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Evaluation of Electronic Dental Anesthesia as a Non-Invasive Method in Children: A Review Study

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Abstract

Background

The findings of various studies have supported the analgesic effect of transcutaneous electrical nerve stimulation (TENS). Studies yielded contradictory findings on electronic dental anesthesia (EDA) as a non-invasive method. This review study aims to evaluate the EDA as a non-invasive method.

Materials and Methods: This review study was conducted by screening all clinical trials evaluating the EDA in children. An electronic search was performed in Scopus, EMBASE, Cochrane, Web of Science, and Medline with no language or time restrictions.

Results: Six clinical trials were included in this study. The results of the first study showed that EDA was less effective than local anesthesia. Another study indicated no statistically significant difference between the two groups in terms of perception of pain intensity and comfort. The third study revealed no significant differences between the two methods in terms of the level of pain in the first deciduous molars, but a higher level of pain was reported in the second deciduous molar in the case of the injection method. A comparison of behavioral responses and changes in vital signs of children in local anesthesia and electronic anesthesia methods showed positive responses to the latter. A combination of music and electronic anesthesia was reported to be effective in the relief of pain in children under the treatment of two corresponding deciduous molars. Another study showed that the vibraject technique led to a statistically significant reduction in pain among children.

Conclusion

The findings of this review study emphasize the importance of analgesic techniques in pediatric dental procedures. The use of new techniques along with conventional methods of analgesia should be taken into consideration, especially in pediatric dentistry.

Key Words: Children, Dental Anesthesia, EDA, TENS.

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1- INTRODUCTION

Chronic pain is a common problem and many people complain of inadequate pain management. It has a serious impact on the quality of life of people suffering from this phenomenon (1). Different mechanisms may cause different types of pain (2). This phenomenon is manifested in children in the form of crying, screaming, biting, kicking, or even moving during dental procedures (3). Although psychological techniques, such as distraction, or the use of audio-visual glasses are used to temporarily reduce pain when injecting local anesthetic (4), many pharmacological and non-pharmacological methods are used to reduce the pain level and intensity and swelling (5). One of these methods is transcutaneous electrical nerve stimulation (TENS), which is used for a wide range of acute and chronic pain (6).

Studies and findings show that TENS reduces pain through peripheral and central mechanisms. There are sites in the spinal cord and brainstem of the central nervous system that use opioid, serotonin, and muscarinic receptors and are activated by TENS. Opioid and α-2 noradrenergic receptors are peripherally involved in TENS-induced anesthesia (7). When the TENS device is used to induce anesthesia during dental treatments, this method of anesthesia is called electronic dental anesthesia (EDA). One of the advantages of this method is a transient unpleasant effect of anesthesia and a long-lasting analgesic effect after the treatment (4).

Results of a study on the behavior and physiological responses of patients during local anesthesia administration showed that EDA was effective in reducing the discomfort of young patients referred to dental offices (8). Another study found that this method was quite comfortable and painless among children referring to dental offices, based on the patients' self-judgment (9). However, dental anxiety, cavity depth, teeth undergoing treatment, operator's attitude, and the physician experience also play a role in determining the success rate in creating a positive attitude in young patients when using this method (3, 10). However, some studies have reported a success rate in the range of 56-100% for EDAs (11-14). However, other studies have not reported significant differences between the use of this method and an inactive instrument (15, 16). Therefore, considering the contradictory evidence in several studies, the present study aimed to review studies on EDA as a non-invasive method in children.

2- MATERIALS AND METHODS

This review study was conducted by screening all clinical trials evaluating the EDA in children. An electronic search was performed in online databases of Scopus, EMBASE, Cochrane, Web of Science, and Medline with no language or time restrictions using a combination of related keywords of Mesh. Two independent researchers examined the results, and a third party resolved any possible discrepancy between the reviewers.

3- RESULTS

Six clinical trials were included in this study. A cross-sectional clinical trial evaluated the efficacy of EDA in 32 eligible healthy 6-12-year-old children with equal caries rate in two primary or permanent molars at Otago Faculty of Dentistry in New Zealand. Anesthesia was performed by two methods of local anesthesia in children of the control group using infiltration of local anesthetics in the maxilla and mandible using an electronic pacemaker by trained dental therapists, after obtaining the consent of parents and children. In this method, electrodes were placed in the mental foramen regions located in the anterior surface of the mandible at half-inch distance to affect the nerve blocks of the permanent molars. Children were given control of the output

of the device and were asked to increase the frequency of the device when feeling the tingling sensation. The treatment process and preparation of the oral cavity began immediately after the children expressed their readiness, and they were asked to increase the intensity of the device output when feeling any pain. The effectiveness of anesthetic was assessed using the visual analogue scale (VAS). Moreover, the level of anxiety in children was assessed using the Venham Picture test (VPT). The results of the present study showed that EDA was less effective than local anesthesia, but anxiety scores did not differ between the two groups. However, 63% of children preferred EDA (17).

Another clinical trial compared the efficacy of EDA with 2% lidocaine anesthesia in minor dental procedures performed on 180 children aged 5-14 years who required endodontic treatment, including pulpotomy and pulpectomy. In this study, two methods of anesthesia, i.e TENS and a combination of lidocaine solution with adrenaline, were administrated for 90 children without a history of allergy to local anesthesia, respectively. Measurement instruments included VAS and COMFORT scale scored based on 4-point and 5-point Likert scale, respectively. Results of the ANOVA test showed no statistically significant differences between TENS and lidocaine groups in terms of perception of pain intensity and comfort level ($P > 0.05$).

However, the TENS method was quite satisfactory (9). Another clinical trial was carried on 20 eligible children aged 5-7 years who had at least two deciduous molars in need of restoration on both sides of the maxilla. This study compared the effectiveness of local anesthesia and EDA with a one-week interval. At the end of each session, the child's pain level was recorded using the Wong-Baker scale. The findings of the study showed higher pain in the first molar, but significantly higher pain in the case of the second molar that underwent the injection method (18). Another study was performed on children aged 24-48 months who required treatment in the anterior maxilla. They were randomly divided into local anesthesia (chloral hydrate and hydroxyzine) and EDA groups. The drug was administered in the local anesthesia group using a cup or a needle-free syringe and the treatment process began 60 minutes later. Patients' behavioral responses (silence, crying, movement, and intense crying) were recorded by a video camera during the analgesic process. Patients' heart rate and blood pressure were also examined by a vital signs monitor. The present study reported increased heart rate and infant movements in the EDA group, while changes in heart rate and blood pressure were significantly affected by the duration of the treatment. Overall, the results of observing the behaviors of infants indicated the usefulness of EDA in increasing the infants' comfort (8).

Another study examined the effect of white music and sound (sound that has all human audible frequencies) as supportive care along with EDA in children aged 9-12 years. The children with two corresponding deciduous molars with the same decay rate underwent EDA with a combination of pleasant music and television sound. The participants controlled the sound of music and television. This technique somehow distracted children, especially when the dentist used the drill, which is the time when the highest pain perception occurs. The SEM scale was used to assess pain and comfort by the dentist and the color scale was used by the child to indicate pain intensity. The results of this study emphasized the positive effect of combining music and EDA in reducing pain in 14 children. This method is useful in children who have a low pain tolerance threshold and needle phobia (3). Another

study compared a two-session use of two injectable anesthetic methods in children aged 8-14 years, who were referred to the Pediatric Dental Department of Mathura College for some dental procedures. In the first session, anesthesia was performed by the conventional injection method and the same procedure was repeated on the other side of the dental arch using a vibraject device in the second session. Pain intensity was measured using VAS and the Frankel scale (FRS) to assess perceived pain and classify child behavior. Physiological parameters, such as heart rate and blood pressure, were also measured and the results showed no statistically significant differences between these two sessions in terms of the physiological symptoms. However, the use of vibraject led to a significant reduction in the pain intensity (19).

4- DISCUSSION

Pain is a complex experience that not only evokes emotions following tissue damage but also triggers a reaction to any stimulus (9). Pain management is one of the most important principles of dental procedures, especially for pediatric patients who have sensitive teeth, low pain tolerance, and needle phobia and have shown negative behaviors, such as fear and severe anxiety, during treatment (20). The need for analgesia and the severe fear and anxiety of patients from anesthesia during dental treatments have led researchers to search for other methods and equipment that are equally effective and have been associated with less discomfort in patients. The use of new techniques, along with conventional techniques of analgesia, has been of interest, especially in pediatric dentistry (21). The effectiveness of EDA in children was reviewed in this review study. Three studies reported a greater sense of satisfaction in patients and therapists with EDA than local anesthesia, although it was not statistically significant. It seems that the absence of needles and thus reducing children's needle phobia and anxiety have played a role in this regard. A study by Ramezanian et al. (2017) referred to the position of teeth in the maxilla and mandible and the type of deciduous molars as factors affecting the efficiency of EDA. Since different treatments use different levels of anesthesia, more caution should be exercised when comparing the efficiency of electronic and injectable analgesia methods to reduce the inconsistency between the results of previous studies.

Shiu-yi et al. (1998) attributed an increase in pain perception in EDA to different denervation and the difficulty of achieving anesthesia in permanent molars as the intensity of perceived pain was not high in deciduous molars (17). Dhindsa et al. (2011) observed a very small difference in the intensity of EDA after treatment with 2% lidocaine. The results of this study indicated a reduction in anxiety levels as an important factor affecting the effectiveness of the TENS technique (9). Other previous studies supported the findings of the present study on TENS-induced analgesia. In this regard, studies have attributed the usefulness of the TENS technique in pediatric dentistry and its 53-78% satisfaction with this method to lower stress, no use of injections, and no paresthesia (22).

However, other physiological and psychological effects of pain control are also taken into consideration. Baghdadi et al. (1999) denoted an elevated analgesic effect when listening to sound along with EDA because of subsequent feeling a sense of relief and distraction (3). Overall, although EDA does not eliminate pain, it exerts its effect by making changes in pain perception and increasing pain tolerance because it is more pleasant than injectable methods, especially in children (20). The present review study also highlighted the use of the vibraject device. In fact, vibration has an inhibitory effect on pain

signals by creating stimulation based on the gate control theory of pain. However, evaluating the effectiveness of this method requires further studies and can be effective as a complementary and useful treatment in pediatric dentistry (19). In their study, Chaudhry and Wilson noted changes in blood pressure and heart rate during dental treatment procedures (8, 19). An increase in heart rate was observed following anxiety due to injectable analgesia. Whereas EDA as a non-invasive method reduces physiological responses, it is today considered a more acceptable method among children and parents (19).

According to the results of reviewed studies, however, it is recommended to evaluate the level of pain to compare new and conventional techniques by reducing the limitations and increasing the accuracy of studies. Some of these limitations included measurements of pain using children's subjective perception and the use of visual scales, while there seems to be the need for a more accurate tool to measure pain intensity to compare electronic techniques with injectable analgesia. Previous experiences of pain perception can also affect patients' responses to pain VAS. Moreover, physiological changes, such as increased heart rate and other responses such as crying in children, cannot be used to determine the level of pain. Considering the age range of children, the type of teeth, and the position of the teeth being treated in the maxilla and mandible should also be taken into account to reduce the rate of bias in the results.

5- CONCLUSION

The findings of the present review study emphasize the importance of analgesic techniques in pediatric dental procedures. Although EDA is considered a valuable and effective method today, there is still a need for further relevant studies in the future. It would be very valuable to use non-invasive techniques and increase their effectiveness, especially in children, considering their needle phobia.

6- CONFLICT OF INTEREST: None.

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