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A Comparative Study To Evaluate Perception Of Pain With Electronic Anesthesia And Metal Aspirating Syringe In Pediatric Patients During Dental Procedures.

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Abstract
Objective*: To assess the difference in pain perception between children aged 6–10 receiving different dental treatments using an electronic anesthetic device (Starpen) and a conventional metal aspirating syringe.*
Methods: *Thirty children were divided into two groups for this randomized study: Group 1 was given anesthesia using a Starpen, while Group 2 was given an aspirating syringe made of metal. Prior to and during the procedure, the following parameters were measured: oxygen saturation (SpO_2), pulse rate, respiratory rate, and pain (VAS scale).*
Results: *The two groups' physiological reactions and pain levels did not differ statistically significantly ($p > 0.05$). The Starpen group, however, reported more ease and comfort during injections in a clinical setting.*
Conclusion: *The electronic Starpen system may provide useful advantages in controlling pedodontic dental anxiety and pain during local anesthesia, even if statistical results did not reveal any considerable differences.*
Keywords: *Pedodontist, pain perception, electronic anesthesia, Starpen, aspirating syringe, VAS scale*

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I. Introduction

The foundation of pediatric dentistry is pain management, which has a big impact on how a kid behaves and cooperates throughout dental treatments. Young patients' fear and anxiety of dental procedures are sometimes caused by traumatic events in the past or a generalized phobia of dental treatment.[1] One of the biggest problems in pediatric dentistry is dental fear and anxiety (DFA).[2] The primary reasons why individuals may skip dentist visits are dental anxiety and fear. It is believed that the prevalence is around 9%.[3]

All subsequent responses and behaviours about dentistry might be influenced by the effect of the initial dental appointment. It has been demonstrated that successive dental visits have a range of consequences on psychological and physiological reactions, with no consistent marker ranging from a rise in negativity to no change or improvement in behaviour. About 6–22% of kids have some degree of dental fear, 11–26% have considerable anxiety, and 5–15% fit the criteria for dental phobia, according to the American Academy of Pediatric Dentistry (AAPD).[4] This variation in frequency might be explained by variations in research populations, evaluation techniques, socioeconomic settings, and cultural factors.

The use of local anesthetics one of the main causes of dental anxiety in kids.[5] Due to needle penetration, anaesthetic deposition pressure, and chemical characteristics such as low pH of anaesthetic solutions, the conventional technique of a metal aspirating syringe frequently results in pain.[6] The management of injection-related pain is still difficult, even with the use of behavioral strategies and topical anaesthetics.

Advances in technology have led to the development of computer-controlled local anesthetic delivery systems (CCLADs), which regulate injection pressure and flow rate to make injections more pleasant.[7] The Wand® system, which first came out in 1997, and later improvements like as the Dentapen® and Single Tooth Anesthesia (STA) systems have demonstrated potential in lowering the feeling of pain during the administration of anesthesia.[8]

During diagnosis and therapy, children with dental anxiety may exhibit resistance or avoidance behaviors, hysteria, sobbing, and in certain situations, treatment plans may be abandoned.[9] When children's dental caries is not treated, it can worsen, leading to discomfort, trouble eating, sleep issues, frequent absences, and, in extreme situations, affecting dietary intake and overall quality of life.[10]

The Starpen, is a more recent and economical electronic anesthetic device that uses a clever algorithm to provide automated pressure feedback. This minimizes the stress brought on by fast deposition by guaranteeing a calm and constant infusion. Because of its ergonomic shape and ability to work with common anesthetic cartridges, it is a useful tool for dentists.[11]

The current study aimed to compare the StarPen-Dental Anaesthesia Device with a traditional method in order to assess and compare the feeling of pain and anxiety in children aged 6 to 10 during the administration of local anesthesia.

II. Material And Method

Thirty children of 6-10 years who had no experience of injection in previous dental appointment were randomly selected from those registered for treatment at department of pediatric and preventive dentistry who show positive and definitely positive Frankel behaviour rating scale. The teeth indicated for pulpotomy, pulpectomy with no signs of radiolucency or abscess, teeth indicated for extraction were randomly selected after obtaining consent from parents. Children who shows negative and extremely negative behaviour, localized abscess, children who require multiple teeth to be treated in same appointment as IANB is required are excluded from the study.

Materials

For both injections 1.8ml cartridge with 2% (20mg/ml) lignocaine (Lignospan Special® (Septodont) anesthetic solution with Adrenaline Bitartrate equivalent to Adrenaline 1:80,000 (0.0125 mg/mL) were used. For metallic syringe, 30 gauge needle (0.3mm ×12 mm) (Septodont, France) were used and starpen system include the same cartridge aling with the same needle.

Methods

Each and every child participating in the study received local infiltration on two separate consequative visits, using metallic and in one visit, and using Starpen in anoter visit. The following was said to the child: "I'm going to use a special sleepy pen to help your tooth take a little nap." All the procedure performed by single operator.

Injection Rate

The injection with metallic syringe was completed in approximately 120 seconds at rate of 1ml/1min and with Sarpen system it was on hybride mode of approximately 0.68-1.0 ml/1min.

Evaluation Criteria

Child's own report of pain: the Visual analague scale (Scott and Huskisson in 1976) was presented to the child and asked to point out a face for his/her current pain status.

Patient's Heart rate

The patient's heart rate was monitored using a pulse oximeter and a stopwatch at two different intervals—prior to the procedure (resting phase), and after the procedure —each recorded over a span of 10 seconds. Along with heart rate patients pulse rate and oxygen saturation was also recorded at same intervals

Study Design and Sample

Thirty kids between the ages of six and ten were divided into two groups at random:

• Group 1 (n = 15): Starpen electronic device administered anaesthesia.(**Woodpecker Star Pen** (Guilin Woodpecker Medical Instrument Co., China)

• Group 2 (n=15): Aspirating a metal syringe administered anaesthesia.(**Septodont Aspirating Syringe** (Septodont, France)

Procedure for Group 1:


Fig 1: Monitoring heart rate, blood pressure and saturation (before anaesthesia)
Fig 2: Application of topical anesthesia (3 min)


Fig 3: Electronic anaesthesia delivery (1ml/min)
Fig 4: Monitoring heart rate, blood pressure and saturation

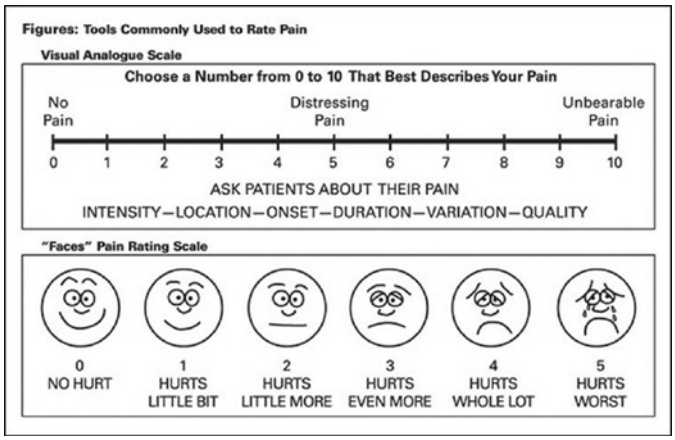
Procedure for Group 2:




Fig 1: Monitoring heart rate, blood pressure and saturation (before anaesthesia)
Fig 2: Application of topical anaesthesia (3 min)
Fig 3: anaesthesia with metal aspirating syringe (1ml/min)
Fig 4: Monitoring heart rate, blood pressure and saturation

Measured Parameters

• Visual Analog Scale (VAS) for pain;
• Pulse rate, respiration rate, and SpO_2 (both before and after anesthesia) as physiological responses



Analysis of Statistics

To examine intergroup differences, chi-square and unpaired t-tests were employed; a p-value of less than 0.05 considered to be statistically significant.

III. Results

Demographic Data

Age: Groups 1 and 2 had mean ages of 7.21 ± 1.42 and 6.5 ± 1.34, respectively (p = 0.184).
Gender distribution: Groups did not differ significantly in terms of gender distribution ($\chi 2 = 0.583$, p = 0.445).

Pain Perception (VAS)

Group 1's pain perception (VAS) was 0.92 ± 0.99, whereas Group 2's was 1.28 ± 1.26.
The difference was not statistically significant (p = 0.415).

Physiological Parameters

Parameter	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	*p*-value
Pulse Rate (Pre)	95.78 ± 18.09	92.5 ± 11.06	0.567
Pulse Rate (Post)	96.71 ± 16.33	94.64 ± 12.74	0.711
Respiratory Rate (Pre)	21.21 ± 3.11	22.28 ± 3.4	0.393
Respiratory Rate (Post)	21.35 ± 1.49	20.78 ± 1.31	0.293
SpO_2 (Pre)	98 ± 1.24	97.92 ± 1.38	0.887
SpO_2 (Post)	99 ± 1.1	99.21 ± 1.12	0.616

No parameter showed statistically significant differences between groups.

Age and gender were similar between the two groups, meaning the groups were well-matched demographically. Pain perception, measured by VAS, showed no significant difference between the groups.

Therefore, any interventions or conditions being compared between the two groups likely did not have a meaningful impact on pain levels, at least based on this data.

Starpen group suggested a greater sense of comfort and ease during the injection procedure.This means that while objective measures (such as pain scores on the Visual Analog Scale and physiological markers) did not show significant variation, the subjective experience of the injection process differed. Specifically, patients in the Starpen group perceived the injection as less distressing or more tolerable, even if their physiological pain responses were similar to those in the comparison group.

The Starpen device may provide psychological reassurance due to its design, appearance, or delivery mechanism—factors that contribute to patient comfort and cooperation, especially in pediatric populations. These qualitative outcomes, although not captured by statistical significance in pain scores, are still clinically relevant, particularly in settings where patient cooperation and anxiety reduction are priorities.

No physiological parameter—pulse rate, respiratory rate, or SpO_2—differed significantly between Group 1 and Group 2, either before or after the procedure. All p-values are greater than 0.05, indicating that any differences observed are likely due to random variation and not caused by the intervention/device.

This suggests that the intervention (e.g., a new injection method or device like the Starpen) did not elicit any measurable physiological stress response compared to the standard method.

IV. Discussion

When local anaesthetic is administered to children, pain and fear can cause behavioral issues.[12] For young children, the injection procedure can be very distressing due to a number of reasons, including the anaesthetic's chemical makeup, high pressure during administration, and tissue damage from the needle.[13] Controlling these elements is crucial for both enabling successful dental treatment and guaranteeing patient comfort.[14]

For this study, children between the ages of 6 and 10 were selected for a variety of scientific, ethical, and developmental reasons. By six years old, the majority of kids are able to follow simple directions and speak well, which makes it simpler for them to consent to take part in research and share symptoms or experiences. Their cognitive and communicative abilities are superior. Thus, patients between the ages of 6 and 10 were selected for this investigation. Research by Lorynn Teena et al. (2023)[15], Ha N. D. Le et al. (2023)[16], Katrina Williams et al. (2012)[17], and others revealed that patients aged 6–10 years had superior cognitive and communicative abilities. Their physiological characteristics are more consistent and predictable, which improves the research of medication metabolism, side effects, and reactions.

The use of topical anesthetics, distraction methods, regulated injection rates, buffering anesthetic compounds, pre-cooling the injection site, and more recent delivery systems like CCLADs are some of the pain-reduction tactics that have been investigated throughout the years.[10] By offering a steady and regulated anesthetic

infusion, these systems work on the principle of minimizing pain by lowering discomfort and tissue distension.[12, 14]

The Star Pen is a computer-controlled dental anesthesia tool that is especially well-suited for use in pediatric dentistry since it can give local anesthetic with extreme precision and little pain. By controlling the anesthetic injections' pressure and speed using artificial intelligence, the gadget enables more regulated and seamless administration. This makes it perfect for treating kids who could be nervous or sensitive during dental operations, especially those between the ages of 6 and 13 years.[15,16]

To help young patients feel more at ease, Star Pen offers manual and automated aspiration modes, flexible injection speeds, and even calming music. Its wireless charging capability and ergonomic, lightweight design make it easier for dental professionals to operate. Star Pen is a useful tool in contemporary pediatric dentistry since it greatly lessens the pain and anxiety associated with conventional injections, enhances patient participation, and may even reduce the need for sedation.[11] Because of its ease of use, price, and dependability, the conventional syringe—a typical dental instrument for delivering local anesthesia—continues to be widely used in pedodontics, or pediatric dentistry. The traditional dental syringe, which is usually constructed of stainless steel, has a barrel that fits the anesthetic cartridge, a plunger that pushes the solution, and a harpoon that engages the rubber stopper for aspiration.[17]

The sympathetic nervous system of the body is triggered when a youngster feels fear, which sets off the "fight or flight" reaction. The release of stress chemicals like adrenaline causes tachycardia, or an increase in pulse rate. Similar to this, tachypnea, a common response to psychological stress, occurs when a youngster starts breathing more quickly and often shallowly. Although healthy people's oxygen saturation (SpO_2) usually stays within normal ranges, acute anxiety can produce hyperventilation or abnormal breathing patterns, which can result in minor, temporary decreases in SpO_2 or changes in CO_2 levels. In addition to offering physicians helpful, unbiased information into the child's anxiety level, monitoring these vital signs throughout dental treatment can help them use the best behavior management and pain management techniques.[11,12,14]

In clinical and scientific environments, the Visual Analog Scale (VAS) is a commonly used and validated instrument for determining subjective pain severity. The VAS is a horizontal line that is normally 10 cm long and is anchored by two ends that stand for "no pain" (0) and "worst pain imaginable" (10). It is commonly used in pediatric dentistry. Children are instructed to put a point along the line to represent how much pain they believe they are experiencing. Children can use the VAS, but how well it works will depend on their age, cognitive development, and capacity for deep thought. Since younger children could find the scale's abstract character difficult to understand, it is typically regarded as suitable for children older than six.[18,19]

In our investigation, the Starpen electronic anesthetic device showed clinically good results, but not statistically significantly outperforming the metal aspirating syringe in terms of VAS scores or physiological indicators (oxygen saturation, pulse rate, and respiration rate). Children who had Starpen treatment reported mean VAS ratings that were lower and displayed fewer physiological variances, indicating a more comfortable overall experience.[7]

Individual variability in pain threshold, psychological variables impacting pain perception, and the limited sample size might all be contributing causes to the absence of statistically significant differences. Furthermore, children could find conventional syringes more frightening because to their appearance and sound, which could increase their anxiety levels and make them feel greater discomfort.[20,21]

When it comes to repeated or multi-visit treatments, pediatric patients' participation can be greatly enhanced by even small decreases in pain and anxiety, according to clinical opinion.[12] In pediatric treatment, where behavioral control is just as crucial as clinical accuracy, the Starpen device's ergonomic design, pressure modulation, and simplicity of handling may make it a useful tool.[7] However, there are several restrictions on the usage of electronic anesthetic devices.

Widespread adoption may be constrained by high startup costs, maintenance needs, and the learning curve for practitioners.[13] Devices like Starpen, however, have the potential to revolutionize pediatric anesthetic techniques as patient-centered care and less traumatic therapies get more attention. The effectiveness and acceptance of electronic anesthetic systems may be better understood in the future with bigger sample sizes, longer follow-up, and subjective input from parents and kids.

V. Conclusion

The results of the two anesthetic techniques were similar in terms of discomfort and physiological reaction. Nonetheless, the Starpen has potential as a safe, effective substitute for local anesthetic in pediatric dentistry.

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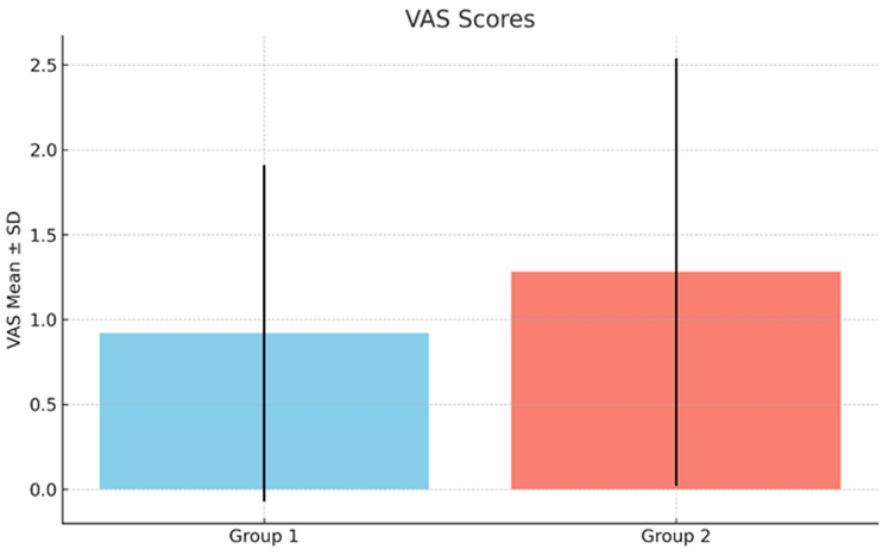
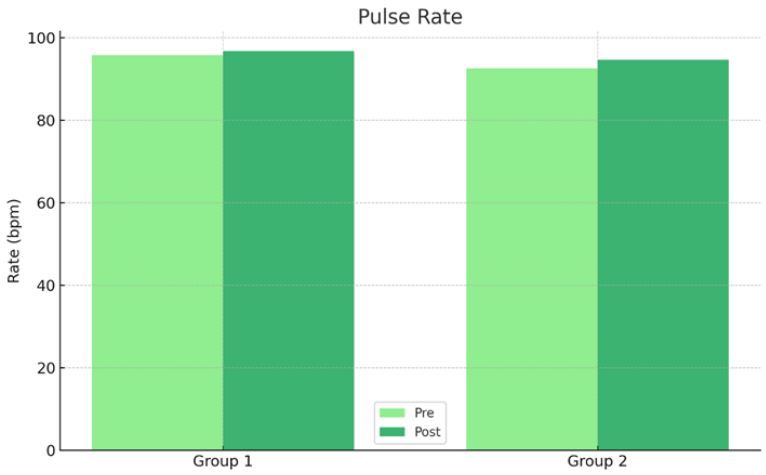
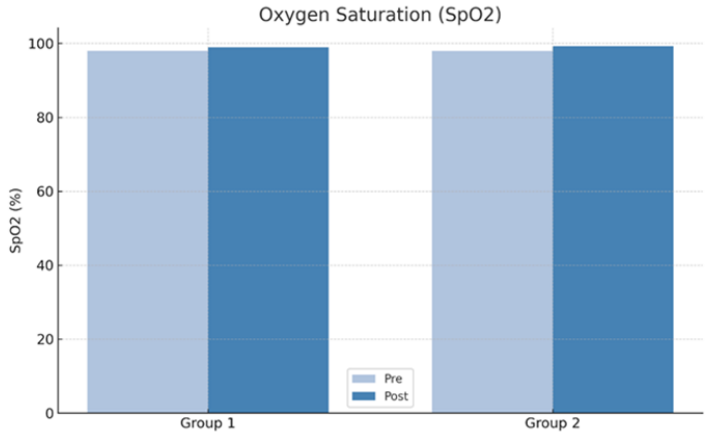


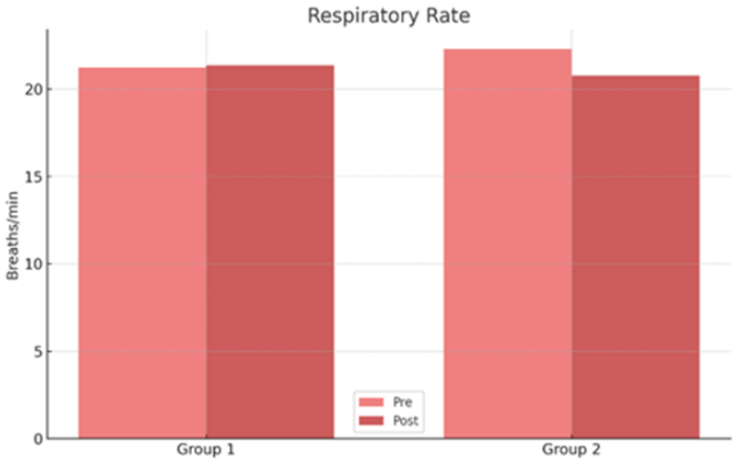
Graph 1: Comparative bar graphs illustrating VAS scores between Group 1 (Starpen) and Group 2 (Metal Aspirating Syringe).



Graph 2: Comparative bar graphs illustrating pulse rate between Group 1 (Starpen) and Group 2 (Metal Aspirating Syringe).



Graph 3: Comparative bar graphs illustrating oxygen saturation (SpO_2) between Group 1 (Starpen) and Group 2 (Metal Aspirating Syringe).



Graph 4: Comparative bar graphs illustrating respiratory ratebetween Group 1 (Starpen) and Group 2 (Metal Aspirating Syringe).