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Comparative Evaluation of Pain Perception by Vibration Anesthesia and Precooling of Anesthesia Site during Anesthesia in Pediatric Patients Undergoing Dental Procedures - An *in Vivo* Study

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Abstract:
Aim: The study was aimed to comparatively evaluate the effectiveness of cooling the anesthetic sites and using Vibraject™ on the pain perception of pediatric patients while administration of local anesthesia in the patients undergoing dental treatment.
Methodology: A total of 20 children aged 4 and 12 years who reported in Department of Pedodontics, Yogita dental college and hospital for dental treatment were selected. In the first appointment, ice application (IA) on anesthesia site and anesthesia was administered by conventional syringe. On opposite side of the same dental arch on the later visit anesthesia was administered by using Vibraject™ (VA). The behavior of child was evaluated using the sound, eye, and motor (SEM) scale during the administration of an inferior alveolar nerve block, and the results were correlated between vibration anesthesia and pre cooling of the anesthesia site. The analysis of variance was used to perform the statistical analysis of the results (ANOVA).
Results: For the VA and IA classes, there were no major variations in the values of the sound, eye, and motor components within the groups ($P>0.05$). In the IA party, all three components of the SEM were consistently lower than in the VA group ($P<0.05$).
Conclusion: In pediatric patients, pre-cooling the anesthetic site was effective in eliminating pain. Even though both the techniques Vibraject™ , and ice tubes used were effective in decreasing the pain perception during the during local anesthesia

Introduction:

The majority of children are afraid and apprehensive about the discomfort that occurs during the injection of local anesthetics. (1) The correlation of pain with avoidance habits grows rapidly, which can influence future clinical procedures. (2,3) Anxiety plays an even bigger role in pediatric patients. The foundation of pediatric behavior management is effective pain control during dental care. To be effective, measures performed under local anesthesia need patient cooperation. (4)
Several strategies for reducing pain induced by the application of local anesthetic agents have

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been proposed. The following are some of them: (5-11)

• Topical analgesics application.
• Distraction techniques.
• Counter irritation.
•Anesthetic agents warming.
• Slowing the injection speed.
• Buffering the local anesthetic solution.

In medicine, cooling distressed tissues has a long tradition. Burns, sprains, bug bites and fractures have also been treated with local peripheral cooling for pain release. It is normal to use local skin cooling to relieve pain from sports injuries. (12,13) Postoperative skin cooling has been observed to minimize wound pain and edema in a various study. (14,15) These cooling strategies have a lot of promising potential for pre-operative use. (16) Ethyl chloride is commonly used in minor surgical operations, myofacial pain and minor sports injuries as a pre-injection anesthetic and for pain management. (17,18) Ice also has been used to treat musculoskeletal pain, postoperative pain, pain at local anesthetic injection site and edema prevention. (19,20) However, it appears that only a single study has looked into the impact of local mucosal cooling before local anesthesia infiltration on nociceptive function in dental procedures. (21)
While soft tissue vibration has been used to alleviate pain in other body parts, there have been very few researchers used vibration to control the pain of oral injections. (22-24). Vibraject, LLC, California, has recently launched a vibrating dental local anesthesia accessory. It centered on the gate-control theory, that states "if a nerve impulses induced by tactile sensation are simultaneously transmitted through A-beta tactile fibers, it depresses pain transmission through A delta and C nociceptive fibers at the secondary neuronal cell bodies in the dorsal horn." It is therefore hypothesized that vibrating a needle with Vibraject™ can result in a reduction of injection pain.
Therefore, the study was aimed to comparatively evaluate the influence of cooling the soft tissue on injection sites and using Vibraject™ on the pain perceptions of pediatric patients while the administration of local anesthesia for subjects undergoing dental procedures.

Methodology:
A total of 20 children aged 4 and 12 years, visited the Department of Pedodontics and Preventive Dentistry, Yogita dental college and hospital khed for dental care were randomly selected. The chosen subjects were in perfect physical and mental health, with no medical history. Carious mandibular primary first or second molars were chosen as the study's target. To begin the research, the ethical committee gave its approval. The patient, parents, or guardian signed a detailed informed written consent before the procedure.
The following parameters were used to determine whether or not a patient should be included in the study:

- Child with Frankel's Class III or IV behavior.
- Because of the presence of carious primary mandibular molars, an inferior alveolar nerve block is required.
- No history ofdental phobia.
- No previous intraoral injections experience.
- No history of pain secondary to or hyperalgesia or allodynia.

Exclusion criteria was as followed-

- Significant behavioral problem.

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- Positive medical history and developmental abnormalities.

The IA group's treatment started with a 2-minute ice pre-treatment of the soft tissues around the injection site by an ice tube, which was formed by filling a finger of a latex glove with water, tying the open end, and putting it in the freezer. For the groups, a standard inferior alveolar nerve block injection technique was used.
On a subsequent visit with the same patient, Vibraject^{TM} was used to deliver local anesthesia on the opposite side of the same dental arch. The vibration range was around 1 mm (short back-and-forth as well as up-and-down motions), and the vibration frequency was 1 cycle per second.
The SEM scale was used by a second dentist who was unaware of the study protocol to measure patient's actions during injections. The SEM scale's evaluation criteria include three different types of data: child sounds (verbalizations), eye signs, and body movements. To determine inter-examiner agreement of the results, another observer did the SEM valuation alongside the second investigator at random.
The means are used to display all quantitative data. The analysis of variance (ANOVA) was used to perform the statistical analysis of the results. $P<0.05$ was used to show statistical significance in the current study.

Results:
The IA group had 6 girls and4 boys with a mean age of 6.1 years, while the VA group had 3 girls and7 boys with a mean age of 6.4 years. In terms of age ($p = 0.24$) and sex ($p = 0.48$), there was no substantial difference between the two classes.
Table 1shows the results of the SEM scale. Both groups expressed a painful response on the SEM scale for all three components (sound, eye, and motor). In the IA group, there were no serious pain reactions. For the VA and IA classes, there were no major variations within group in the values for the sound, eye, and motor components ($P>0.05$).

Table 1: The results of the SEM scale

Group	Sound	Eye	Motor	Sum
Ice Application (n=10)	1.15	1.25	1.10	3.50
Vibraject Application (n=10)	1.54	1.25	1.28	4.07

There was a statistically significant difference between the VA and IA groups ($P<0.05$). In the IA group, all three components of the SEM were consistently lesser than in the VA group. Furthermore, the VA group's SEM value was higher than the IA group's ($P<0.05$).

Discussion:
The study aimed to compare the effects of cooling soft tissue at injection sites and using VibrajectTM on pediatric patients' for the assessment of pain experiences during the administration of local anesthesia for dental procedures.
The current study found that cooling the site of injection at 0°C for 2 minutes before injecting a local anesthetic agent substantially reduced discomfort during local anesthesia administration.
These results are in line with the research studied laser therapy and inguinal hernia repair by skin cooling. Chan et al. (16) treated patients with nevus of Ota using a laser with a cooling

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unit and lesser pain was reported on the side where cooling was used. In patients undergoing inguinal hernia repair, Leff et al. (25) found that pre-cooling the site of injection for a nerve block 5 minutes before to the local anesthesia administration substantially reduced the pain experienced during the injection. Harbert (21) applied topical ice to alleviate pain sensitivity relatedto palatal injections, and his findings are similar to those of the current research. Furthermore, Goel et al. (20) applied ice cubes as a cryoanalgesic before administering local anesthetic for eyelid surgery, and observed that injection pain was significantly reduced. The discomfort produced by lidocaine and epinephrine injection was also minimized by ice application, according to Kuwahara and Skinner. (26)

Several hypotheses have been proposed to understand how ice pretreatment decreases the symptoms of injury and causes analgesia at the local level. These include decreased tissue metabolism and vasoconstriction, that reduce inflammatory mediator inflow and reduce edema. This may explain why topical cooling is so effective at reducing swelling and bleeding after sports injuries and orthopedic surgery. (27,28) Local cooling is often thought to delay or stop the conduction of pain signals. (29) Cold has the effect of slowing the conduction of nerve impulses. While nerve fibers transmit at different speeds, they show a significant decrease in speed with each degree fall in temperature, eventually stopping totally between 10°C to 0°C. (6)

This research, however, had some limitations. Ice touch discomfort is time-dependent, and the threshold is highly particular. The recommended duration to wait for topical anesthetic diffusion ranges from 2 to 5 minutes. This procedure's 5-minute length can be well tolerated by nervous adults and adolescents, but less tolerated by anxious children. (25) Based on our preliminary research, a 2-minute application time for the ice tube was found to be optimum. The findings of this study back up the theory that topical pre-cooling increases the pain tolerance to noxious stimuli like needle penetration during local anesthetic injections.

Vibraject^{TM} is a vibration-based battery-operated detachable system that can be used in routine local anesthesia procedures. Vibration relieves discomfort and deliversinterventional relaxation. (30) In our research, we discovered that using Vibraject for anesthetic injections reduces pain sensitivity considerably.

Marie et al. (23) looked at the efficacy of stimulationby vibration as a treatment for orthodontic pain and discovered a substantial difference in average pain ratings over time periods. The affects of extraoral vibration stimuli on pain encountered during inferior alveolar nerve block and buccal infiltration of local anesthetic injections were investigated by Nanitsos et al. (22). They proposed that vibration can be used to diminishthe discomfort while administration of a dental local anesthetic.Shahidi Bonjar (31) proposed the idea of mounting a promising revolutionary technology in pain and anxiety control, the syringe micro vibrator, with a traditional dental anesthesia injection syringe. This system is more beneficial for both children and those who are afraid of intraoral injections or pain.

Conclusion:

In pediatric patients, pre-cooling the anesthetic site was more effective in eliminating pain. Even though Vibraject^{TM}, also had a significant improvement in decreasing the pain perception during administration of local anesthesia.

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