* test.

Results

It was observed that a score of 0 with a subjective scale suggesting no hurt is expressed by 16 children in the ice group, 14 children in the LA gel group, and only 7 children in the LBS group (Table 1). Similarly, score 1 with an objective scale suggesting comfort is recorded with 28 children in the ice group, 23 children in the LA gel group, and only 12 children in the LBS group (Table 2).

On intergroup comparisons, the difference in the subjective and objective pain scores between LA gel and ice groups is found to be statistically not significant. Whereas, the difference in pain scores is found to be statistically significant between LBS and LA gel groups. Similarly, when scores in the LBS group were compared with the ice group, the differences are found to be statistically significant (Tables 1 and 2).

Discussion

Intraoral local anesthesia is frequently used in children to reduce pain during various dental procedures.[3] Paradoxically, administration of LA injection itself produces pain and anxiety which may cause subsequent unfavorable behavior. Application of topical anesthetic gel at the site of injection is the most practiced technique to reduce the pain associated with the LA injection.[3]

In the present study, strawberry-flavored 20% benzocaine gel was used as a control with a piece of evidence to consider it as the most effective topical anesthetic agent used in pediatric dentistry.[4] Fewer allergic reactions are being reported on prolonged repeated use of 20% benzocaine proving its safety in children.[11]

Cooling the injured tissues to suppress/reduce inflammatory signs was in practice since the olden days. Local application of ice packs for pain relief is being done for treating sprain and burn injuries, bruises, insect bites, and musculoskeletal pain. We considered the application of ice for reducing injection pain as one of the test groups based on the understanding of its effectiveness in reducing pain, ease of making the desired shape, and low cost.[5]

The application of lasers for many soft and hard tissue procedures is commonly done in dental practice. It is learned to be less invasive with the least discomfort for the patients.[12,13] Laser biostimulation is considered as other test group to reduce injection pain based on the premise that low-level lasers are effective in producing analgesia.[7]

Measurement of pain is a challenging task, especially while working with children because of their limited experiences and vocabulary, lower cognition, and underdeveloped capacity of expressions.[14] Self-report of pain in children is not reliable since it is influenced by developmental, situational issues, and anxiety. Hence, observational and/or physiologic measures should be considered in conjunction with self-report measures.[15]

Subjective measurement is generally considered a gold standard while assessing pain.[16] We employed Wong-Baker FACES Pain Rating Scale for subjective evaluation since this can be used in all age groups, easy to use, and repeatable with fewer errors.[16] SEM scale was used for objective measurement of pain as it consider eyes, movements of the body, and verbal expressions.

Findings of this study have shown that lower pain scores were recorded in the pre-cooling with ice group and found to be equally effective as LA gel. Topical cold application triggers myelinated A-fibers, activates inhibitory pain pathways, which in turn suppresses the pain perception.[6] The observations by Mohiuddin et al. have shown that pre-cooling before infiltration anesthesia reduced the pain perception in pediatric patients when compared to topical anesthetic gel.[1]

Laser biostimulation was found to be less effective compared to LA gel and pre-cooling with ice in reducing the injection pain. Similar observations were reported by Ghaderi et al., who found that there was no reduction in pain perception with concurrent application of laser and topical anesthetics on the buccal mucosa before the administration of LA injection.[17] Contrarily, Sattayut when evaluated the effectiveness of low-intensity laser therapy (LILT), topical anesthesia, pressure, and light touch for pain reduction during palatal injection, found no significant differences in pain scores among the different techniques used.[18] Variations in choice of laser parameters such as the wavelength of the laser unit, the power delivered, mode of application, i.e., either contact or non-

Table 1: Distribution of subjective pain scores in proportions after the use of LA gel, ice, and laser biostimulation (LBS) for reduction of injection pain

Subjective scores	*LA Gel (n = 30)*	*Ice (n = 30)*	*Laser biostimulation (LBS) (n = 30)*	*Kruskal–Wallis ANOVA*	*p value*	*Pairwise comparison, Mann–Whitney U test*
Score 0	14 (46.7%)	16 (53.3%)	7 (23.3%)	7.100	0.029, S	LA gel vs Ice, $p = 0.657$
Score 2	13 (43.3%)	11 (36.7%)	16 (53.3%)			
Score 4	3 (10%)	3 (10%)	5 (16.7%)			LA gel vs LBS, $p = 0.037$, S
Score 6	0 (0%)	0 (0%)	2 (6.7%)			
Score 8	0 (0%)	0 (0%)	0 (0%)			Ice vs LBS, $p = 0.014$, S
Score 10	0 (0%)	0 (0%)	0 (0%)			
Mean ± SD	1.27 ± 1.34	1.13 ± 1.36	2.13 ± 1.66			

Kruskal–Wallis ANOVA and Mann–Whitney *U* test; S, significant

Table 2: Distribution of objective pain scores in proportions after the use of LA gel, ice, and laser biostimulation for reduction of injection pain

Objective scores	*LA Gel (n = 30)*	*Ice (n = 30)*	*Laser biostimulation (LBS) (n = 30)*	*Kruskal–Wallis ANOVA*	*p value*	*Pairwise comparison, Mann–Whitney U test*
Score 1	23 (76.7%)	28 (93.3%)	12 (41.7%)	11.273	0.004, S	LA gel vs Ice, $p = 0.073$
Score 2	7 (23.3%)	2 (6.7%)	16 (53.3%)			
Score 3	0 (0%)	0 (0%)	2 (6.7%)			LA gel vs LBS, $p = 0.04$, S
Score 4	0 (0%)	0 (0%)	0 (0%)			
Mean ± SD	1.23 ± 0.43	1.07 ± 0.25	1.67 ± 0.61			Ice vs LBS, $p = 0.00$, S

Kruskal–Wallis ANOVA, Mann–Whitney *U* test; S, significant

contact, time of exposure, type of exposed tissue, and physiological condition of the exposed tissue can affect the outcome.[13]

Pain management during LA injection is a critical step in gaining initial trust and during the subsequent treatment visits. The observations of the current study suggest that pre-cooling the injection site with ice can be considered as an effective non-pharmacological technique to reduce injection pain.

Conclusion

Pre-cooling the injection site with ice is equally effective as topical anesthetic gel in alleviating the injection pain during maxillary posterior buccal infiltration in children and it can be considered as a cost-effective, non-pharmacological method for reducing LA injection pain in children. Laser biostimulation therapy was found to be less effective compared to the other two techniques.

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