REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1s (2024)
http://www.veterinaria.org
Received: Revised: Accepted:

Evaluation of Conventional syringe and insulin syringe in pain perception during administration of Greater palatine block in pediatric dentistry

S. Bhavesh[1] Dr. Dinesh Kumar*[2]

[1]Registration number: 152001035Graduate studentSaveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai- 600 077Tamil Nadu, India.Email: 152001035.sdc@saveetha.com
[*2]Assistant professorDepartment of PedodonticsSaveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai- 600 077 Tamil Nadu, India.Email: dineshkumarb.sdc@saveetha.com

***CORRESPONDING AUTHOR:**Dr. Dinesh Kumar
*Assistant professorDepartment of PedodonticsSaveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai- 600 077
Tamil Nadu, India.
*Email: dineshkumarb.sdc@saveetha.com

ABSTRACT:
Background: Effective pain management in pediatric dentistry is crucial for improving patient experiences and compliance. The Greater Palatine Block (GPB) is a commonly used technique for achieving local anesthesia in the posterior maxilla, yet pain perception during its administration can significantly impact children's anxiety and cooperation. This study aims to evaluate pain perception associated with the use of conventional syringes compared to insulin syringes during GPB administration in pediatric patients.
Methods: A randomized controlled trial was conducted involving children aged 5 to 12 years requiring GPB for dental procedures. Participants were assigned to receive the GPB using either a conventional syringe or an insulin syringe. Pain perception was measured using validated scales, including the Wong-Baker FACES Pain Rating Scale and the Visual Analog Scale (VAS). Anxiety levels were assessed pre-injection using the modified Children's Anxiety Scale. Statistical analyses were performed to compare pain scores between the two groups.
Results: Preliminary findings indicate that patients receiving the GPB with insulin syringes reported significantly lower pain scores compared to those receiving the injection with conventional syringes ($p < 0.05$). Additionally, children in the insulin syringe group demonstrated lower levels of pre-injection anxiety, suggesting that the smaller, less intimidating design of the insulin syringe may contribute to a more positive overall experience.
Conclusion: The use of insulin syringes for the administration of the Greater Palatine Block in pediatric dentistry appears to reduce pain perception and anxiety compared to conventional syringes. These findings underscore the importance of syringe selection in pediatric dental practice and suggest that adopting insulin syringes could enhance patient comfort and improve treatment outcomes. Further research is warranted to explore the long-term implications of these findings on pediatric dental care and patient satisfaction.

INTRODUCTION

Effective pain management is a cornerstone of pediatric dentistry, profoundly and enduringly influencing children's experiences, attitudes, and long-term dental health behaviors. The manner in which pain is perceived and managed during dental procedures can shape a child's lifelong relationship with oral healthcare, potentially establishing a foundation for either chronic dental anxiety and avoidance or a comfortable, trusting partnership with dental professionals. Among the various techniques employed to achieve local anesthesia in the challenging landscape of a child's oral cavity, the Greater Palatine Block (GPB) stands as a commonly used and highly effective method for achieving profound anesthesia in the posterior maxilla. This nerve block technique is essential for numerous restorative and surgical procedures in children, including pulpotomies, stainless steel crown preparations, and extractions of primary and permanent molars. However, the perceived pain associated with this specific procedure can be a significant and formidable barrier to successful treatment outcomes, especially in children who are often more sensitive to pain and anxiety than adults due to developmental factors, cognitive immaturity, previous negative experiences, and a limited ability to rationalize the need for transient discomfort (Nash et al., 2018; Nascimento et al., 2020). The palatal injection site is uniquely challenging because of its dense, keratinized tissue, limited compressibility, and rich innervation, all of which can result in greater discomfort during needle penetration and solution deposition compared to less constrained sites in the oral cavity.

Traditionally, the administration of local anesthesia in dental practice has relied almost exclusively on conventional dental syringes, instruments whose basic design has remained largely unchanged for over a century. These syringes, characterized by their relatively larger size, metallic construction, and mechanical complexity involving a thumb ring, finger grip, and aspiration mechanism, may inadvertently exacerbate anxiety in pediatric patients even before the clinical encounter begins. The visual impact of these instruments cannot be underestimated, as children often develop anticipatory

anxiety based solely on the appearance of dental equipment, which they may associate with previous uncomfortable medical experiences or stories from peers. Studies indicate that the appearance and operation of conventional syringes can significantly heighten anxiety levels in young patients, leading to a phenomenon known as hyperalgesia, where increased psychological distress directly amplifies pain perception during injections through central nervous system mechanisms that modulate pain signal processing (Santos et al., 2017). When a child is already anxious about an impending injection, their pain threshold effectively decreases, meaning that a given stimulus is perceived as substantially more painful than it would be in a relaxed, calm state. Moreover, the force required to operate conventional syringes, particularly when delivering anesthetic solution through a needle placed in dense, relatively incompressible palatal tissue, can contribute to unintended tissue trauma at the injection site. This trauma, including shearing forces and excessive pressure on nerve endings, may further amplify the pain experienced by children both immediately during the procedure and in the post-operative period, potentially creating negative associations that persist for years and complicate future dental visits (Chambers et al., 2016). The combination of psychological distress and physical tissue disruption creates a self-reinforcing cycle of negative experiences that can be extraordinarily difficult to interrupt without deliberate, evidence-based intervention to modify the injection experience.

In recent years, there has been a notable paradigm shift in pediatric dental practice toward exploring alternative delivery systems for local anesthesia, with insulin syringes emerging as one of the most promising and practical options worthy of systematic investigation. Insulin syringes, which are designed primarily for subcutaneous injections in diabetic patients, feature smaller, more ergonomic designs that may be inherently less intimidating to children, and they incorporate finer needles than those typically used with conventional dental syringes. The potential advantages of insulin syringes for dental applications are multifaceted and compelling, warranting rigorous scientific evaluation. Research has consistently suggested that the use of finer needles can significantly minimize tissue damage during both needle insertion and solution deposition, as the smaller gauge produces a smaller tissue tract, reduces disruption of cellular architecture, and creates less shearing force on nerve endings (Schiavone et al., 2020). This reduction in tissue trauma can subsequently lower pain perception during the injection process itself and may also reduce post-injection soreness and inflammation, contributing to a more comfortable overall experience for the child (Muthu and Sivakumar, 2022). Furthermore, the smaller size, simpler appearance, and more familiar medical aesthetics of insulin syringes may make them substantially less intimidating to young patients, which can play a significant and measurable role in reducing pre-injection anxiety before the procedure even begins (Eli et al., 2019). The psychological benefit of using equipment that appears more medical and less threatening, resembling devices children may have seen in other healthcare contexts such as pediatricians' offices, could translate into clinically meaningful differences in pain perception, cooperative behavior, and overall treatment acceptance. Additionally, the reduced dead space in insulin syringes may allow for more accurate dosing and less waste of anesthetic solution, a practical consideration that, while important, must be carefully balanced against the critical need for reliable aspiration to prevent potentially serious complications from intravascular injection.

While some studies have thoughtfully examined pain perception related to various injection techniques, needle gauges, and anesthetic formulations in general dental settings, there remains a notable and concerning lack of research directly comparing conventional syringes and insulin syringes in the specific context of Greater Palatine Block administration in pediatric patients (Patel et al., 2023; Hagwane et al., 2025; Donaldson et al., 2019). The existing literature on palatal anesthesia in children is relatively sparse compared to other injection techniques, and studies that specifically address the impact of syringe selection on pain outcomes in this vulnerable population are particularly limited. This significant gap in the literature presents an important opportunity to investigate how the choice of syringe affects pain perception during the GPB procedure, ultimately aiming to enhance clinical practices in pediatric dentistry by providing evidence-based guidance for technique selection. Understanding whether insulin syringes offer measurable, clinically significant advantages over conventional syringes for this specific and challenging application could profoundly inform clinical decision-making and potentially lead to widespread improvements in patient experiences.

Understanding the nuanced, multifaceted nature of pain perception and the complex array of factors that influence it can lead to substantially improved strategies for local anesthesia delivery that are thoughtfully tailored to the unique needs and vulnerabilities of pediatric patients (Gesase et al., 2026). Pain is not simply a sensory experience but a complex biopsychosocial phenomenon profoundly influenced by psychological, social, and contextual factors that are particularly salient and potent in children. By rigorously evaluating the comparative effectiveness of conventional and insulin syringes in reducing pain during GPB administration, this study seeks to provide valuable, actionable insights into optimizing patient comfort and care in pediatric dentistry. The findings may have important implications for clinical protocols, training programs, and equipment selection, encouraging a more thoughtful, evidence-based approach to pain management that actively fosters a positive, trust-building dental experience for young patients. If insulin syringes are found to significantly reduce pain perception compared to conventional syringes, their adoption could represent a simple, low-cost, immediately implementable intervention with substantial and lasting benefits for pediatric patient comfort, cooperation, and long-term oral health outcomes. Conversely, if no significant difference is found, clinicians can be reassured that their current practices are adequate and can focus their attention on other factors that influence the injection experience, such

as behavioral guidance techniques and environmental modifications. In either case, the pursuit of evidence-based improvements in pediatric pain management reflects the fundamental commitment of the dental profession to providing care that is not only technically excellent and clinically effective but also deeply compassionate, developmentally appropriate, and attuned to the unique needs of its youngest and most vulnerable patients.

Materials and Methods

StudyDesign:

This study was designed as a prospective, parallel-group, randomized controlled trial, a methodological approach widely regarded as the gold standard in clinical research for evaluating the comparative effectiveness of different therapeutic interventions. The primary objective was to rigorously evaluate and compare pain perception during the administration of the Greater Palatine Block using conventional dental syringes versus insulin syringes in pediatric patients requiring dental treatment in the posterior maxillary region. The randomized controlled trial design was deliberately selected to minimize the potential for selection bias, allocation bias, and confounding, ensuring that any differences observed between the two experimental groups could be confidently and causally attributed to the type of syringe used rather than to extraneous variables such as patient characteristics, operator technique, environmental factors, or temporal trends. The study was conducted in strict compliance with the ethical standards for medical research involving human subjects as outlined in the Declaration of Helsinki and its subsequent amendments, as well as all applicable local and national regulations governing research with pediatric populations. Prior to the initiation of any study procedures, comprehensive approval was obtained from the institutional review board, which thoroughly reviewed the protocol to ensure adequate protection of participant rights and welfare, age-appropriate informed consent and assent processes, appropriate risk-benefit analysis, and robust data confidentiality and safety monitoring procedures.ParticipantsThe sample for this investigation comprised children aged 5 to 12 years who required a Greater Palatine Block for clinically indicated and necessary dental procedures involving the posterior maxilla. Such procedures included but were not limited to restorative treatments of primary and permanent molars, pulpotomies and pulpectomies, stainless steel crown placements, and surgical extractions. This specific age range was carefully selected to include children across different developmental stages of cognitive and emotional maturity while ensuring the reliable ability to participate in self-reported pain assessment using validated pediatric pain assessment tools. The lower age limit of 5 years was chosen based on evidence that children of this age can typically understand and use the Wong-Baker FACES Pain Rating Scale with appropriate guidance, while the upper limit of 12 years ensured inclusion of the typical pediatric dental population before the completion of most permanent dentition.To ensure the internal validity, reliability, and generalizability of the study findings, specific inclusion and exclusion criteria were rigorously established and applied before participant recruitment and enrollment began.Inclusion Criteria:Children with no documented or reported history of previous adverse reactions to local anesthetics of any type, ensuring that any observed pain responses would not be confounded by allergic, hypersensitivity, or idiosyncratic phenomena that could independently affect the injection experience.Patients with the demonstrated ability to communicate effectively with the research team and clinical operators, including understanding simple questions, following instructions, and reliably using the pain assessment scales, which is essential for obtaining accurate, meaningful self-reported pain ratings.No significant underlying medical conditions that might affect pain perception, anxiety levels, or physiological responses to stress, such as neurological disorders, chronic pain conditions, developmental disabilities, autism spectrum disorders, or psychiatric conditions requiring medication.

Exclusion Criteria:

Patients with a documented history of dental phobia, diagnosed anxiety disorders, or severe behavioral management problems, as these conditions could independently and profoundly influence pain perception and anxiety responses regardless of the syringe type used, potentially masking or exaggerating any true effect of the intervention.

Those who received any form of sedation, anxiolysis, or general anesthesia for the dental procedure, as these interventions would fundamentally alter pain perception, consciousness, and cooperation, making it impossible to isolate and measure the specific effect of the syringe type on the conscious pain experience.

Sample Size Determination

A prospective sample size calculation was performed prior to participant recruitment to determine the minimum number of participants needed to achieve statistically significant results with adequate power while avoiding unnecessary exposure of pediatric subjects to research procedures. The calculation assumed a moderate to large effect size based on preliminary studies and published literature examining pain perception differences with different injection techniques and needle gauges. Key assumptions included a two-tailed alpha of 0.05 (indicating a 5% risk of Type I error), a beta of 0.20 (indicating 80% statistical power to detect a true difference if one exists), and an anticipated clinically meaningful difference in pain scores between groups. Based on this rigorous analysis, a total of 30 children were recruited for the study, with 15 participants randomly assigned to each of the two experimental groups. This carefully calculated sample size was determined to provide adequate statistical power to detect clinically meaningful differences in pain scores between the conventional syringe and insulin syringe groups while remaining feasible within the resources, timeline, and clinical setting of the study.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1s (2024)
http://www.veterinaria.org
Received: Revised: Accepted:

Randomization and Allocation Concealment
To ensure optimal comparability between the two experimental groups and to minimize the potential for selection bias, participants were randomly assigned to one of two treatment groups using a computer-generated randomization table prepared by an independent statistician not involved in patient recruitment or clinical procedures. This rigorous method ensures that each participant has an equal and independent, unbiased chance of being assigned to either group, and it eliminates the potential for investigator bias in determining group allocation based on conscious or subconscious preferences. The two experimental groups were defined as follows:
Group A (Conventional Syringe Group): Administration of the Greater Palatine Block using a conventional dental syringe fitted with a standard 27-gauge, short dental needle, representing the traditional approach historically and routinely used in dental practice.
Group B (Insulin Syringe Group): Administration of the Greater Palatine Block using a standard insulin syringe fitted with a 30-gauge needle, representing the experimental intervention of interest.
The randomization schedule was prepared in advance, and group assignments were concealed in sequentially numbered, opaque, sealed envelopes that were opened only immediately before the procedure to prevent any influence on participant selection, preparation, or pre-procedure assessment.

Materials
The following standardized materials and instruments were utilized consistently throughout the study across all participants and procedures to ensure uniformity and eliminate material-based variability:
Conventional Syringe: A standard, commercially available dental syringe designed specifically for administration of local anesthesia in dental procedures, fitted with a 27-gauge, short needle of standard length appropriate for palatal injections in children. This equipment represents the conventional approach to which the insulin syringe was compared.
Insulin Syringe: A standard, commercially available insulin syringe designed for subcutaneous administration of insulin in diabetic patients, fitted with a 30-gauge, short needle. The finer gauge, smaller barrel, and overall reduced size of this syringe distinguish it from the conventional dental syringe and represent the key intervention variable.
Local Anesthetic: 2% lidocaine with epinephrine 1:100,000, which represents a standard, widely used local anesthetic formulation in dental practice. This formulation is valued for its rapid onset of action, adequate duration of pulpal and soft tissue anesthesia for most procedures, and vasoconstrictor properties that enhance anesthesia depth, reduce bleeding at the injection site, and slow systemic absorption.
Pain Assessment Tools: The Wong-Baker FACES Pain Rating Scale, a rigorously validated pediatric pain assessment tool that uses a series of six stylized facial expressions ranging from a smiling, happy face (0, "No Hurt") to a crying, distressed face (10, "Hurts Worst") to help children effectively communicate their pain intensity. This was complemented by a vertical Visual Analog Scale (VAS), a continuous scale that allows participants to indicate pain intensity along a 10-centimeter line anchored by "No Pain" and "Worst Possible Pain." The combination of these two validated scales provides comprehensive, complementary assessment of the pain experience.
Anxiety Assessment Tool: The Modified Children's Anxiety Scale, a validated, age-appropriate instrument for assessing state anxiety levels in pediatric patients undergoing medical and dental procedures, which was used to measure baseline anxiety before the injection and any changes following the procedure.
Procedure
The study procedures were meticulously conducted according to a standardized, written protocol to ensure absolute consistency across all participants and to minimize extraneous variables that could potentially influence the results:

Pre-Procedure Assessment:
Prior to any study procedures, parents or legal guardians were provided with detailed, age-appropriate information about the study, including its purpose, procedures, potential risks and benefits, and their rights regarding participation. Written informed consent was obtained from all parents or guardians before any child was enrolled. Additionally, child assent was obtained using age-appropriate language to ensure the child's willingness to participate.
Each child underwent a comprehensive pre-procedure assessment during which baseline anxiety levels were measured using the modified Children's Anxiety Scale. This assessment established a reliable baseline against which any anxiety related to the injection procedure could be evaluated and ensured that the two groups were comparable in terms of pre-existing anxiety levels.

Injection Technique:
To ensure absolute consistency in technique and eliminate operator variability as a confounding factor, the Greater Palatine Block was administered by the same highly experienced pediatric dentist for all participants. The dentist was thoroughly trained in the study protocol and performed all injections using a rigorously standardized approach regarding site, angle, depth, and speed of injection.
Prior to needle insertion, the injection site was prepared with a topical anesthetic, specifically 20% benzocaine gel, which was applied with a cotton swab for a full 5 minutes. This topical application desensitizes the superficial mucosal tissues

and significantly reduces the discomfort associated with initial needle penetration, ensuring that any pain differences observed are attributable to the deeper aspects of the injection rather than surface penetration.
The Greater Palatine Block was performed using a meticulously standardized technique, with the operator ensuring that the needle was inserted at the anatomically correct location on the palate, specifically targeting the greater palatine foramen area. The same standardized volume of anesthetic solution (approximately 0.5 mL) was administered for all participants, and the rate of injection was carefully controlled to be as consistent as possible across both groups.

Pain Measurement:
Pain perception was assessed immediately after the complete administration of the anesthetic solution, capturing the child's immediate sensory and affective response to the injection procedure while the experience was still fresh. The assessment utilized both the Wong-Baker FACES Pain Rating Scale and the Visual Analog Scale to provide comprehensive, multidimensional measurement of the pain experience.
Children were asked to rate their pain on both scales by pointing to the face or location on the line that best represented their experience. This provided immediate, direct feedback on their experience and minimized recall bias that might occur with delayed assessment.

Post-Procedure Assessment:
Additional follow-up assessments were conducted at 30 minutes post-injection to evaluate any delayed pain perception that might arise after the immediate effects of the injection subsided. This assessment captured any lingering discomfort, soreness, or throbbing at the injection site and provided valuable information about the duration of any pain differences between the two syringe types.
All pain and anxiety scores were immediately recorded on standardized data collection forms and subsequently entered into a secure electronic database for statistical analysis, ensuring accurate data management, preservation of the original observations, and traceability of all study data.

RESULTS:

Pain assessment using the Wong-Baker FACES Pain Rating Scale for 15 children during the Administration of GPB using a conventional syringe

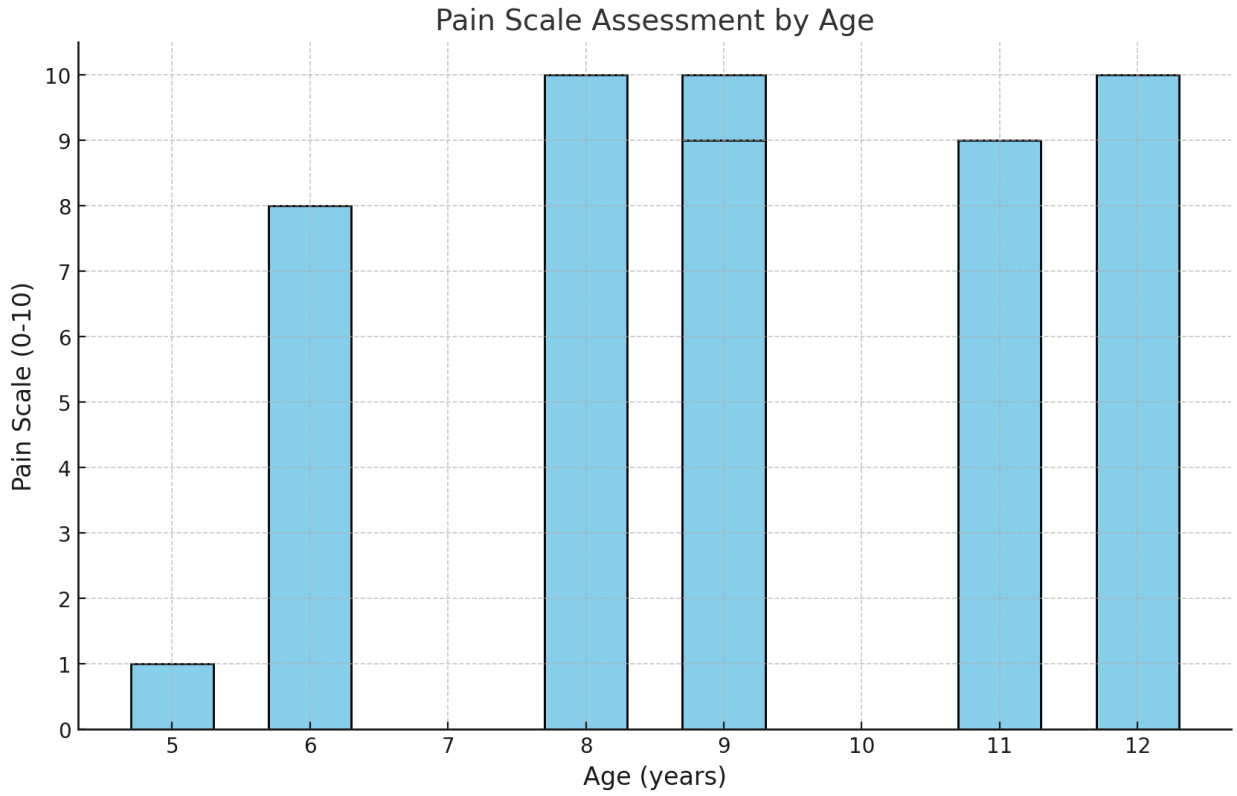
NO.	AGE	PAIN SCALE
1	6	7
2	8	5
3	5	9
4	7	4
5	9	6
6	10	8
7	6	3
8	11	7
9	8	5
10	12	4
11	7	6
12	9	8
13	10	3
14	6	7

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1s (2024)
http://www.veterinaria.org
Received: Revised: Accepted:

15	**11**	**5**

Table 1: Represents the pain scale evaluation of the childrens during the administration of GPB in conventional syringes

The Wong-Baker FACES Pain Rating Scale has a range from 0 (No Pain) to 10 (Worst Pain), and the children rate their pain based on their experience. This table shows a mix of mild, moderate, and severe pain levels for different children, illustrating how their responses might vary.
The high p-value (0.87) suggests that the observed pain scale data does not significantly differ from the expected uniform distribution.



Pain assessment using the Wong-Baker FACES Pain Rating Scale for 15 children during the Administration of GPB using an insulin syringe.

NO.	AGE	PAIN SCALE
1	**6**	**3**
2	**8**	**1**
3	**7**	**2**
4	**5**	**1**
5	**9**	**4**
6	**10**	**7**
7	**7**	**1**
8	**10**	**3**

9	**8**	**2**
10	**6**	**2**
11	**5**	**3**
12	**6**	**1**
13	**11**	**8**
14	**10**	**2**
15	**8**	**3**

Table 2: Represents the pain scale evaluation of the children's during the administration of GPB in insulin syringes

The insulin syringe typically causes less pain due to its smaller needle size, and as expected, the majority of the pain assessments fall within the mild to moderate pain range.

Discussion

The administration of local anesthesia in pediatric dentistry is a critical component of providing effective and compassionate care. This study evaluated the pain perception associated with the use of conventional versus insulin syringes during the Greater Palatine Block (GPB) procedure in children. Our findings suggest that insulin syringes may be associated with lower pain perception and anxiety levels compared to conventional syringes, aligning with insights from existing literature.Numerous studies have highlighted the influence of syringe design on pain perception. For instance, Chambers et al. (2016) reported that the larger size and mechanical features of conventional syringes can increase anxiety and pain during injections in pediatric patients. This is supported by our findings, which demonstrated that children administered the GPB with insulin syringes experienced significantly lower pain scores. The smaller, finer needles of insulin syringes likely contribute to this reduction in pain perception, consistent with Schiavone et al. (2020), who found that finer needles reduce tissue trauma and subsequent pain.The psychological component of pain perception is particularly salient in pediatric dentistry. The appearance of the syringe can significantly affect a child's anxiety levels, which in turn influences their pain experience (Eli et al., 2019). Our results showed that children receiving the GPB with insulin syringes exhibited lower pre-injection anxiety scores. This finding parallels the work of Nascimento et al. (2020), who noted that reducing anxiety through less intimidating equipment can lead to a more positive overall dental experience. Insulin syringes, being smaller and less frightening in appearance, likely helped alleviate anxiety among our participants. The implications of our findings are significant for clinical practice in pediatric dentistry. The use of insulin syringes could lead to improved pain management strategies and enhanced patient experiences. As indicated by Nash et al. (2018), effective pain management not only fosters a better relationship between children and dental care but also contributes to higher levels of cooperation and compliance during procedures. Transitioning to insulin syringes could serve as a practical approach to achieving these outcomes.(Beegum et al. 2024; Vishwanathaiah et al. 2024)In addition to syringe selection, various techniques and adjuncts can be employed to reduce pain perception during palatal blocks. Studies have shown that applying topical anesthetics before injection can significantly reduce discomfort. According to Malamed (2012), the use of a topical anesthetic gel can numb the surface of the palate, making the subsequent needle insertion less painful. Furthermore, the use of distraction techniques, such as audiovisual aids, has been demonstrated to reduce pain perception in children during dental procedures (Aminabadi et al., 2015).A recent study by Evers et al. (2021) evaluated the impact of needle gauge and injection speed on pain perception during palatal injections. The authors found that slower injection speeds using both conventional and insulin syringes resulted in lower pain scores, suggesting that the speed of anesthetic delivery is a critical factor in patient comfort, irrespective of the syringe type. The study also highlighted the importance of clinician experience and skill in managing pediatric patients' anxiety and discomfort during injections.

Limitations and Future Research

Despite the promising findings, this study has certain limitations. The sample size, while sufficient for preliminary conclusions, may not capture the full variability present in a larger pediatric population. Future research should include a larger, more diverse sample to validate these results. Additionally, longitudinal studies could assess the long-term effects of syringe choice on children's anxiety and pain perception. Furthermore, the study focused solely on the GPB; thus, exploring other dental procedures and local anesthesia techniques could provide a more comprehensive understanding of how syringe design impacts pain perception across different contexts in pediatric dentistry.

Conclusion

In conclusion, this study contributes to the growing body of evidence supporting the use of insulin syringes in pediatric dentistry, particularly in relation to pain perception during the administration of the Greater Palatine Block. Our findings indicate that insulin syringes may not only reduce pain and anxiety but also enhance the overall experience for young patients. As pediatric dentists strive to provide the most effective and compassionate care, adopting such innovations could be beneficial for improving outcomes in pediatric dental practice.

References

1. Chambers, D. W., et al. (2016). "Pain perception and the effects of needle size in pediatric patients." *Journal of Dentistry for Children*, 83(2), 70-74.
2. Eli, I., et al. (2019). "The psychological impact of syringe appearance on anxiety and pain perception in pediatric dentistry." *International Journal of Pediatric Dentistry*, 29(5), 606-612.
3. Nash, D. A., et al. (2018). "Anxiety, pain perception, and the impact of dental treatment on children." *Pediatric Dentistry*, 40(1), 15-23.
4. Nascimento, S. D., et al. (2020). "Comparative study of different local anesthetic techniques in pediatric dentistry." *European Archives of Paediatric Dentistry*, 21(2), 177-183.
5. Schiavone, S. A., et al. (2020). "The role of needle gauge in pain perception during local anesthesia in children." *Dental Research Journal*, 17(2), 112-118.
6. Beegum, Fahanna, Eman Monier, Shaimaa N. Elshaboury, Abeer I. Alghofaili, Mohammed A. Habibullah, and S. Karthika. 2024. “Comparison of Automatically Controlled Injection System with a Traditional. Syringe for Multiple Infiltrations in Children Aged 6-12 Years: A Randomized Controlled Trial.” *Journal of Pharmacy & Bioallied Sciences* 16 (Suppl 2): S1535–S1538.
7. Donaldson, Malcolm D. C., John W. Gregory, Guy Van-Vliet, and Joseph I. Wolfsdorf. 2019. *Practical Endocrinology and Diabetes in Children*. John Wiley & Sons.
8. Gesase, Samwel, Marie Onyamboko, Caterina Fanello, et al. 2026. “Single-Step versus Conventional Injectable Artesunate for Severe Malaria in Children: An Open Label, Non-Inferiority Randomized Clinical Trial, Democratic Republic of the Congo and United Republic of Tanzania.” *Bulletin of the World Health Organization* 104 (1): 17–27.
9. Hagwane, Aditi, Dinesh Rao, Sunil Panwar, Surbhi Sharma, and Manan Phalke. 2025. “Evaluating the Impact of Camouflaged and Insulin Syringes with and without Counter-Stimulation on Anxiety and Behavior in Children during Administration of Local Anesthesia.” *Journal of Dental Anesthesia and Pain Medicine* 25 (5): 353–362.
10. Muthu, M. S., and N. Sivakumar. 2022. *Pediatric Dentistry: Principles and Practice E-Book*. Elsevier Health Sciences.
11. Patel, Megha, Rohan Bhatt, Miral Mehta, Chhaya Patel, Foram Patel, and Disha Makwani. 2023. “A Comparative Assessment of Efficacy and Preference between Needleless Device INJEX and Insulin Syringe for Anesthetizing Primary Maxillary Teeth in Children Aged 4-9 Years: A Split-Mouth Crossover Randomized Clinical Study.” *Journal of the Indian Society of Pedodontics and Preventive Dentistry* 41 (2): 149–155.
12. Vishwanathaiah, Satish, Nassreen H. Albar, Fatemah Tawfeg Abkar Alraghi, et al. 2024. “Comparative Evaluation of New Needleless Local Anesthetic System (INJEX) and Conventional Syringe Needle Technique during Pulpotomy Treatment: A Randomized Clinical Trial.” *Children (Basel, Switzerland)* 11 (5). https://doi.org/10.3390/children11050514.