Comparison of Insulin and Safety Syringes for Pain and Anxiety Reduction in Pediatric Dental Anesthesia: A Randomized Controlled Trial

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Abstract

Background:
Dental anxiety is a prevalent issue among children, often triggered by the administration of local anesthesia. Fear of needles can lead to behavioral management challenges and avoidance of dental treatment. Various syringe techniques have been explored to minimize pain and anxiety. This study evaluates the impact of an insulin syringe compared to a safety syringe on pain perception and dental anxiety in children undergoing dental extractions.

Aim:
To assess and compare pain perception, dental fear, and anxiety in children receiving local anesthesia using insulin and safety syringes.

Materials and Methods: A split-mouth randomized controlled trial was conducted on 250 children aged 6 to 9 years requiring local anesthesia for dental extractions. Participants were divided into two groups: Group I received local anesthesia using an insulin syringe (31G, 5/16-inch), and Group II received anesthesia using a safety syringe (24G, 5/8-inch). Pain perception and anxiety were evaluated using the Venham Pictorial Test (VPT), Sound, Eye, and Motor (SEM) scale, and pulse rate monitoring at baseline, during the procedure, and postoperatively.

Results:
Children in the insulin syringe group exhibited significantly lower pain perception and anxiety levels compared to those in the safety syringe group. Positive behavior scores improved postoperatively, with a notable reduction in fear-related responses. Pulse rate analysis further supported reduced physiological stress in the insulin syringe group.

Conclusion:
The use of an insulin syringe for local anesthetic administration effectively reduces pain perception and dental anxiety in children. This approach may serve as a valuable tool in pediatric dental practice to enhance patient comfort and cooperation

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INTRODUCTION

Pain management during dental procedures is critical, as unmanaged pain can lead to noncompliance and avoidance of treatment. Among the various sources of pain, injections are the most common cause of discomfort in children undergoing dental procedures. In India, injections are frequently administered throughout infancy, childhood, and adolescence, often resulting in iatrogenic pain. Such pain can induce severe anxiety in children, which, if not addressed, may lead to preprocedural anxiety. Thus, it is crucial to develop techniques that reduce pain during injections, helping prevent avoidance behavior and improving cooperation for dental treatment.[1]

Dental fear is a psychological and physiological response to dental stimuli, often triggered by the anticipation of pain. In children, this fear is particularly associated with invasive procedures, such as tooth extractions and surgeries, although it can also arise from non-invasive treatments. Local anesthetics are the safest and most effective means of managing pain, but the injection process itself can instill fear, as many individuals, including children, are apprehensive about needles. Even preverbal children may experience the effects of untreated pain, which can negatively impact future medical outcomes.[2]

In Chennai, the prevalence of dental fear and anxiety in children is about 23.6%, with higher levels of fear observed in first-time dental patients. The fear of needles is the most common cause of dental anxiety in children, and this often leads to avoidance of dental care. Similar to childhood vaccinations, anticipatory guidance for parents can minimize pain, reduce needle-related fear, and prevent healthcare avoidance behaviors.[3] Positive early experiences foster trust in healthcare providers and reduce anxiety in future visits.

Dental treatment in children requires effective behavior management, which is significantly influenced by perceived pain and situational factors, such as the needle size and the rate of anesthetic delivery. [4] Smaller-bore needles, like insulin syringes, tend to cause less pain, but limited studies have explored this in pediatric dentistry. Children's behavior during invasive procedures varies widely and is largely determined by the degree of pain experienced.[5] Therefore, the main focus of my study is to evaluate pain perception, dental anxiety, and fear in children undergoing dental procedures with insulin and safety syringes, aiming to identify methods to reduce discomfort and improve cooperation, ultimately enhancing the overall treatment experience.

AIM

To find out the pain perception & dental fear and anxiety in children undergoing treatment using insulin and safety syringe

OBJECTIVE

To evaluate the pain perception in children undergoing dental extraction using insulin & safety syringe

To evaluate the dental fear and anxiety in children undergoing dental extraction using a safety syringe
To compare the pain perception & dental fear and anxiety in children using both the syringe method

MATERIALS AND METHODS

The study was conducted at the Department of Pedodontics & Preventive Dentistry of Saveetha Dental College & Hospital, Chennai, India. The data was collected in August 2021 - September 2022.

ETHICAL CLEARANCE

The study was initiated after approval of the Institutional Ethical Committee SDCDCH. (Ref no: SDCDCHIEC/PEDO/67/2021-22).

SELECTION CRITERIA:

250 hundred children who attend the clinic of the Department of Pedodontics and Preventive Dentistry, Saveetha Dental College were selected for the study after obtaining informed consent from the parents. The subjects included in the study were shy, fearful, and anxious coming under the negative category of Frankl's Behaviour rating chart. The purpose of the study was explained to the children and their caregivers, and written informed parental consent was obtained before the study.

INCLUSION CRITERIA

Children between 6 years and 10 years of age require local anesthesia for dental extraction on both sides of the dental arch for various dental treatment procedures.
Healthy children with no systemic illness, allergies, etc.
Children who had previous experience of extraction who are shy and
The patient requires infiltration LA for dental treatment.
Children with proper parental consent
Group-I classification criteria of the American Association of Anesthesiologists.

EXCLUSION CRITERIA

Patients having significant behavioral management problems.
Children having previous negative dental experiences; and
Medically and mentally compromised children
Children with known systemic disease.
Children with known allergy to local anesthetic agents.
Children below 5 years of age

METHODOLOGY

A split-mouth randomized controlled trial was conducted with 250 children aged 6 to 9 years, who visited the Department of Pedodontics and Preventive Dentistry, Saveetha Dental College & Hospital, Chennai, India. The study protocol was approved by the institutional ethical committee. After screening and applying inclusion criteria, written consent was obtained from the parent or caretaker, and the children were randomly divided into two groups. Group I (Insulin syringe group) included 125 subjects, and Group II (Safety syringe group) included 125 subjects.

Before treatment, the procedure was thoroughly explained to the children in simple terms, focusing on the administration of local anesthesia (LA). The children were randomly assigned to one of the two groups using a random number table, with stratification based on the Frankel behavior rating scale and block sizes of 10. LA was administered after applying a topical anesthetic spray.

- **Group I (Study group: Insulin syringe)**: Children in this group were treated using an insulin syringe (BD Ultra Fine 100IU/31G Syringe) with a gauge size of 31 and a length of 1/2 inch or 5/16 inch.
- **Group II (Control group: Safety syringe)**: Children in this group were treated using a safety syringe (Ultra Safety Plus Twist XL - Septodont USA) with a 24-gauge needle, 5/8 inch in length. Anesthesia was delivered within one minute, and the time was measured using a timer.

Procedure:

For both groups, the following steps were followed:

1. **Baseline measurement**: Before the start of the treatment, the procedure was explained to the child, and a pulse oximeter was placed on the index finger. The child was asked to select a face from the Venham pictorial pain rating scale (VPT) that best described how they were feeling.
2. **Administering local anesthesia (LA)**:

   Group I: The LA (LOX × 2% adrenaline) was delivered using an insulin syringe in the area adjacent to the tooth requiring invasive treatment. Pulse oximeter readings and pain ratings using the SEM pain scale were noted.

   Group II: The LA (LOX × 2% adrenaline) was delivered using a safety syringe in the area adjacent to the tooth requiring invasive treatment. Pulse oximeter readings and pain ratings using the SEM pain scale were also recorded.
3. **Post-procedure measurement**: After the procedure, the child was again asked to choose a face from the VPT pain rating scale. The parameters were assessed and recorded at baseline (before LA administration) and during LA administration. The pulse oximeter reading was continuously monitored, and the average value was calculated.

Follow-up:

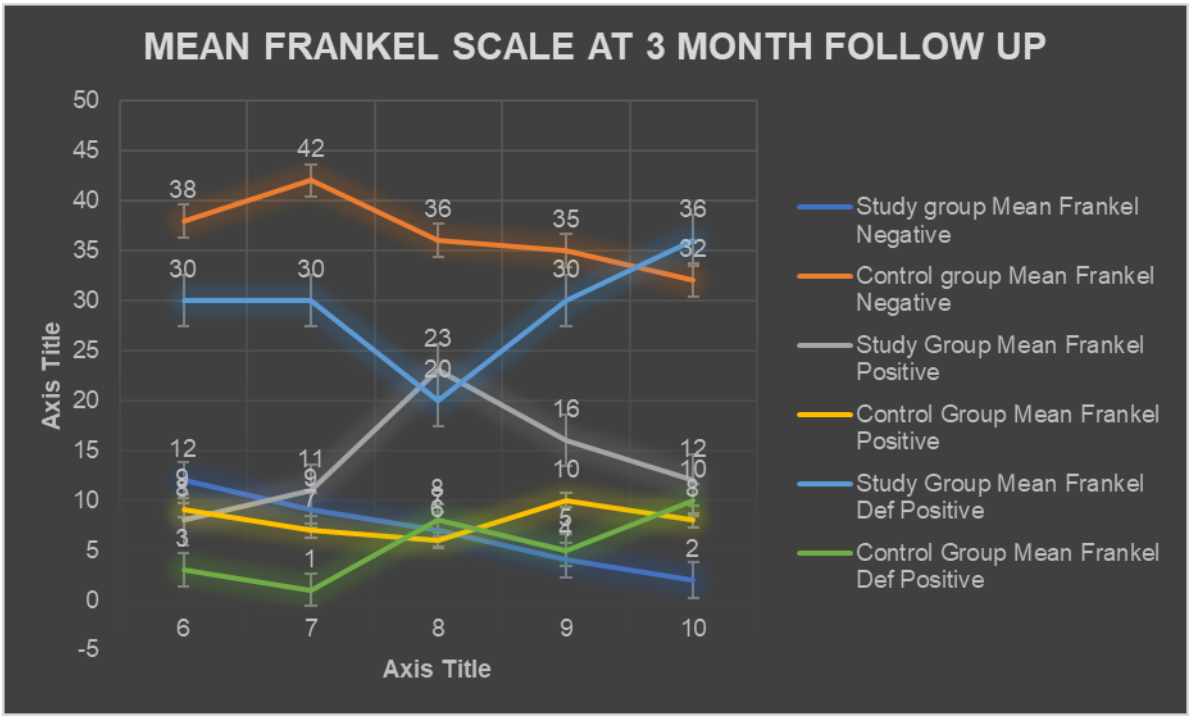
A follow-up assessment was conducted 2 weeks after the procedure to evaluate any residual anxiety or pain. The data collected from the baseline and 2-week follow-up were compared and analyzed.

All parameters, including pulse oximeter readings and pain scores, were documented in a custom-designed chart for both groups. The results were compared to determine the efficacy of the insulin syringe versus the safety syringe in reducing dental anxiety and pain perception during the injection process.

RESULTS

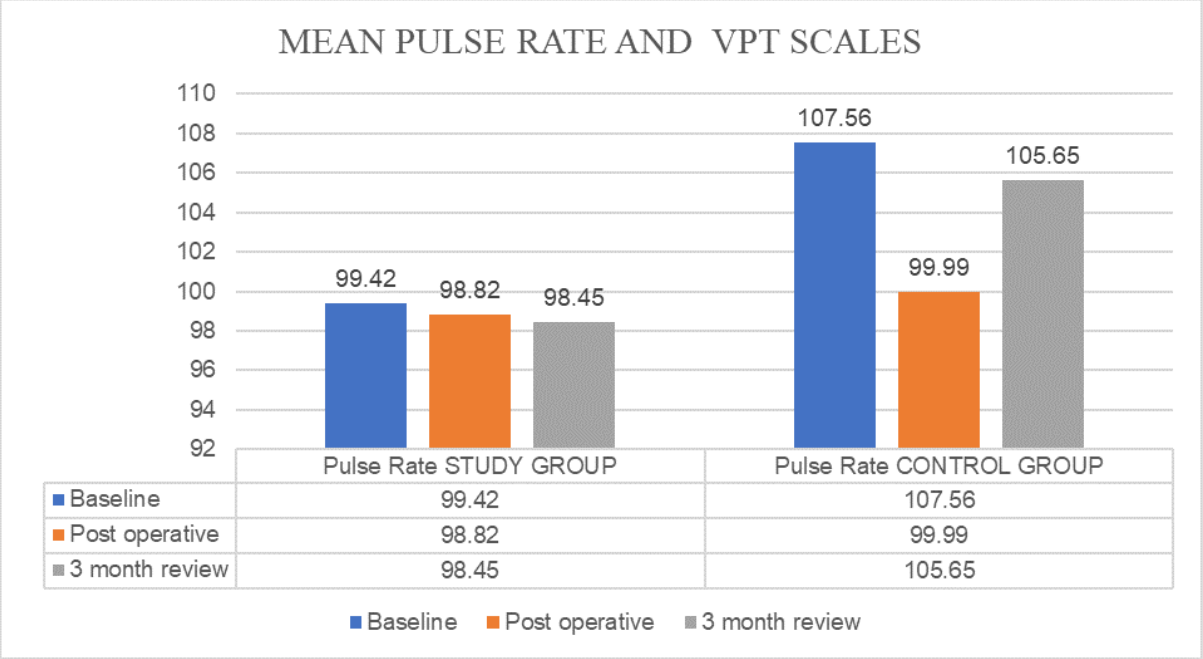
In the test group, 49.3% of participants were female, and the remaining 50.7% were male. The age distribution was as follows: 67% were 8 years old, 92% were 9 years old, 5% were 10 years old, and none were 11 years old. In the control group, 37.3% of participants were female, and the remaining 62.7% were male. The age distribution in the control group was: 74% were 8 years old, 10% were 9 years old, 10.6% were 10 years old, and the rest were 11 years old.

The study results show a significant improvement in the behavior of the child who had undergone local anesthetic procedures under the insulin syringe technique compared to the safety syringe technique. The pain perception and tomophobia in children for local anesthetic procedures also reduced significantly with good behavior scores at 2 weeks follow-up. The children who showed positive behavior; results recorded in the insulin syringe group at baseline 48%, postoperative 72, and 3 months follow-up 96% as compared to the safety syringe group at baseline 8%, postoperative 10%, and 3-month follow-up 4% respectively. The prevalence of dental fear and anxiety among these children was 59.46%.



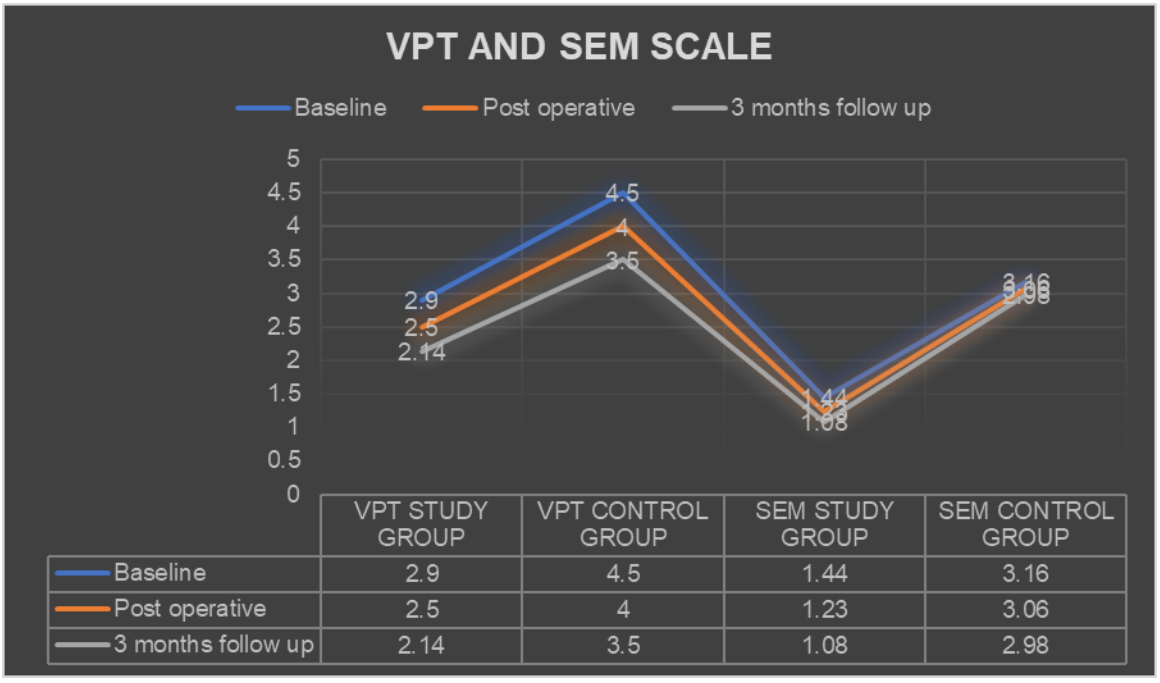
Graph 1: shows the mean frankel scale at 3-month follow-up, providing insights into behavioral responses over time. The frankel negative scores, which indicate anxiety or uncooperative behavior, decreased post-operatively, particularly in the study group. conversely, the frankel positive scores, reflecting cooperative behavior, showed an upward trend, suggesting that the intervention had a positive impact on patient compliance. The study

group demonstrated a more consistent and notable shift towards positive behavior compared to the control group, indicating better adaptation and reduced anxiety levels in the long run.



Graph 2: shows mean pulse rate values between the test and control group

Graph 2: shows mean pulse rate values between the test and control group in children. This graph, depicting the mean pulse rate and vpt scales, shows a notable difference in pulse rate trends between the study and control groups. In the study group, the baseline pulse rate was 99.42, which slightly decreased to 98.82 post-operatively. In contrast, the control group exhibited a more significant drop from 107.56 at baseline to 99.99 post-operatively. This suggests that the intervention in the study group led to a more stable physiological response, while the control group experienced a greater initial stress response that later subsided



Graph 3: shows mean VPT scale and SEM scale

Graph 3: shows mean VPT scale and SEM scale values between the test and control group in showing a decline in VPT values post-operatively. In the study group, the baseline VPT was 2.9, which reduced to 2.5, while in the control group, it dropped from 4.5 to 4.0. This decline suggests a reduction in pain perception or improved tolerance after the intervention. Similarly, the SEM Scale, which measures stability and response, showed a more pronounced improvement in the study group, with values decreasing from 1.44 to 1.23. In contrast, the control group exhibited only a slight reduction from 3.16 to 3.06. These findings indicate that the study group benefitted more significantly from the intervention, showing better physiological and behavioral stability compared to the control group.

Group	Score Type	Original Mean ± SD	Sample Size	p-value	2-Week Follow-Up (Mean ± SD)	p-value
Study Group	Negative Scores	29.8 ± 2.588	4	0	28.31 ± 2.459	0
Study Group	Positive Scores	5.6 ± 6.877	4	0.143	5.32 ± 6.533	0.143
Study Group	Definitively Positive Scores	24.2 ± 1.67	4	0.01	23.99 ± 1.59	0.01
Control Group	Negative Scores	28.6 ± 1.67	4	0	27.17 ± 1.59	0
Control Group	Positive Scores	15.6 ± 7.09	4	0.008	14.82 ± 6.735	0.008
Control Group	Definitively Positive Scores	14.4 ± 5.07	4	0.003	13.68 ± 4.82	0

Table 1 : Changes in Mean and Standard Deviation (SD) Scores at Baseline and 2-Week Follow-Up for Study and Control Groups

Table 1 summarizes the changes in mean and standard deviation (SD) scores for both the study and control groups after a 5% reduction, assessed at 2-week follow-up. For the study group, negative scores decreased from 29.8 ± 2.588 to 28.31 ± 2.459 (p = 0.00), positive scores slightly reduced from 5.6 ± 6.877 to 5.32 ± 6.533 (p = 0.143), and definitively positive scores dropped from 24.2 ± 1.67 to 23.99 ± 1.59 (p = 0.01). In the control group, negative scores decreased from 28.6 ± 1.67 to 27.17 ± 1.59 (p = 0.00), positive scores from 15.6 ± 7.09 to 14.82 ± 6.735 (p = 0.008), and definitively positive scores from 14.4 ± 5.07 to 13.68 ± 4.82 (p = 0.003). Both groups exhibited reductions across all categories, with statistically significant results in most instances.

Group	Test Type	Chi-Square Value (Baseline)	df	Chi-Square Value (2-Week Follow-Up)	df	Asymptotic Significance (2-sided)
Study and Control Group	Pulse Rate (PR Rate)	250	4	237.5	4	0.000 (p < 0.05)
Study and Control Group	Sound Eye Motor Scale (SEM Scale)	251.107	4	238.552	4	0.000 (p < 0.05)
Study and Control Group	Venham Pictorial Test (VPT Scale)	253.534	6	240.857	6	0.000 (p < 0.05)

Table 2 shows Chi-Square Test Results for Study and Control Groups at Baseline and 2-Week Follow-Up

The table displays the Chi-Square test results for pulse rate (PR rate), sound eye motor scale (SEM scale), and Venham pictorial test (VPT scale) for both study and control groups, both at baseline and after a 2-week follow-up. For all three tests, the Chi-Square values showed a 5% reduction in the follow-up period. The results were statistically significant with p < 0.05 (Asymptotic Significance 2-sided) for both the baseline and follow-up periods, indicating that the changes observed between the study and control groups were meaningful.

DISCUSSION

Pain perception in children during dental procedures, particularly needle-related ones, is a critical aspect of pediatric dentistry. The ability to effectively manage pain in young patients is essential not only to reduce immediate discomfort but also to prevent long-term anxiety and phobia that may affect their willingness to seek dental care in the future. This study focuses on understanding how needle-related procedures, specifically injections, are perceived in terms of pain by children, comparing the pain levels associated with safety syringes versus insulin syringes. The results highlight significant findings on the influence of needle gauge, technique, and pain management strategies on children's pain perception during injections.[6]

Pain perception in pediatric patients varies widely depending on several factors, such as age, past dental experiences, individual pain thresholds, and the type of needle or syringe used. This study found that the prevalence of dental fear and anxiety was notably high among children, especially with the use of safety syringes.[7] This is consistent with other research that indicates the level of dental fear can significantly impact a child's willingness to undergo dental treatment. A key finding of this study is that safety syringes, with their larger needle gauge, contributed to greater pain perception compared to insulin syringes, which are designed with smaller needles to minimize discomfort.[8] The results showed a significant difference in the pain tolerance between children receiving injections with these two types of syringes, with insulin syringes resulting in lower pain levels and reduced anxiety.

The bore gauge of a needle plays a central role in determining how much pain a child experiences during an injection. Larger needles, such as those in safety syringes, cause greater tissue trauma upon insertion and can lead to a more intense pain experience.[9] This is primarily because of the increased friction and tissue resistance encountered by the needle. Additionally, the larger the needle, the more force is needed to inject the anesthetic solution, which can lead to more rapid and forceful tissue distension, heightening discomfort. In contrast, smaller needles, like those used in insulin syringes, cause less resistance and allow for a more gradual, controlled injection of the anesthetic, resulting in a less painful experience for the child. The study corroborates these findings by showing that the children who received injections with insulin syringes experienced lower pain levels, measured both subjectively and objectively, than those who were administered injections with safety syringes.[10]

Pain management strategies are crucial in minimizing discomfort and preventing the development of dental anxiety in children. Topical anesthesia, such as numbing gels or creams, has proven effective in reducing the pain associated with needle injections. The topical anesthetic works by desensitizing the skin and mucous membranes at the injection site, allowing the needle to be inserted with minimal discomfort.[11] Additionally, distraction techniques—such as allowing children to watch cartoons, listen to music, or engage in games during the procedure—have been shown to help alleviate anxiety and reduce the perception of pain. These techniques help children shift their focus away from the needle, making the procedure less stressful. If these strategies are not implemented effectively, anxiety may escalate into dental phobia, a long-term fear of dental treatments that can affect a child’s willingness to seek care in the future.[12]

Moreover, patient communication plays an integral role in pain management. Children often experience anxiety due to uncertainty and fear of the unknown. By explaining the procedure to

children in an age-appropriate manner and providing them with some control over the situation, dental professionals can help reduce this fear. For example, allowing children to ask questions and express their concerns before the procedure can make them feel more in control and reduce their anxiety.

This study also emphasized the importance of needle choice in pediatric pain management. Insulin syringes, with their smaller gauge, offer a viable option for reducing injection-related pain. By using these smaller needles, dental professionals can minimize the risk of tissue trauma, reducing the likelihood of complications such as nerve or blood vessel injury.[13] The smaller gauge of the needle also means that less pressure is exerted during the injection, allowing for a smoother flow of the anesthetic solution.[14] This controlled flow reduces the potential for discomfort associated with the sudden, forceful delivery of anesthetic, a common issue with traditional safety syringes. The results of this study clearly demonstrated that insulin syringes provided a more comfortable experience for pediatric patients, resulting in lower heart rates, reduced anxiety, and lower pain levels.

However, there are several mechanisms behind the increased pain perception associated with traditional safety syringes. One possible explanation is the inconsistent application of pressure by the operator on the syringe plunger. When the pressure is not evenly applied, the anesthetic solution is delivered in an uneven, forceful manner, which can cause sudden tissue distension and pain.[15] The release of anesthetic into tightly bound tissues, such as those found in the mouth, can further contribute to this sensation of discomfort.[16] In contrast, the smaller-gauge needles used in insulin syringes encounter less resistance, allowing for a smoother and more gradual injection process that is less likely to cause pain.

In this study, pain perception was assessed using various tools, including the Visual Pain Tolerance (VPT) scale, the Visual Analog Scale (VAS), and the Sound, Eye, and Motor (SEM) scale. The VPT scale, in particular, was useful in quantifying pain levels in young children who may have difficulty verbally expressing their discomfort. The SEM scale provided additional insights by measuring the physiological and behavioral responses to pain, including changes in pulse rate and facial expressions. [17] The objective measurement of pulse rate, which serves as an indicator of pain perception, confirmed that children receiving injections with insulin syringes exhibited lower pulse rates, suggesting reduced stress and pain levels. This objective data, along with the subjective assessments, strongly supports the conclusion that insulin syringes cause less pain and anxiety in pediatric patients.[18]

Despite the valuable insights provided by this study, there are some limitations to consider. The sample size was relatively small, which may affect the generalizability of the findings. Larger, multicenter studies would be beneficial in confirming these results and providing a more robust analysis.[19] Additionally, while the study accounted for differences in syringe type, it did not fully address the psychological factors that can influence pain perception, such as previous experiences or anxiety levels. Future studies should take these variables into account to offer a more comprehensive understanding of pediatric pain perception.[20]

Furthermore, this study did not evaluate the long-term effects of repeated injections on children's dental anxiety. While the immediate impact of needle size on pain perception is clear, it is also important to investigate how pain management strategies influence children's future attitudes toward dental care. Early interventions that focus on reducing pain and anxiety may

play a critical role in shaping a child's long-term experience with dental visits, potentially reducing the development of dental phobia.

CONCLUSION

In conclusion, this study reinforces the importance of choosing the appropriate needle size in pediatric dental procedures to minimize pain and anxiety. Insulin syringes, with their smaller gauge, offer significant advantages in terms of pain reduction compared to traditional safety syringes. By incorporating effective pain management strategies such as topical anesthesia, distraction techniques, and clear communication, pediatric dentists can help ensure that their young patients have positive dental experiences. As research continues, it will be essential to explore new techniques, such as needle-free injectors and advanced anesthetic delivery systems, to further improve pain management in pediatric dentistry and reduce the incidence of dental anxiety.

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