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A Comparative Evaluation Of Pain Perception And Anxiety In Pediatric Patient During Local Anesthesia Administration Using Conventional Syringe, Buzzy System And Computerized Controlled Local Anesthesia Delivery System

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Abstract

Background: *The administration of local anesthesia in pediatric dentistry can evoke significant pain and anxiety, impacting treatment outcomes and patient cooperation. This study aimed to evaluate and compare the effectiveness of three anesthesia delivery systems– conventional syringe, Buzzy system, and computer-controlled local anesthetic delivery system (CCLADS)–in managing pain perception and anxiety in children.*

Methods: *A total of 39 pediatric patients were randomly assigned into three equal groups (n=13 each) based on the anesthetic technique used: conventional syringe, Buzzy system, and CCLADS. Pain perception was assessed using the Visual Analog Scale (VAS), while anxiety levels were measured pre- and post-procedure using the Modified Dental Anxiety Scale (MDAS). Physiological responses, including pulse rate and oxygen saturation (SpO_2), were monitored using a pulse oximeter.*

Results: *The CCLADS group exhibited the lowest VAS scores, indicating significantly reduced pain, followed by the Buzzy system. MDAS scores showed a marked reduction in anxiety post-treatment in the CCLADS group compared to the other two groups. Physiological parameters also reflected better stability in the CCLADS group.* ***Conclusion:*** *The computer-controlled local anesthetic delivery system proved to be the most effective in minimizing pain and anxiety in pediatric dental patients, followed by the Buzzy system. Conventional syringe administration was associated with the highest discomfort and anxiety, highlighting the importance of adopting child-friendly anesthesia techniques in pediatric dentistry.*

Keywords: *Pain Perception, Dental Anxiety, Cclad, Buzzy System, Conventional Syringe.*

INTRODUCTION

Pain and anxiety are two of the most common challenges encountered during dental procedures in pediatric patients. Among the various dental interventions, the administration of local anesthesia is particularly anxiety-inducing for children, largely due to the fear of needles and the anticipated pain associated with injections. This emotional distress can significantly compromise patient cooperation, hinder effective dental treatment, and lead to long-term dental fear. Therefore, minimizing pain and anxiety during the delivery of local anesthesia has become a critical focus in pediatric dentistry.[5] Local anesthesia remains a fundamental component in dental pain control. Its efficacy and widespread use have made it an indispensable tool in clinical practice. However, traditional methods of delivery, such as the use of a conventional hypodermic syringe, present certain limitations. The administration of anesthetic using a standard syringe requires the dentist to simultaneously control needle insertion and the rate of anesthetic solution deposition. This manual coordination can be challenging, especially in anxious or uncooperative pediatric patients, potentially resulting in painful injections or improper anesthetic delivery. Moreover,

the palm-thumb grasp commonly used to hold the syringe is not ergonomically ideal, which may further affect precision and increase operator fatigue over time.[9] To overcome these limitations and enhance patient comfort, several alternative anesthetic delivery systems have been introduced. One such advancement is the Computer-Controlled Local Anesthetic Delivery System (CCLADS), first introduced in 1997. This system was developed to improve the ergonomics and control of traditional syringes. It features a lightweight handpiece designed to be held in a pen-like grasp, which provides greater tactile sensitivity and allows for precise needle placement. The anesthetic solution is delivered at a consistent, computer-regulated flow rate through a foot-activated control, ensuring a smooth and gentle deposition. Additionally, the continuous positive pressure exerted by the device allows a drop of anesthetic to precede the needle tip, thereby creating a numbed pathway and reducing the pain associated with needle penetration. Despite its clear clinical advantages, CCLADS is not without limitations. Its higher cost, operational complexity, need for storage space, and longer setup time may limit its routine use, especially in resource-constrained settings.[12] In recent years, non-pharmacological approaches have also gained popularity in pediatric pain management. One such device is the Buzzy system, a bee-shaped device that combines cold and vibration to alleviate procedural pain. The Buzzy device operates on the principles of the gate control theory of pain, which suggests that non-painful input, such as vibration and cold, can interfere with and reduce the transmission of painful stimuli to the brain. The device is applied extraorally near the injection site, where the main body provides vibrational stimuli while detachable wings filled with ice offer a precooling effect. The simultaneous application of vibration and cold serves to distract the patient and diminish the perception of pain by modulating afferent nerve activity. This dual sensory approach has shown promise in reducing both anxiety and discomfort during injections, particularly in children who are more responsive to external sensory modulation.[20]

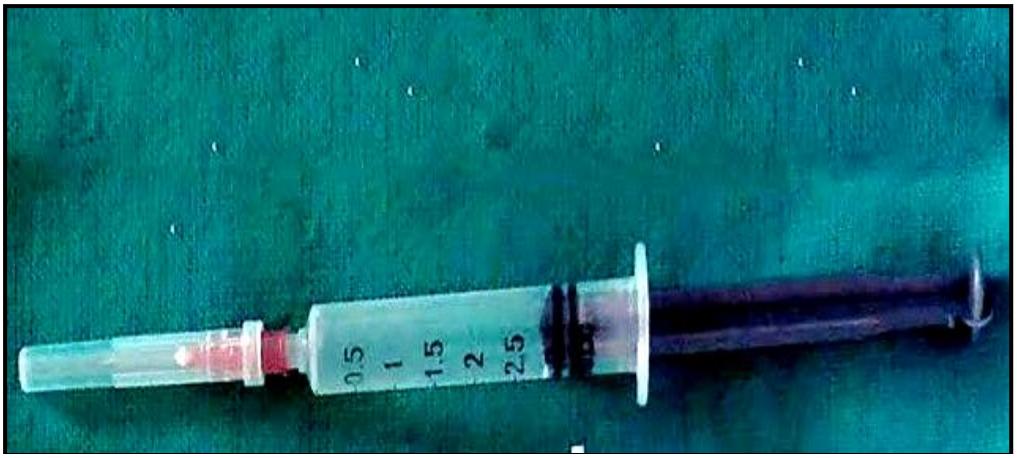

Fig.1 Conventional Syringe

Fig.2 Buzzy System

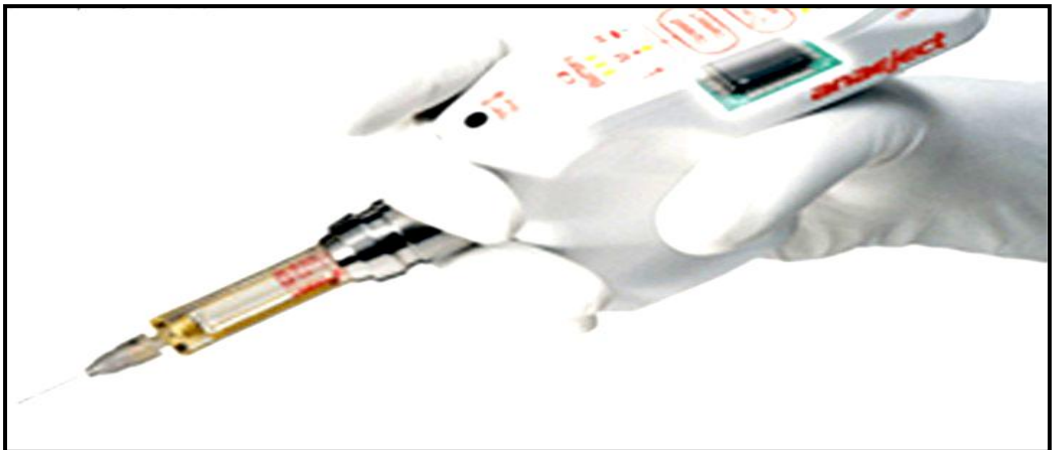

Fig.3 Computer-controlled anesthetic delivery system

MATERIALS & METHOD

This study was conducted to compare the efficacy of three anesthetic delivery systems in pediatric patients. A total of 39 patients were selected and divided into three groups, with 13 patients in each group: The study was conducted to evaluate and compare the effectiveness of different anesthetic delivery systems on pain perception, anxiety levels, and physiological responses in pediatric dental patients undergoing local anesthesia administration. The sample population was randomly divided into three groups, each receiving local anesthesia via a distinct method. All procedures were performed under standardized clinical conditions in a pediatric dental operatory. Group A: Conventional syringe, Group B: Buzzy system, Group C: Computer-controlled anesthetic delivery system.

Children requiring local anesthesia for dental procedures, Children without systemic diseases or chronic conditions, Children with no disability, Children with no history of adverse reactions associated with previous dental anesthesia were included in the study. Patients with special health care needs, Parent or guardian not giving consent, Uncooperative patient Patients with a history of allergy to local anesthetics were excluded from the study

Procedure

Grouping and Intervention:

- Group A- Conventional Syringe (Control group) Patients in this group received local anesthesia through a traditional dental syringe with a standard 26-gauge needle (Fig.1). A topical anesthetic gel was applied to the mucosa for 1 minute prior to the injection. The anesthetic solution (2% lignocaine with 1:80,000 adrenaline) was administered at a slow rate by the operator. Care was taken to minimize patient discomfort through verbal reassurance and gentle technique.
- Group B-Buzzy System: In this group, the Buzzy device, (Fig.2) which combines vibration and cold stimulus, was used as a non-pharmacological adjunct to minimize injection pain. The Buzzy unit was activated and positioned approximately 2–3 cm above the injection site on the facial skin for 1 minute prior to and during the administration of the local anesthetic. The same anesthetic protocol as Group A was followed. The dual stimulation of vibration and cold from the Buzzy device was aimed at distracting the child and reducing pain perception by stimulating descending inhibitory pain pathways.
- Group C- Computer controlled local anesthetic delivery system (CCLAD) Patients in this group received local anesthesia using a computer-controlled local anesthetic delivery system– Anaject (Fig.3). The CCLAD unit delivered the anesthetic at a precisely regulated flow rate, thereby minimizing tissue distension and discomfort. Topical anesthesia was similarly applied for 1 minute before the injection. The CCLAD handpiece was held in a pen-like grip, which facilitated a more controlled and less intimidating delivery experience for the child.

Assessment and Measurement

- Pain Perception: Immediately after the administration of anesthesia, children were asked to rate their perceived pain using the Visual Analog Scale –VAS (Fig.4). The VAS is a 10 cm horizontal line ranging from 0 (“no pain”) to 10 (“worst possible pain”), and the child marked the point that best represented their experience. This subjective assessment provided direct insight into the child’s perceived pain during injection.
- Anxiety Evaluation: Anxiety levels were measured using the Modified Dental Anxiety Scale (MDAS). (Fig.5)This was administered twice—first, pre-operatively (before the anesthetic procedure) and then post-

operatively (after the injection) to assess any changes in anxiety as a result of the anesthetic delivery method. The MDAS consists of five questions, each scored from 1 (not anxious) to 5 (extremely anxious), with a total possible score ranging from 5 to 25.

- Physiological Parameters: To assess the physiological response to the injection, pulse rate and oxygen saturation (SpO_2) were monitored using a digital pulse oximeter. Readings were taken before, during, and immediately after the administration of local anesthesia. An increase in pulse rate was interpreted as an indicator of physiological stress or anxiety, whereas SpO_2 levels were monitored to ensure the child's overall stability throughout the procedure.

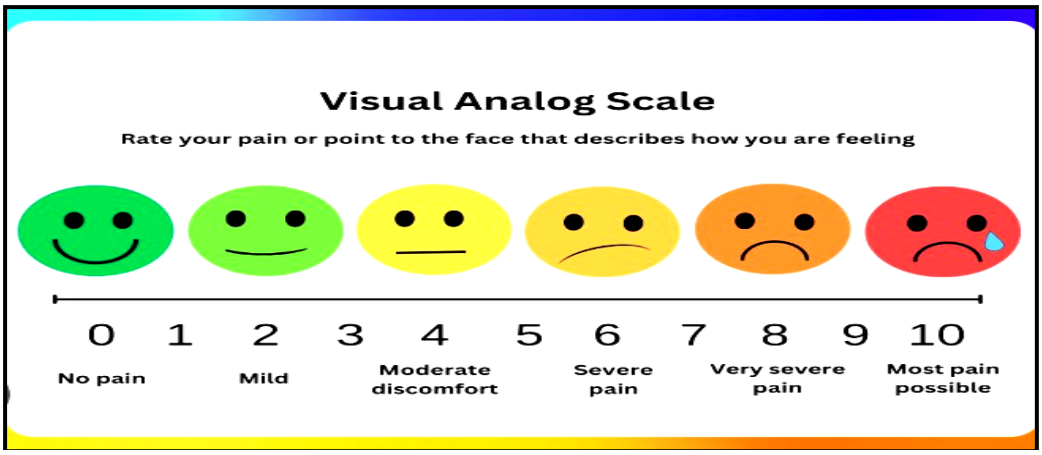

Fig.4 Visual Analog Scale

Modified Dental Anxiety Scale

CAN YOU TELL US HOW ANXIOUS YOU GET, IF AT ALL, WITH YOUR DENTAL VISIT?

PLEASE INDICATE BY INSERTING 'X' IN THE APPROPRIATE BOX

1. **If you went to your Dentist for TREATMENT TOMORROW, how would you feel?**

Not Anxious ☐	*Slightly Anxious* ☐	*Fairly Anxious* ☐	*Very Anxious* ☐	*Extremely Anxious* ☐

1. **If you were sitting in the WAITING ROOM (waiting for treatment), how would you feel?**

Not Anxious ☐	*Slightly Anxious* ☐	*Fairly Anxious* ☐	*Very Anxious* ☐	*Extremely Anxious* ☐

1. **If you were about to have a TOOTH DRILLED, how would you feel?**

Not Anxious ☐	*Slightly Anxious* ☐	*Fairly Anxious* ☐	*Very Anxious* ☐	*Extremely Anxious* ☐

1. **If you were about to have your TEETH SCALED AND POLISHED, how would you feel?**

Not Anxious ☐	*Slightly Anxious* ☐	*Fairly Anxious* ☐	*Very Anxious* ☐	*Extremely Anxious* ☐

1. **If you were about to have a LOCAL ANAESTHETIC INJECTION in your gum, above an upper back tooth, how would you feel?**

Not Anxious ☐	*Slightly Anxious* ☐	*Fairly Anxious* ☐	*Very Anxious* ☐	*Extremely Anxious* ☐

Instructions for scoring (remove this section below before copying for use with patients)

The Modified Dental Anxiety Scale. Each item scored as follows:

Not anxious	=	1
Slightly anxious	=	2
Fairly anxious	=	3
Very anxious	=	4
Extremely anxious	=	5

Total score is a sum of all five items, range 5 to 25: Cut off is 19 or above which indicates a highly dentally anxious patient, possibly dentally phobic

Fig.5 Modified Dental Anxiety scale

Statistical Analysis

The data for the present study was entered in the Microsoft Excel 2010 and analyzed using the SPSS statistical software 27.0 Version. The intergroup comparison of the quantitative data was done by One Way ANOVA test.

RESULT

The study revealed significant differences among the three anesthetic delivery systems in terms of pain perception, anxiety reduction, and physiological response in pediatric patients. The CCLADS group (Group C) showed the lowest pain scores on the Visual Analog Scale and the greatest reduction in anxiety levels post-treatment. It also exhibited the most stable pulse rates, indicating minimal stress during anesthesia administration. The Buzzy system (Group B) was moderately effective, reducing pain and anxiety to some extent. In contrast, the conventional syringe group (Group A) showed the highest pain and anxiety scores and the greatest physiological stress response. Overall, CCLADS was the most effective method, followed by the Buzzy system, with the conventional syringe being the least effective.

Table 1: Evaluation of Pain perception and anxiety in pediatric patient during local anesthesia administration using conventional syringe

Parameters	Group	Mean	Std. Deviation	t-value	p-value
SPO2	Pre	93.69	0.751	4.200	0.001,S
	Post	92.08	1.320		
Pulse	Pre	89.77	3.320	-4.268	0.001,S
	Post	95.00	2.887		
VAS	Pre	2.31	1.032	-14.498	0.000,S
	Post	4.92	1.115		
MDAS	Pre	12.85	3.158	1.185	0.259,NS
	Post	11.62	1.044		
p ≤ 0.05 – Significant, CI = 95 %					

Table 2: Evaluation of Pain perception and anxiety in pediatric patient during local anesthesia administration using buzzy system

Parameters	Group	Mean	Std. Deviation	t-value	p-value
SPO2	Pre	97.38	1.044	-7.500	0.000,S
	Post	98.54	0.519		
Pulse	Pre	88.62	3.124	5.333	0.000,S
	Post	85.69	1.750		
VAS	Pre	2.69	1.182	12.490	0.000,S
	Post	0.69	0.751		
MDAS	Pre	10.23	3.219	1.339	0.205, NS
	Post	6.54	1.761		
p ≤ 0.05 – Significant, CI = 95 %					

Table 3: Evaluation of Pain perception and anxiety in pediatric patient during local anesthesia administration using computerized controlled local anesthesia delivery system

Parameters	Group	Mean	Std. Deviation	t-value	p-value
SPO2	Pre	93.92	0.760	-15.584	0.000,S
	Post	98.46	1.127		
Pulse	Pre	89.77	3.320	7.548	0.000,S
	Post	83.54	2.876		
VAS	Pre	3.54	1.266	18.500	0.000,S
	Post	0.69	0.855		
MDAS	Pre	10.38	3.280	6.268	0.000,S
	Post	5.62	0.870		

p ≤ 0.05 – Significant, CI = 95 %

Table 4: Comparative Evaluation of Pain perception and anxiety in pediatric patient during local anesthesia administration using conventional syringe, Buzzy system and computerized controlled local anesthesia delivery system

Parameters	LA System	Mean	Std. Deviation	F-value	p-value, S/NS
SPO2	Conventional	1.61	1.386	88.934	0.000,S
	Buzzy	2.30	1.109		
	Computerized controlled	4.53	1.050		
Pulse	Conventional	4.46	3.777	38.323	0.000,S
	Buzzy	5.15	3.484		
	Computerized controlled	6.23	2.976		
VAS	Conventional	2.61	0.650	316.699	0.000,S
	Buzzy	2.00	0.577		
	Computerized controlled	2.84	0.554		
MDAS	Conventional	1.23	3.745	5.679	0.007,S
	Buzzy	1.07	2.900		
	Computerized controlled	4.76	2.743		
p ≤ 0.05 – Significant, CI = 95 %					

DISCUSSION

Most of the pediatric patients experience fear and anxiety concerning the pain occurring while giving injection of local anesthetics. Although local anesthesia is considered as the backbone of pain control in dentistry.[5] Local anesthesia (LA), though essential for pain control in dentistry, is often a source of fear for many patients. This apprehension significantly contributes to the avoidance or delay of dental treatment. Most of the individuals exhibit heightened anxiety toward dental procedures, largely due to anticipated discomfort. A key factor in this fear is the pain caused by needle penetration. This combination of physical pain and emotional distress emphasizes the importance of adopting less invasive and more patient-friendly anesthesia techniques to improve the overall dental experience, especially for anxious patients.[12] In the field of pediatric dentistry, recent advancements have introduced multi-sensory tools aimed at reducing procedural discomfort without relying on medication. One such innovation is a buzzy system specifically designed to mitigate the pain and anxiety associated with local anesthesia injections. This device is positioned on the skin surface above the targeted injection area and functions by delivering two concurrent stimuli cold and vibration. The wings, chilled prior to application, produce a cooling sensation, while the vibrating central body distracts the child by overriding the brain's perception of pain signals. This technique taps into neurological pathways that prioritize non-painful stimuli, effectively blunting the pain response. By simultaneously engaging both thermal and mechanical receptors, the device helps children remain calmer and experience reduced discomfort during the injection process.[15] However, the Computer-Controlled Local Anesthetic Delivery (CCLAD) system administers anesthetic at a precisely regulated and consistent pace, aiming to minimize pain and enhance patient comfort. The Computer-Controlled Local Anesthetic Delivery system has emerged as a significant innovation in the administration of local anesthesia, particularly in the context of pediatric dentistry. Unlike the traditional syringe technique, which often results in pain due to sudden pressure changes and inconsistent flow, CCLAD utilizes an electronically controlled microprocessor to deliver the anesthetic at a precisely regulated, slow, and steady pace. This ensures that the solution is deposited at a rate that matches the resistance of the tissue, significantly reducing the sensation of pressure and the associated pain during injection. The system also features an ergonomic handpiece that resembles a pen, making it less intimidating to patients

especially children and easier for clinicians. Beyond just the mechanical advantage, CCLAD aligns with principles of patient-centered care, aiming to minimize discomfort and anxiety through a controlled and predictable injection experience. By automating the delivery process, the device also helps standardize anesthesia administration across operators, minimizing variability and improving clinical outcomes. The combination of technological precision, improved patient tolerance and operator ease-of-use makes CCLAD an increasingly preferred option in modern dental practices seeking to enhance pain control and reduce injection-related fear, especially in children and anxious patients.[19] In the present study, pain perception was evaluated using the Visual Analog Scale (VAS), along with facial expression indicators corresponding to a numerical score from 0 to 10. This face- based VAS is particularly suitable for pediatric populations, as it allows children to associate their level of discomfort with visual cues, making it easier to express subjective pain levels. A score of 0 represented "no pain", while 10 indicated the "worst possible pain." Similarly Manekar VS et al.(2017)[9] and Singh et al.(2025)[21] utilized the Visual Analog Scale (VAS) in their study to measure pain perception, thereby reinforcing its validity and reliability in dental pain assessment. In the present study, anxiety was evaluated using the Modified Dental Anxiety Scale (MDAS). The MDAS is a validated questionnaire designed specifically to evaluate dental-related anxiety. It consists of five items; each rated on a five-point Likert scale, ranging from "not anxious" to "extremely anxious." The cumulative score provides an overall indication of the patient's anxiety level, with higher scores indicating greater anxiety. Together, the VAS and MDAS offer reliable and standardized methods for evaluating subjective experiences of pain and anxiety, especially useful in comparative clinical studies involving pediatric populations. Similarly Deogade SC et al.(2016)[8] and Singh K et al.(2025)[21] utilized the Modified Dental Anxiety Scale (MDAS) in their respective studies to assess dental anxiety levels. In the present study the physiological parameters were assessed by monitoring the pulse rate and oxygen saturation (SpO_2) with the help of a digital pulse oximeter. Readings were recorded before, during, and immediately after the administration of local anesthesia. An increase in pulse rate was taken as a marker of anxiety or physiological stress, while SpO_2 levels were observed to ensure the child remained physiologically stable throughout the procedure. Study conducted by Beck et al.(1999)[1] demonstrated that pulse oximetry serves as a reliable tool for assessing stress and anxiety in patients receiving dental treatment. In the present study it was observed that CCLADS was the most effective than the buzzy system and conventional syringe .Children in the CCLAD group reported the least pain on the Visual Analog Scale, It was also observed reduction of anxiety as measured by the Modified Dental Anxiety Scale (MDAS), and exhibited the most stable physiological parameters, including pulse rate and oxygen saturation. The effectiveness of Computer-Controlled Local Anesthetic Delivery Systems (CCLADS) can be attributed to their ability to deliver anesthetic solution at a precise and consistent flow rate, minimizing sudden pressure buildup that are often associated with conventional syringe injections.The result of the present is in accordance to the Study done by Baghlaf et. Al (2015)[6] who also observed that Buzzy significantly reduced pain compared to conventional injection but was less effective than CCLAD. Similarly in the studies done by Thoppe-Dhamodhara et al.(2015)[7] and Garret-Bernardin et al.(2017)[11]they also observed that CCLADS are better in lowering pain levels and anxiety compared to traditional syringe based methods. In the present study it was observed that Buzzy system was moderately effective. It combines cold and vibration stimuli to interfere with pain signal transmission based on the gate control theory. While not as effective as CCLADS, it significantly reduced pain and anxiety when compared to the conventional syringe. The cold and vibration distraction helped divert the child's attention away from the injection process, making it a practical tool especially in settings where advanced delivery systems are not available. Similar study done by Özge An et al.(2024)[23] CCLAD showed the lowest pain scores buzzy was significantly better than conventional but less effective than CCLAD. Similar to the study conducted by Naidu et al.(2023)[20] Alanazi et al.(2019)[13] and Hegde et al.(2019)[14] the Buzzy system produced a notable better in lowering both pain and pulse rate, with VAS scores significantly decreasing after administration as compare to the conventional syringe. In the present study, an increase in pulse rate, VAS, and MDAS scores was observed in the conventional syringe following the administration of local anesthesia. In the present study it was observed that the conventional syringe was found to be the least effective than buzzy system and computer-controlled local anesthetic delivery. Children in conventional group experienced higher levels of pain and anxiety, along with noticeable changes in pulse rate, indicating greater physiological stress during the administration of anesthesia. Local anesthesia administered with a conventional syringe resulted in a significant increase in pain perception, indicating limited effectiveness in pain control. Pulse rate also increased significantly post-procedure, reflecting increased physiological

stress. Similar study done by Baghlaf et. al(2015)[6] who also observed this technique demonstrated the lowest reduction in pain and anxiety among the three methods evaluated.

CONCLUSION

The present study demonstrated that the computer-controlled local anesthetic delivery system (CCLADS) is the most effective method for minimizing pain and anxiety in pediatric dental patients. The Buzzy system, utilizing vibration and cold stimuli, also showed favorable results in reducing discomfort, though to a lesser extent than CCLADS. In contrast, the conventional syringe was associated with the highest levels of pain and anxiety. These findings emphasize the need for incorporating more child-friendly and technologically advanced anesthesia delivery systems in pediatric dentistry to improve patient comfort, reduce procedural fear, and enhance cooperation during dental treatment.

REFERENCES

1. Beck FM, Weaver JM 2nd. Blood pressure and heart rate responses to anticipated high-stress dental treatment. J Dent Res. 1981;60(1):26–29.

2. Asarch T, Allen K, Petersen B, Beiraghi S. Efficacy of a computerized local anesthesia device in pediatric dentistry. Pediatr Dent. 1999;21(7):421-4.

3. Allen KD, Kotil D, Larzelere RE, Hutfless S, Beiraghi S. Comparison of a computerized anesthesia device with a traditional syringe in preschool children. Pediatr Dent. 2002;24(4):315-20.

4. AI LR. Objective and subjective measures for assessing anxiety in paediatric dental patients. Eur J Paediatr Dent. 2011;12(4):239-44.

5. Chaudhry K, Shishodia M, Singh C, Tuli A. Comparative evaluation of pain perception by vibrating needle (Vibraject™) and conventional syringe anesthesia during various dental procedures in pediatric patients: a short study. Int Dent Med J Adv Res. 2015;1(1):1-5.

6. Baghlaf K, Alamoudi N, Elashiry E, Farsi N, El Derwi DA, Abdullah AM. The pain- related behavior and pain perception associated with computerized anesthesia in pulpotomies of mandibular primary molars: A randomized controlled trial. Quintessence Int. 2015;46(9).

7. Thoppe-Dhamodhara YK, Asokan S, John BJ, Pollachi-Ramakrishnan G, Ramachandran P, Vilvanathan P. Cartridge syringe vs computer controlled local anesthetic delivery system: Pain related behavior over two sequential visits–a randomized controlled trial. J Clin Exp Dent. 2015;7(4):e513.

8. Deogade SC, Suresan V. Psychometric assessment of anxiety with the Modified Dental Anxiety Scale among central Indian adults seeking oral health care to a dental school. Ind Psychiatry J. 2016;25(2):202-9.

9. Manekar VS. Comparison of the Pain Perception of Conventional and Computer- controlled Anesthesia Techniques for Extraction of Maxillary First Premolar. World J Dent. 2017;6(3):150-3.

10. Deepak V, Challa RR, Kamatham R, Nuvvula S. Comparison of a new auto- controlled injection system with traditional syringe for mandibular infiltrations in children: A randomized clinical trial. Anesth Essays Res. 2017;11(2):431-8.

11. Garret-Bernardin A, Cantile T, D'Antò V, Galanakis A, Fauxpoint G, Ferrazzano GF, et al. Pain experience and behavior management in pediatric dentistry: a comparison between traditional local anesthesia and the wand computerized delivery system. Pain Res Manag. 2017;2017:7941238.

12. Aggarwal K, Lamba AK, Faraz F, Tandon S, Makker K. Comparison of anxiety and pain perceived with conventional and computerized local anesthesia delivery systems for different stages of anesthesia delivery in maxillary and mandibular nerve blocks. J Dent Anesth Pain Med. 2018;18(6):367.

13. Alanazi KJ, Pani S, Al Ghanim N. Efficacy of external cold and a vibrating device in reducing discomfort of dental injections in children: a split mouth randomized crossover study. Eur Arch Paediatr Dent. 2019;20(2):79-84.

14. Hegde KM, Srinivasan I, Melwani A, Radhakrishna S. Effect of vibration during local anesthesia administration on pain, anxiety, and behavior of pediatric patients aged 6– 11 years: A crossover split-mouth study. J Dent Anesth Pain Med. 2019;19(3):143-9.

15. Suohu T, Sharma S, Marwah N, Mishra P. A comparative evaluation of pain perception and comfort of a patient using conventional syringe and buzzy system. Int J Clin Pediatr Dent. 2020;13(1):27.

16. Carugo N, Paglia L, Re D. Pain perception using a computer-controlled anaesthetic delivery system in pediatric dentistry: A review. Eur J Paediatr Dent. 2020;21:180- 2.

17. Jain N, Juneja P, Masih U, Bhushan AB, Bhaduaria US, Badjatya K. Efficacy of external cold and a vibrating device in reducing pain and anxiety during local anesthesia. J Family Med Prim Care. 2021;10(11):4017-22.

18. Kohli N, Hugar SM, Patil VH, Saxena N, Kadam KS, Karmarkar S. Evaluating anxiety levels and pain perception while administering local anesthesia using conventional, insulin, and deception syringes in 6-12-year-olds. J Dent Anesth Pain Med. 2022;22(3):197.

19. Attia S, Austermann T, May A, Mekhemar M, Conrad J, Knitschke M. Pain perception following computer-controlled versus conventional dental anesthesia: randomized controlled trial. BMC Oral Health. 2022;22(1):425.

20. Naidu SY, Eregowda NI, Parameshwarappa P, Kenchappa M, Korishettar R, Rani K. Comparative evaluation of pain perception in pediatric patients during administration of local anesthesia with and without three preanesthetic procedures— Buzzy

system, topical anesthesia and precooling agent. Int J Contemp Pediatr. 2023;10(6):798.

21. Singh K, Jhingan P, Mathur S, Malik M, Kashyap K. Intercomparison of Efficacy of Transcutaneous Electrical Nerve Stimulation and Precooling Vibration Device on Pain and Anxiety Management during Administration of Local Anesthesia Injection in 6–12-year-olds. Int J Clin Pediatr Dent. 2024;17(3):297.

22. Narimany R, Faghihian R, Jafarzadeh Samani M. Effectiveness of External Precooling and Vibration Induced by BUZZY on Pain and Anxiety During Inferior Alveolar Nerve Block Injection in Children. Int J Dent. 2024;2024:5515522.

23. Özge AN, Keskin G. Comparison of computer-controlled local anesthetic delivery and traditional injection regarding disruptive behaviour, pain, anxiety and biochemical parameters: a randomized controlled trial.2024.

24. Patel M, Joshi V, Patel F, Mehta M, Patel R, Patel T, Ruparelia D. Assessment of Computer-Controlled Starpen Device and Conventional Aspirating Cartridge on Pain Perception in Paediatric Dental Patients–A Split-Mouth Crossover Study. Adv Hum Biol. 2025;15(1):99-107.

25.