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Research Article

The Effectiveness of Pre-Cooling the Injection Site in Alleviating the Pain of Oral Injections in Pediatric Subjects

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Abstract

Successful dental treatment of children, in regards to relieving their fear, anxiety and discomfort during restorative and surgical procedures, is promoted by profound local anesthesia. Pre-cooling the injection site has been found to be an effective and safe method to alleviate the anxiety in such young children. Numerous methods have been used to minimize pain during injection of local anesthetics (L.A), such as the application of topical anesthetics, warming the local anesthetic agents, adjusting the rate of the infiltration or buffering the local anesthetic. The aim of the present study is to compare and evaluate the effect of topical cooling of injection site and application of topical aesthetic gel on pain perception in maxillary infiltrations among paediatric patients undergoing extractions. There was a statistically significant difference between all the variables among the groups ($p < 0.001$) proving that pre-cooling the injection site serves as a safe and effective method to reduce the anxiety and fear in children. It also provides distraction from the process of L.A. administration making the process smooth and uneventful for the pediatric subjects.

Keywords: Anxiety; Ice; Local Anesthesia; Children

Introduction

For children, the anticipation of pain or discomfort associated with dental care is a significant deterrent in seeking appropriate treatment. Local anesthetic injections are one of the most feared or anxiety-inducing stimuli in dental operatory. Due to the subjective fear of pain, attributed to injection of anesthetic agents, providing appropriate dental care in children is difficult [1]. The pain associated with infiltration of local anesthesia quickly develops into avoidance behavior, with implications for future procedures [2-4]. Anxiety induced by preceding infiltrative pain is counterproductive [5].

Successful dental treatment of children, in regards to relieving their fear, anxiety and discomfort during restorative and surgical procedures, is promoted by profound local anesthesia [6]. Numerous methods have been introduced to minimize pain felt by the child during injection of local anesthetics (L.A), such as the application of topical anesthetics (e.g., Benzocaine, lidocaine) [7] in the form of gels, ointments, solutions, and adhesive patches warming or buffering the local anesthetic agents, [8-11] changing the rate of the infiltration (WAND teq.) [10] by reducing the speed of injection, counter-irritation, [11] and distraction technique [12].

Furthermore, vibrating the surrounding tissue while administering the injection, applying pressure to the injection site, acupuncture and use of a mechanical delivery system (eg. dental vibe, vibra ject) have been seldom used to alleviate the pain experienced during administration of dental anesthetic agents [13,14].

Cooling of the injection site is one of the most primitive methods to relieve the pain of the injection. In various studies, ice has been used to reduce pain and discomfort during administration of a local anesthetic injection, and helps to control postoperative pain and edema [5,15-17]. Ice is believed to help control pain by inducing anesthetic effect around the treatment area. "Investigators have also shown that it reduces edema, nerve conduction velocities, cellular metabolism, and local blood flow" [5].

There have been numerous studies conducted in the dental field to assess the effect of pre-cooling the injection site. The first study was done by Harbert., *et al*. in 1989 and he reported cooling of palatal area before injecting L.A. relieved pain perception [18]. Other studies by Ghaderi., *et al.* and Aminabadi., *et al.* concluded that pre-cooling the injection site prior to administration of local anaesthesia significantly reduced the pain perceived by pediatric

patients [19,20] In a study by Kosaraju., *et al.* a comparison was made between 5-s application of a refrigerant and a 2-min application of a topical anesthetic gel in the maxillary posterior palatal area prior to injection of a local anesthetic solution. They reported that the application of a cooling agent e.g. refrigerant as a pre-injection anesthetic was more effective compared to the use of a topical anesthetic gel in reducing the pain [21].

A study conducted by Aminah M., *et al.* compared the effect of different desensitizing techniques such as application of topical anesthetic gel, pre-cooling the site, vibration and buffering the anesthetic agent in reducing pain of injection among pediatric patients. They concluded that out of all the above stated methods, pre-cooling the injection site significantly reduced the pain perception in pediatric patients [22].

The aim of the present study is to compare and evaluate the effect of topical cooling of injection site and application of topical anesthetic gel on pain perception in maxillary infiltrations among pediatric patients undergoing extractions.

Materials and Method

A single-centered, randomised, cross-over study was conducted in the Outpatient Department of Pedodontics and Preventive Dentistry over a period of four months. Ethical clearance was obtained from the University Ethics Committee and written informed consent was taken from parents/guardians prior to the start of the study:

- A total of 50 patients of age ranging from 7 - 12 years, requiring bilateral extraction of maxillary 1st and 2nd primary molars were included in the study and were divided into Group A and B.
- Group A: Consists of 50 patients in whom injection site was pre-cooled by ice application for 4 mins prior to the infiltration injection on the right side. "The appropriate time of application of ice ranges from 2–5 minutes" [25], In order to prepare ice, empty lignocaine cartridges were filled with water and placed in a freezer.
- Group B: Consists of 50 patients in whom lignocaine gel was applied before the needle penetration on the left side.
- In each patient, after pre-cooling or application of anaesthetic gel on the contra-lateral sides, 2% Lignocaine was administered. With this crossover design, each subject served as his or her own control and hence, the inter-patient variability during evaluation was avoided.
- After checking the subjective and objective symptoms, the tooth was extracted.
- The appointments were spaced at least one week apart.

Inclusion criteria

1. All the patients selected were co-operative i.e. Frankel's rating scales III (positive) and IV (definitely positive).
2. Patients indicated with bilateral extraction of maxillary 1st and 2nd primary molars were included in the study.
3. They have no aversive or negetive experience about medical or dental treatment.
4. Patients willing to participate in the study, with due considerations and informed written consent
5. Patient not taking any medications for pain or infection.

Exclusion criteria

1. Subjects allergic to LA drugs or cartridge components
2. Patients who were systemically compromised (congenital heart disorders, genetic disorders) or specially-abled.

Patients were allotted by lottery method for deciding the type of topical anesthesia to be delivered first. The patients self-reported the pain on injection pain which was immediately reported and evaluated using the visual analogue scale (VAS) that is often used to measure pain intensity (Figure 1). The VAS is a 100 mm horizontal line with hash marks every 10mm labeled 0-10. "NO PAIN" was labeled under the "0" on the left end and "WORST POSSIBLE PAIN" was labeled under the "10" on the right end. Immediately after each injection, the patient was instructed to mark a vertical line on the 100 mm line to indicate the level of discomfort experienced during the injection. The objective assessment of pain was done by the dentist using the sound, eye and motor (SEM) scale during administration of local anaesthesia (Figure 2). SEM scale has score ranging from 0-3 depicting comfort to severe discomfort based on Sounds, Eye and Motor parameters and the total scores for SEM range from 0 to 9.

Figure 1: Visual Analogue Scale (VAS).

Score	Designation	Sounds	Eyes	Motor
0	Comfort	No sound indicating pain	No eye signs of discomfort	Hands, relaxed, no apparent body tenseness
1	Mild discomfort	Nonspecific possible pain indication	Eyes wide show of concern, no tears	Hands show some tension
2	Moderately painful	Specific verbal complaint e.g. ow! Voice raised	Watery eyes	Random movement of arms/body grimace, twitch
3	Painful	Verbal complaint indicates intense pain	Crying tears running down the face	Movement of hands to make aggressive physical contact, pulling head away punching

Figure 2: Sound, Eye, Motor Scale (SEM).

Statistical analysis

The data was collected and tabulated on an Excel Spreadsheet. Descriptive and inferential analysis was done using SPSS software 20.00. Normality of data was checked with statistical inference for application of parametric tests. (Table 1) Data was analyzed using paired t test. P value < 0.05 was considered significant.

	Control				Case				Difference			
	VAS	Sound	Eye	Motor	VAS	Sound	Eye	Motor	VAS	Sound	Eye	Motor
Mean	1.14	1.26	1.30	1.36	0.40	0.38	0.44	0.52	0.74	0.88	0.86	0.84
SD	0.783	0.633	0.678	0.525	0.495	0.490	0.501	0.544	0.944	0.799	0.808	0.710
Median	1	1	1	1	0	0	0	0.50	1	1	1	1
IQR	1	1	1	1	1	1	1	1	1	1	1	1
Normality Assumptions Satisfied									Yes	Yes	Yes	Yes
Parametric Statistical Test Applicable									Yes	Yes	Yes	Yes

Table 1: Normality of Data.

Results

VAS: The mean VAS score and standard deviation for the ice application group was 0.40 ± 0.49 and for the control group was 1.14 ± 0.78. The difference between the groups was statistically significant. (p < 0.001) (Table 2 and 3)

Variable	Group	N	Mean	Std. Deviation	Std. Error Mean
VAS	Control	50	1.14	0.783	0.110
	Case	50	0.40	0.495	0.070
Sound	Control	50	1.26	0.633	0.089
	Case	50	0.38	0.490	0.069
Eye	Control	50	1.30	0.677	0.095
	Case	50	0.44	0.501	0.071
Motor	Control	50	1.36	0.525	0.074
	Case	50	0.52	0.544	0.077

Table 2: Mean and SD for the case and control groups.

SEM values

The mean score and standard deviation for sound for the ice application group was 0.38 ± 0.49 and for the control group was 1.26 ± 0.63. The mean score and standard deviation for eye movement for the ice application group was 0.44 ± 0.50 and for the control group was 1.30 ± 0.67 and mean score and standard deviation for the motor movements was 0.52 ± 0.54 and for the ice application group was 1.36 ± 0.52 for the control group respectively. There was a statistically significant difference between all the variables among the groups. (p < 0.001) (Table 2 and 3).

Discussion

Pain and anxiety have been associated with the fear of dental injections. "Cry anesthesia is based on the application of ice or cold to a surface area of the body, causing reduction of action potentials and resulting in sensorial nerve conduction blockade" [23]. In dentistry, the application of topical pre-cooling the oral mucosa prior to local anesthetic infiltration injections can alter the perception of pain for both children and adults.

Variable	Mean Difference between control and case groups	SD	95% Confidence Interval of the Difference		t-value	df	p-value
			Lower	Upper			
VAS	0.74	0.944	0.472	1.008	5.546	49	<0.001
Sound	0.88	0.799	0.653	1.107	7.788	49	<0.001
Eye	0.86	0.808	0.630	1.089	7.523	49	<0.001
Motor	0.84	0.710	0.638	1.042	8.363	49	<0.001

Table 3: Comparison of pain using the VAS & SEM scales for both the groups.

In the present split mouth study, a comparison was made to study the effect on pain perception by topical cooling of injection site and application of topical local anaesthetic gel in maxillary infiltrations. A statistically significant difference was noted in the amount of pain perceived by children in whom the injection site was pre-cooled with ice.

Several pain rating scales exist and were developed primarily to be used in young children. In the present study, Visual Analogue Scale (VAS) and SEM Scale was used for the subjective and objective assessment of pain perception. "The scales are repeatable, easy to use and have proven to have significant positive correlation". It has been used for pain assessment in children and adults in various studies [20,24].

Harbert., et al. [18] in their study observed significant reduction in pain perception during LA infiltration when ice was applied topically on the palatal mucosa before and during the infiltration procedure. Ghaderi., et al. [20] used a cross-over design in 50 healthy pediatric patients, evaluating the pain perception during LA buccal infiltration after using topical anesthesia (20% benzocaine, 1 min) with or without the application of an ice pack (1 min) using VAS and SEM scale. It was observed that cooling the injection site before infiltration of the LA reduced the perceived pain. The mean value of SEM scale in their study and control groups were significantly different in totals (SEM) as well as sound, eye and motor parameters individually($P = 0.000$). Also, the means of VAS values in their study and control groups were 42.20 ± 12.70 (range: 0-100) and 58.40 ± 16.83 (range: 0-100) respectively, with statistically significant lower VAS scores in the study group ($P < 0.05$).

Another such study by Aminah M, Nagar P, Singh P and Bharti M reported a statistical significant difference when pre-cooling was used at the injection site compared with topical anesthesia and buffered local anesthesia ($P < 0.001$) using Mann-Whitney test [22].

Study done by Kosaraju A and Vandewalle KS had similar results. The group receiving the refrigerant had a mean VAS score of 17.7 +/- 15.3 mm, and the group receiving the topical anesthetic gel had a VAS score of 26.2 +/- 18.0 mm. The use of the refrigerant compared with the use of topical anesthetic gel significantly reduced the pain experienced during administration of local anesthetic injections ($P = .02$) [21].

In another study by Aminabadi NA and Farahani RMZ applied Benzocaine, for 1 min followed by a 2-min application of ice at the injection site in pediatric subjects aged 5-6 years. Sound, eye, and motor (SEM) was used to evaluate pain perception of children during injection. They found that all the three variables of the SEM in the IP (ice pretreatment) group were consistently lower than the WIP (without ice pretreatment) group ($P < 0.05$). Moreover, the SEM value for the WIP group surpassed the IPgroup($P < 0.05$) [19].

"Local cooling is also believed to slow or eliminate pain signal transmission and to retard neuromuscular transmission. In addition, cooling muscle tissue reduces its tone via a reduction in the activity of muscular spindles. Topical cold application stimulates myelinated A fibers, activating inhibitory pain pathways, which in turn raises pain threshold" [25]. The results of the present study can be generalized with prudence, as there were limitations of smaller sample size and no use of placebo or negative controls in the study design.

Conclusion

Cooling the injection site prior to administration of L.A. significantly reduced the pain on injection. The application of ice helps reduce the anxiety and fear in children as it serves as a distraction from the process of L.A. administration. The ice application is safe, easy and effective method of pain reduction at no additional cost and aids in better clinical management of the child.

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Conflict of Interest

Nil.

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