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A brief review on the efficacy of different possible and nonpharmacological techniques in eliminating discomfort of local anesthesia injection during dental procedures

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Abstract

Dental anxiety and fear of needle injection is one of the most common problems encountered by dental practitioners, especially in the pediatric patient. In consequences, it might affect the patient's quality of life. Several methods are suggested to lower the discomfort of local anesthesia injection during dental procedures. Desensitization of injection site is one of the recommended strategies. Among chemical anesthetic topical agents that are effective but might have allergic side effects, using some nonpharmacological and safe techniques might be useful. This study aimed to overview the efficacy of using cooling techniques, mostly by ice or popsicles, warming or pH buffering of drug, and using modern devices to diminish the discomfort of local anesthesia injection during dental procedures.

Keywords: Dental anesthesia, injection, pain, vibration

INTRODUCTION

Needle injection of the local anesthetics may induce fear and anxiety to some patients, especially during dental procedures.[1] The feeling of needle being attached to a syringe and penetrating the oral mucosa is quite distressing and carries a negative impact on patient's psychology. Researches have shown that most of the patients postpone their dental visits primarily due to the fear of needles, pain and biting injury from injection.[2,3] Poor pain control alongside the fear and anxiety of the needle might interfere with appropriate dental managements.[4] So, profound local anesthesia is critical, and several methods are introduced to reduce pain during injection such as applying topical anesthetics pastes,[5] warming or buffering the local anesthetic agents,[6,7] and slow inflation of local anesthetics.[8] Furthermore, some studies have focused on cooling the injection site for better pain relief before or after local anesthetic injection. Also, vibration or pressure to the injection site by high-tech mechanical delivery systems has been tried out recently.[9]

Topical anesthetic agents are common to apply prior to local anesthesia injection. They are presented in various chemical bases with different potent and clinical indication; therefore, toxic sequel due to over absorption by mucosa cannot be prohibited. Also, dissolution of these topical agents with saliva can impose negative impact on its anesthetic efficacy.[10]

So, the aim of this study is to overview the possible, nonpharmacological, and common techniques to lower the pain of local anesthesia injection during dental procedures.

MATERIALS AND METHODS

A data search was performed using PubMed's electronic database of dental reports, based on the following search terms in simple or multiple conjunctions: “Buffering,” “dental anesthesia,” “cooling,” “injection,” “pain,” “vibrating,” and “warming.” Some of the searched studies that had more relevance with the scope of this article were chosen. Consequently, case reports, studies with missing data, repeatedly published studies, and those in other languages than English were excluded. After screening both abstracts and full texts, the information was gathered for summarizing.

RESULTS AND DISCUSSION

Cooling techniques

Mainly, the cooling technique is mostly attracted by researchers of different branches of medical sciences. Chan *et al*. surveyed the effect of precooling for skin laser treatments and observed lesser pain perception by their patients.[11] The same statement was expressed by Leff *et al*.[12] In another study, Kuwahara *et al*. compared the pain relief effects of eutectic mixture of local anesthetics (EMLA) (2.5% lidocaine and 2.5% prilocaine cream) and ice prior to injection with a 30 gauge needle. They observed that clinically both EMLA and ice decreased the discomfort of needle injection.[13] Moreover, several other studies stated that applying ice had caused reduction in pain perception.[12,13,14]

How much efficient is precooling technique before local anesthesia injection?

As a matter of fact, there are not a vast published data on the effect of cooled injection site in dental procedures; however, this technique has get focused recently.

First, Harbert presented the idea of precooling technique for palatal injection technique.[15] He observed that prior palatal cooling is efficient for relieved pain perception and claimed that cooling reaches the nerves through the tissue and blood supplies. Similar findings were reported by Duncan *et al*. who utilized a cotton pellet that was saturated by dichlorodifluoromethane spray as a cooling agent in contact with the tissue for 5 s before administrating palatal injection. Their final results revealed less discomfort during the needle penetration.[16] In another study, Kosaraju and Vandewallecompared 5 s

application of a refrigerant (1,11,33-pentafluoropropane/1,11,2-tetrafluoroethane) versus 2 min application of a topical anesthetic gel (20% benzocaine gel) before local anesthetic injection in the posterior palatal site with a 30-gauge needle. They found that refrigerant agent prior to anesthetic injection was more effective than that of topical anesthetic gel.[17]

Ice popsicles can be an effective nonpharmacological intervention for pain management, and its analgesic effects can maintain for 30 min.[18] Since 2009, two studies were conducted on pediatrics to evaluate the effect of precooling of injection site on the pain perceptions during the infiltration of local anesthesia. The final results clarified that the precooling technique significantly reduced the induced pain during injection.[19,20] In another recent research, Wiswall *et al*. surveyed the patient's perceived pain response to different injection site preparation (pressure, pressure + topical anesthetic [20% benzocaine], and pressure + precooling) prior to greater palatine nerve block. That represented that there was no significant visual analog scale differences among test groups and all of them were effective.[21]

Genuinely, there are small branches of arterioles and capillaries which supply the subepithelial network in such greater extension than skin. There is no arteriovenous shunts or venae comitantes in the palatal area and the vessels transfer cold more rapidly and deeply than skin.[15] There is a theory called, “gate control theory,” which claims that applying cold decreases the neural transmission of the thin unmyelinated neurons that transfer stimuli from the periphery and reduces the pain by providing a continuous stimulus. So, according to that theory, cold application from a nonanesthetized region may arouse the cells that regulate pain pulses.[22] Although there are different types of nerve fibers with different speeds, the cooling might decrease the velocity of each one to some proportions.[23] Moreover, the mild pressure of the ice popsicle itself may produce other stimuli and reduce the pain. In other aspects, the local cooling causes vasoconstriction and reduces the tissue metabolism, the inflow of inflammatory mediators during penetration of needle. Also, as mentioned before, it stimulates myelinated Ad fibers, activating inhibitory pain pathways, which in turn raises the pain threshold,[24] especially to noxious stimuli such as local anesthetic agents.

Discomfort after receiving dental anesthesia due to numbness is one of the unpleasant side effects of dental procedure, especially for pediatrics.[25] Two different studies by Ram *et al*. was tried out to evaluate the efficacy of using ice or popsicles in reducing the discomfort or self-inflicting biting after receiving local anesthesia. The results manifested that the children were less restless[26] with lower self-inflicting biting.[27]

As the ice temperature is not too low and prolonged ice contact to the vital tissues is not necessary, there is no need to worry. If any damages were observed, it might be due to immunological disease responsible. Ice is contraindicated in the case of hypersensitivity to cold.[15] Also, other chemical cooling agents are not as safe as ice, for instance, 1,11,2-tetrafluoroethane with 10 s pressure appeared to make injurious to the oral mucosa.[21]

Warming or buffering techniques

The rationale behind warming of local anesthesia before injection is related to a hypotheses which claim 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.[28] A systematic review was yield about the effectiveness of administering warmed local anesthesia during medical procedures and reported that warming of a local anesthetic would result in lesser pain induction during injection.[6] Clinical dental trials about the efficacy of this techniques are few to prepare a comprehensive conclusion.

There are some technical advances to lower the pain of injection by alkalization of dental anesthetics prior to injection.[29] There is a strong theory which clarifies that by adding the sodium bicarbonate ($NaHCO_3$) to the anesthetic agents, an interaction would take place between $NaHCO_3$ and the hydrochloric acid (HCL) in the local anesthetic which produces water (H_2O) and carbon dioxide (CO_2).[30] It has been reported that CO_2 would provide an independent anesthetic effects that enhance the anesthetic's action sevenfold. The CO_2 diffuses out of solution immediately after injection and potentiates the action of lidocaine by a direct depressant effect on the axons and results in changing of nerve's charge.[31] However, clinical studies showed diverse results. Whitcomb *et al*. compared the clinical properties of administering buffered 2% lidocaine with 1:100,000 epinephrine/$NaHCO_3$ formulation and an unbuffered 2% lidocaine with 1:100,000 epinephrine formulation. The result suggested no significant difference in the elimination of pain during injection.[32] Similar results were notified by Saatchi *et al*.[33] and Ram *et al*.[34] in contrast to Kashyap *et al*.[35] Maybe the study protocols and designs are the reason of various reported results.

Using modern devices or techniques

Injection and vibing The vibration technique was first prescribed to minimize concurrent pain.[36] The gate control theory of pain, which was explained previously, is the base of the analgesic effect of vibration. 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.[37]

Different brands and devices are available, in which the vibrating stimuli are produced such as VibraJect, DentalVibe, and Accupal.[38] Released data about these devices are not vast enough. However, based on available executed studies, controversial effects of these systems are published. About VibraJect, two studies suggested using the device[39,40] in contrast to another study.[41] The same controversy can be found about DentalVibe.[42,19]

Computer-aided delivery systems One of the pain-induced factors is the volume and rate of drug infiltration. Therefore, computer-controlled local anesthetic delivery (CCLAD) systems were designed for the better manipulation and delivery of local anesthesia. Most of the released researches support the efficacy of using these delivery systems in reducing the pain of local anesthesia injection.[43,44,45,46]

Jet injectors The mechanism of jet injectors is to create and release sufficient energy to push out the anesthetic drug through the soft-tissue without using any needle. They are supposed to induce no or little pain by injecting the drugs without needles by being fast and less irritative.[38] According to the dental researches, they are not as much effective as expected and similar pain was induced during injection in comparison to conventional needle syringes.[47,48]

CONCLUSION

Since achieving an appropriate anesthesia is critical in modern dentistry and the needle phobia has become to an obstacle for clinicians, administrating desensitization techniques are suggested before needle injection. Among them, using ice or popsicles and CCLAD systems seems to be helpful. However, conducting more clinical trials and comparing each one of those discussed techniques to each other, which has not been executed until now, are strongly recommended to make a determinant recommendation.

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Conflicts of interest

There are no conflicts of interest

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