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Different Techniques in Eliminating Discomfort of Local Anesthesia Injection during Dental Procedures

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1. Introduction

Pain control during dental treatment is one of the most important aspects of pediatric patient behavior management during dental visits. Experiencing pain during dental treatment not only disturbs the cooperation, but may also affect the patients point of view of dentistry in the future. Local anesthesia is commonly indicated in dental procedures in order to prevent discomfort during treatment, so that dental procedure can be carried out effectively[1]. Although local anesthesia is considered to relief the pain, the injection on its own may cause pain and therefore cause uneasiness and mistrust [2], to the extent that the perceived pain is one of the obstacles of providing appropriate dental treatment for pediatric patients [3].

The pain caused by the local anesthesia is influenced by different factors such as: type of anesthetic solution, gauge size of the needle, temperature and pH of the anesthetic solution [4], location of the injection site [5],and the pace and amount of the injection [6]. On the other hand, psychologic factors like anxiety, fear of dental pain, fear of dental injection, and also demographic factors like gender may also influence pain perception [7].

Various techniques have been introduced in order to minimize the pain of local anesthesia. The most widely advocated technique is the use of topical anesthetic agent before injection [8], however, due to shortcomings such as longer duration of action, displeasing taste, and spread of the anesthetic agent to non-injection sites, other modalities have been developed [9]. Other methods include, warming [10] and buffering [11] the local anesthetic solution, cooling the injection site [8, 12], slow infiltration of local anesthesia [13], distraction and other counter-irritation methods [14]. Some newly introduce mechanical devices have been used such as: Computer Controlled Local Anesthesia Delivery System (CCLAD) [15], Wand [16] and Comfort Control Syringe (CCS) [17]. Furthermore vibrotactile devices like Vibraject [18] and Dental Vibe [19] may act as counter stimulation and therefore reduced the pain. Low Level Laser Therapy (LLLT) or soft laser is also a method which claims an analgesic effect and can reduce the pain from local anesthetic injection [4].

Considering local anesthesia injection may cause the greatest negative response for pediatric patients, and the fact that this negative response increases over a series of four or five injections [1]; we overview available strategies of pain reduction during local anesthesia injection for dental procedures.

2. Low Level Laser therapy

Considering the recent advances, laser therapy seems more promising. Low level Laser Therapy (LLLT) is a monochromatic and coherent light of single wavelength of 600 to 950 nm, as this wavelength demonstrates greater diffusion and does not have any ablating effects. LLLT is based on the principle of photobiostimulation of the cells and has different applications such as pain reduction and healing promotion [20]. There are a few dental reports in this field, however, only some medical studies have been conducted [21, 22] Jagtap et al [4] that surveyed the effect of Low level Laser Therapy for pain reduction during local anesthetic injection. In the study, pain perception of patients was assessed, considering the application of LLLT (diode laser, wavelength 660 nm, and output power 60 wM) at the site of injection and without LLLT application, using Visual Analogue Scale (VAS). The comparison of pain perception in the laser and placebo conditions indicated that LLLT reduced pain during injection of local anesthesia. In another study, Ghaderi et al [23] assessed pain perception during needle insertion into mucosa following topical anesthetic agent(Benzocaine gel)

plus low power laser(Aluminum gallium arsenide, energy density of 4 J/cm2, power 100 mil W, continuous wave, wavelength 960 nm) in comparison to topical anesthetic agent plus placebo. Pain perception upon insertion of the needle in both groups were recorded by Visual Analogue Scale (VAS). They concluded that simultaneous application of laser with local anesthetic products containing benzocaine before dental needle insertion does not reduce pain perception.

The analgesic effect of LLLT may be attributed to a few things such as: lesser transmission of impulses as a result of decreased nociceptive signals arising from peripheral nerves, the inhibitory effect of laser on Aδ and C pain fiber, increase in synthesis of nitric oxide, elevation of action potential in nerves, regrowth of axons, regeneration of neurons, reduction in amount of bradykinin, and increase in production of acetylcholine or standardization of ion channel [24-26].

There are not a vast published data on the effect of LLLT on injection sites in dental procedures, and the review of literature provides conflicting results[4, 23]. The reason for this could be attributed to multiple factors which may influence the treatment protocols such as treatment dosage, wavelength, irradiance, contact or noncontact application, exposure time, tissue type, physiological condition and optical properties of the tissue [23]. Further research is needed on the efficacy of LLLT in pain reduction in children.

3. Cooling Technique

There are a few reports on the efficacy of precooling the injection site prior to local anesthetic injection. Various cooling agents have been used such as dichlorodifluoromethane spray [27], tetrafluorethane spray[9], Ice [28], pentafluoropropane/ tetrafluoroethane (refrigerants) [29], and Ethyl chloride [30]. Ice cone has shown significantly higher efficacy in comparison to refrigerants [8]. Harleen Kaur et al. [28] assessed the effectiveness of precooling the injection site by using ice in relieving the pain caused by injection of maxillary infiltration in pediatric patients using VAS sound, eye, and movement (SEM) scale. They concluded that pre-cooling the injection site serves as a safe and effective method to reduce the anxiety and fear in children. Hameed et al [9] evaluated the efficacy of precooling the injection site using tetrafluorethane spray on pain perception in children aged 8-10 years, during IAN block using VAS and SEM. They concluded that precooling the injection site using refrigerant tetrafluorethane spray is effective in eliminating pain before local anesthesia administration in children. In another study Ghaderi et al [12] evaluated the effect of ice pack on pain relief during infiltration of local anesthetic agent in children aged 8-10 years using SEM and VAS. The results confirmed the conclusion of the previous studies. Moreover, several other studies stated that Cryoanesthesia using refrigerant as a topical anesthesia caused reduction in pain perception [29, 31-35].

The rationale behind cooling of injection site is related to delayed neuromuscular transmission [36], increased pain threshold by stimulating myelinated A-σ fibers, activating inhibitory pain pathways, and also inhibiting stretch reflex at the spinal level [37].

4. Warming or buffering techniques

A systematic review performed to analyze the effect of warming the local anesthetic on injection pain, Hogan et al [38] concluded that warming (body temperature in comparison to room temperature) local anesthetics alleviates the pain during subcutaneous or intradermal injection of local anesthetic injections. In another study, performed by Aravena et al [39], the effect of warming(42°C) anesthetics on pain perception during dental injection was evaluated; the results indicated a significant reduction of perceived pain during the injection of anesthesia. Other studies have confirmed these results[40-42].

The mechanism of temperature on pain reduction is that warmed local anesthesia would accelerate the onset of sensory block by increasing the passive diffusion across nonneural structures and simultaneously increasing the nonionized (more penetrable) form of the local anesthetic drug[43] and the synergic action on the permeabilization of the Transient Receptor Potential Vanilloid-1 channels, allowing the passage of anesthetic inside the nociceptors [39].

Reports regarding the effect of buffering solution on pain is controversial [44, 45], Spivakovsky et al[46] performed a review article to evaluate the effect of buffering the local anesthetic solution on pain and concluded that buffered lidocaine does not reduce pain during injection. In a systematic review by Aulestia-Viera et al [47], it was concluded that adjusting the pH of lidocaine was not effective in reducing the pain of intraoral injections in normal or inflamed tissues, therefore, routine alkalinization of local anesthetics was not recommended in dentistry.

5. Vibrotactile Devices

The basis of Vibrotactile devices is the gate control theory of pain. Vibration and touch receptors stimulate inhibitory interneurons in the spinal cord and results in elimination of pain transmit information by A-δ and C fibers to the second-order neurons of the spinal cord [48]. The executed studies showed a controversy regarding the efficacy of Vibraject and DentalVibe. Some of the studies have shown that VibraJect [49] or DentalVibe [50-52] significantly reduced pain and discomfort, while the others did not show any significant difference [53-56].

6. Computer-Aided Delivery Systems

Computerized local anesthetic delivery systems have been developed to make continuous anesthetic solution delivery possible at a slower rate and constant pressure; which may cause less pain in comparison to conventional techniques. Several studies have shown the efficacy of computer-controlled local anesthetic delivery

systems (CCLADS) such as the Wand STA system, Smartject, or comfort control syringe (CCS) in providing less painful injections [17, 57-61]. The results of a review by Kwak EJ et al. [58] stated that using CCLAD resulted in less pain and was more effective anesthesia in adults than in children [58], although, application of CCLADS were still efficient in children[59]. It can be concluded that the main reason of pain during injection is due to inconsistent anesthetic solution pressure on nerve fibers which can be omitted using CCLADS.

7. Jet Injectors

10% of general population suffer from needle-phobia known as blenophobia [62, 63], therefore, needle-less local anesthesia injection techniques have been developed. The mechanism of action of jet-injection is based on releasing the anesthetic solution through a very small orifice with pressure. The most common jet injector devices are Syrijet Mark II and MED-JET [64]. limited clinical evidence is available and the result are controversial. Some of the reposts expressed that needleless jet injection system and conventional techniques did not differ concerning the pain experience during anesthesia [65], while some reports were in favor of Jet injection (INJEX) and showed lower pain perception using INJEX [66].

8. Iontophoresis

Iontophoresis is a non-invasive technique based on the application of electrical potential at a constant low voltage to enhance the delivery of drug ions through biological membranes. Studies regarding the application of iontophoresis in dentistry are limited. Cubayachi et al [67] investigated the influence of iontophoresis as a physical method of permeation enhancement of prilocaine hydrochloride (PCL) and lidocaine hydrochloride (LCL) in buccal mucosa. They concluded that applying iontophoresis to a semisolid formulation of this drug combination can serve as a needle-free strategy to speed the onset and prolong the duration of buccal anesthesia.

9. Aromatherapy

Recently, aromatherapy (application of fragrant volatile essential oils for therapeutic effects) has been stated as a complementary approach in medical and dental settings[68-70]. The concept of the therapeutic use of aromatic essential oils is that it can produce a positive physiological effect through the sense of smell. Aromatherapy can relieve anxiety symptoms and pain in an inexpensive, simple way The aroma of lavender essential oil may lead to decreased anxiety, and increased sedation due to parasympathetic stimulation [71]. However, there was only two studies evaluating the effect of aromatherapy on pain perception during dental treatment including local anesthesia. The results of both studies showed significant decrement in pain perception related to dental injection following aromatherapy. However, more research is needed [72-73].

10. Conclusion

Considering pain control is one of the most important aspects of behavioral management in pediatric dentistry, multiple procedural, behavioral, and pharmacological strategies have been suggested for dental anesthesia injections. Multiple techniques have been indicated to be efficient in reducing pain perception during injection, such as LLLT, cooling techniques, and CCLADS. Conducting more clinical trials to compare effectiveness of pain relief using these techniques in pediatric patients in similar conditions with omitting interfering factors such as type of anesthetic solution, gauge size of the needle, temperature and pH of the anesthetic solution, location of the injection site, and the pace and amount of the injection, is recommended.

11. Conflicts of Interest

The authors deny any conflicts of interest related to this study.

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