

Comparative Analysis of Pain And Anxiety Using Conventional, Insulin and Camouflaged Syringes During Administration of Local Anesthesia In 6–12-Year-Old Children : A Randomized Controlled Trial

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ABSTRACT

Background: The sight of dental injection can bring about severe anxiety in children. Therefore, convenient and effective alternatives that conceal the needle have been adopted by dentists to make local anesthetic administration more child-friendly. One of the most convenient practices is to use an insulin syringe that is smaller, colorful, and less frightening than conventional syringes. Another alternative is to use less threatening camouflaged syringes.

Objective: To evaluate and compare anxiety levels and pain perception using conventional syringe, insulin syringe, and camouflaged syringe during the administration of local anesthesia in children.

Materials and methods: Forty-five children aged 6–12 years who required buccal infiltration anesthesia in maxillary arch were selected and equally divided into three groups (A, B, C). Local anesthesia was administered using a conventional syringe to Group A participants and an insulin syringe for Group B participants. Group C participants were administered local anesthesia using a camouflaged syringe. Anxiety levels were assessed using Venham's Picture Scale (VPS) and pulse rate at baseline and after administration of local anesthesia. Pulse rate was assessed using pulse oximeter. The Wong-Baker Faces Pain Rating Scale (WBFPRS) was used to assess pain perception after the administration of local anesthesia.

Results: Postoperative VPS scores were significantly higher in Group A (mean 5.13 ± 1.64) compared to Group B (1.47 ± 1.51 ; $p < 0.03$) and Group C (1.73 ± 1.03 ; $p < 0.02$). WBFPRS scores were significantly lower in Group B (1.73 ± 2.25 ; $p < 0.01$) and Group C (2.53 ± 2.20 ; $p < 0.02$) compared to Group A (5.87 ± 2.56). The mean increase in pulse rate was significantly greater in Group A (27.2 ± 2.73 bpm) compared with Groups B (10.6 ± 2.6 bpm) and C (9.0 ± 1.93 bpm).

Conclusion: Both insulin and camouflaged syringes were significantly more effective than the conventional syringe in reducing anxiety and pain during local anesthesia in children. These child-friendly alternatives are recommended as effective substitutes for the conventional syringe in pediatric dental practice.

Keywords: dental anxiety; insulin syringe; camouflaged syringe; local anesthesia; pain perception; pediatric dentistry; Venham's Picture Scale; Wong-Baker Faces Pain Rating Scale.

INTRODUCTION

Local anesthesia (LA) administration is one of the most technically demanding and psychologically challenging procedures in pediatric dental practice. The intraoral injection of the anesthetic solution has been consistently identified as the stimulus that provokes the greatest negative response in children.¹ Fear of the needle and the anticipation of pain are primary drivers of dental anxiety, acting as significant barriers to co-operative behavior in dental operator.^{2,3} A child's uncooperative or unmanageable behavior can impede the efficient delivery of dental care and compromise the quality of treatment being rendered.⁴ The visual and psychological perception of the conventional dental syringe as a threatening instrument is a well-recognized contributor to pre-procedural anxiety.⁵ To enhance patient comfort during local anesthetic administration, several techniques have been employed, including the application of topical anesthetics, precooling of the injection site, use of fine-gauge needles, buffering and warming of the anesthetic solution, distraction methods, vibrating devices, and slow computer-controlled delivery systems.⁴

Within this context, modifying the physical characteristics of the syringe represents a simple yet potentially effective behavioral intervention. Camouflaged syringes, designed to conceal the needle and present a more child-friendly appearance, have been shown to reduce physiological markers of anxiety and improve behavioral responses during LA administration when compared to conventional syringes.⁶

Similarly, insulin syringes—with their smaller and less threatening profile—have been reported to elicit lower pain and anxiety responses in pediatric patients, suggesting that syringe design itself may influence children's perceptual and emotional experiences during injections.⁴

While these individual approaches have shown promise, there remains a paucity of comprehensive comparative studies that evaluate pain and anxiety outcomes across conventional, insulin, and camouflaged syringes in pediatric patients. Therefore, this study aims to conduct a comparative analysis of pain and anxiety associated with the use of conventional, insulin, and camouflaged syringes in 6–12-year-old children, with the goal of identifying child-friendly LA delivery techniques that can enhance clinical outcomes and improve the overall pediatric dental experience.

MATERIALS AND METHODS

Study Design and Ethical Approval

The study was a randomized, parallel, three-arm study conducted on patients reporting to the outpatient department of the Department of Pediatric and Preventive Dentistry. Ethical clearance was obtained from the Institutional Ethics Committee prior to the initiation of the study. Written informed consent was obtained from the parents/guardians of all participating children.

Sample Size and Participant Selection

The sample size was estimated using G*Power software (Version 3.1.9.7) based on the effect size derived from the study by Kohli et al., which compared pain perception among children receiving local anesthesia using conventional, insulin, and deception syringes.⁴ Sample size estimation was performed with an effect size (Cohen's f) of 0.55, a significance level (α) of 0.05, a statistical power of 90%, and three study groups. The required total sample size was 45 participants, with 15 participants in each group. As the present study involved a single-visit intervention with immediate outcome assessment, no additional sample was included for anticipated dropouts.

Forty-five children aged 6–12 years were randomly assigned into three groups of 15 children each using a simple randomization technique through the lottery method.

Inclusion criteria: (a) children aged 6–12 years; (b) children requiring buccal infiltration anesthesia in the maxillary arch for routine dental treatment; (c) no prior experience of dental injections; (d) Frankl behavior rating scale score of 3 (positive) or 4 (definitely positive); (e) patients with written informed parental consent; (e) Children classified as American Society of Anesthesiologists (ASA) Physical Status I or II.

Exclusion criteria: (a) medically compromised children; (b) children with a history of allergy to local anesthetic agents; (c) children with acute dental infections requiring emergency treatment; (d) children with prior painful dental injection experiences; (e) children rated as Frankl score 1 (definitely negative) or 2 (negative).

Group Allocation and Interventions

Participating children were randomly allocated into three equal groups:

Group A ($n = 15$) - Conventional syringe group (Care Medical Devices Ltd., India) with a 26-gauge needle.

Group B ($n = 15$) - Insulin syringe group (Polymed insulin syringe fitted with a 30-gauge needle).

Group C ($n = 15$) - Camouflaged syringe group (The Angelus™ alligator-shaped syringe sleeve mounted over the conventional metal aspirating syringe, with a 30-gauge needle).



(a) (b) (c)
a) Group A: Conventional syringe b) Group B: Insulin syringe c) Group C: Camouflage syringe

METHODOLOGY

Each child was comfortably positioned in the dental chair, and the treatment procedure was explained to both the child and the accompanying parent/guardian.

A topical anesthetic (10% lidocaine) was sprayed onto the sterile cotton pellet and applied to the dried mucosal surface at the injection site prior to needle insertion for 1 min in all groups. In all three groups, buccal infiltration anesthesia was administered using a standard 2% lignocaine solution with 1:100,000 adrenaline, delivered with the syringe assigned to the respective study group.

- In Group A (conventional syringe group, 26-gauge) and Group B (insulin syringe group, 30-gauge), the respective syringes were preloaded with the local anesthetic solution. A topical anesthetic spray was applied at the injection site, followed by informing the child that the tooth would “go to sleep” after receiving the “magic water.” Subsequently, the preloaded syringe was used for administration of the local anesthetic at the designated site.
- In Group C (camouflaged syringe group), a dental cartridge syringe fitted with an alligator sleeve was used for local anesthetic administration. A topical anesthetic was applied at the injection site, followed by informing the child that the tooth would “go to sleep” after receiving the “magic water” from the alligator. Subsequently, the local anesthetic was administered using the camouflaged syringe.



(a)



(b)

a) Group B: LA administration with Insulin syringe b) Group C: LA administration with Camouflage syringe

Outcome Measures

Subjective Anxiety assessment : Venham's Picture Scale (VPS) was used to assess the child's subjective anxiety at baseline (prior to the administration of topical anesthesia) and immediately post-administration of local anesthesia. The VPS comprises eight cards, each displaying two figures representing anxious and non-anxious emotional states.

The child selects the figure that best matches their current emotional state; selection of the anxious figure scores 1, and the non-anxious figure scores 0, yielding a total score ranging from 0 (no anxiety) to 8 (maximum anxiety).⁷

Objective Anxiety assessment : Pulse rate (beats per minute, bpm) was recorded at baseline and post-administration of local anesthesia using a finger pulse oximeter. Pulse rate is a widely accepted physiological indicator of anxiety, as sympathetic stimulation associated with anxiety and procedural stress results in a measurable increase in heart rate.⁸ Pain perception: The Wong-Baker FACES Pain Rating Scale (WBFPRS) was used to assess pain experienced during and immediately after the administration of local anesthesia. This validated, self-report pictorial scale consists of six facial expressions ranging from 0 ('No hurt') to 10 ('Hurts worst').⁹

STATISTICAL ANALYSIS

Data were compiled and analyzed using SPSS statistical software version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean $\pm$ standard deviation) were computed for all continuous variables. Comparisons across the three groups were performed using one-way Analysis of Variance (ANOVA), followed by Tukey's multiple post-hoc test to identify pairwise differences. A p-value of < 0.05 was considered statistically significant.

RESULTS

Demographic Profile

A total of 45 children were recruited. The demographic distribution was comparable across the three groups, with no statistically significant differences in age distribution between Group A, Group B, and Group C ($p = 0.613$) (Table 1).

Table 1: Demographic profile of patients across three groups

Age (years)	Group A (n=15)	Group B (n=15)	Group C (n=15)	P value
6	3 (20%)	3 (20%)	6 (40%)	0.613
7	5 (33.3%)	4 (26.7%)	3 (20%)	0.613
8	4 (26.7%)	7 (46.7%)	5 (33.3%)	0.613
9	3 (20%)	1 (6.7%)	1 (6.7%)	0.613

Group A = Conventional syringe; Group B = Insulin syringe; Group C = Camouflaged syringe; $P < 0.05$ is statistically significant.

Venham's Picture Scale (Anxiety) Scores

Table 2: Comparison of baseline and post-operative Anxiety scores across three groups (Tukey's multiple post-hoc test)

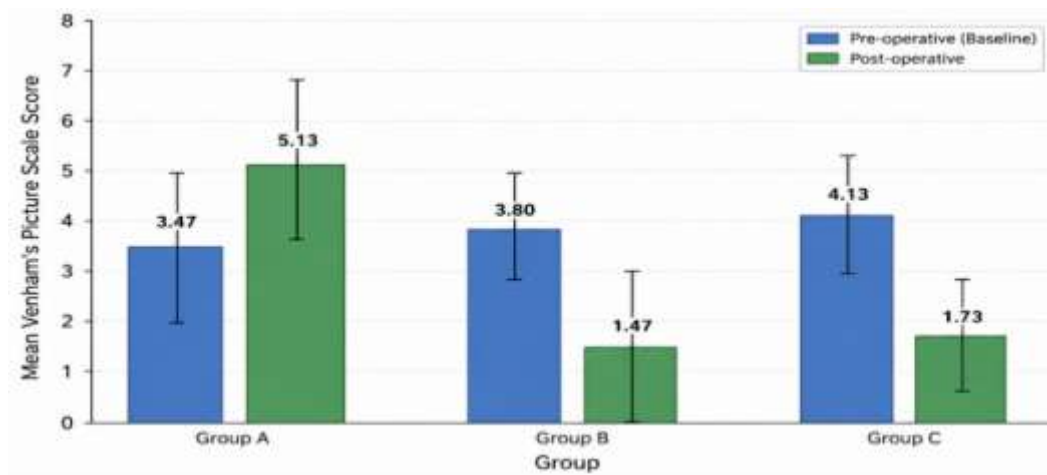
Time		Group A	Group B	Group C	A vs B	A vs C	B vs C
Baseline	Mean $\pm$ SD	3.47 $\pm$ 1.55	3.80 $\pm$ 1.01	4.13 $\pm$ 1.19	0.754	0.332	0.754
Post-operative	Mean $\pm$ SD	5.13 $\pm$ 1.64	1.47 $\pm$ 1.51	1.73 $\pm$ 1.03	$<0.03^*$	$<0.02^*$	0.864
Difference	Mean $\pm$ SD	-1.66 $\pm$ 1.17	2.33 $\pm$ 1.64	2.40 $\pm$ 1.20	$<0.04^*$	$<0.01^*$	NS

* $P < 0.05$ is statistically significant; SD = standard deviation.

Observations from table 2 and graph 1: At baseline, VPS scores were comparable across the three groups (Group A: 3.47 $\pm$ 1.55; Group B: 3.80 $\pm$ 1.01; Group C: 4.13 $\pm$ 1.19), with no statistically significant intergroup differences. Following local anesthesia administration, post-operative VPS scores increased in Group A (5.13 $\pm$ 1.64) but declined in Group B (1.47 $\pm$ 1.51) and Group C (1.73 $\pm$ 1.03), reflecting a reduction in subjective anxiety in the insulin and camouflaged syringe groups. Tukey's post-hoc analysis revealed statistically significant differences between Group A

and Group B ($p < 0.03$) and between Group A and Group C ($p < 0.02$). No significant difference was observed between Groups B and C ($p = 0.864$).

Pre vs post operative Venham's Picture Scale (Anxiety) Scores - Graph 1



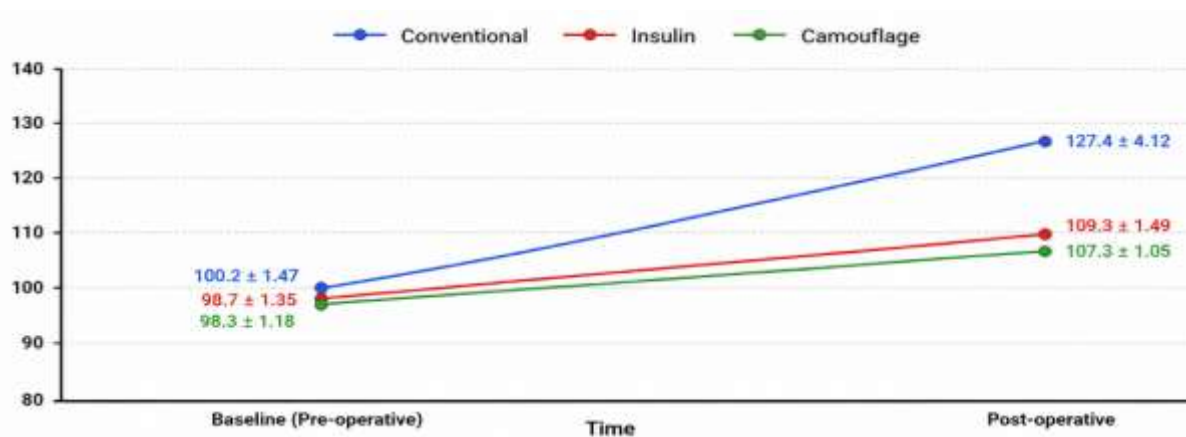
Pulse Rate (Objective Anxiety) Assessment

Table 3 and Graph 2: Comparison of pulse rate changes across three groups (Tukey's multiple post-hoc test)

Time		Group A	Group B	Group C	A vs B	A vs C	B vs C
Baseline	Mean $\pm$ SD	100.2 $\pm$ 1.47	98.7 $\pm$ 1.35	98.3 $\pm$ 1.18	0.491	0.279	0.915
Post-operative	Mean $\pm$ SD	127.4 $\pm$ 4.12	109.3 $\pm$ 1.49	107.3 $\pm$ 1.05	<0.001*	<0.001*	0.071
Increase in pulse rate	Mean $\pm$ SD	27.2 $\pm$ 2.73	10.6 $\pm$ 2.61	9.0 $\pm$ 1.93	<0.001*	<0.001*	NS

* $P < 0.05$ is statistically significant; SD = standard deviation.

Observations from table 3 and graph 2: Baseline pulse rates were comparable among the three groups with no significant difference. Post-operatively, Group A showed a significantly higher pulse rate than Groups B and C ($p < 0.001$). The increase in pulse rate was greatest in Group A, indicating higher anxiety levels. No significant difference was observed between Groups B and C, suggesting similar effectiveness in reducing anxiety-related pulse rate changes.



Pulse rate - Pre vs Post operative - Graph 2

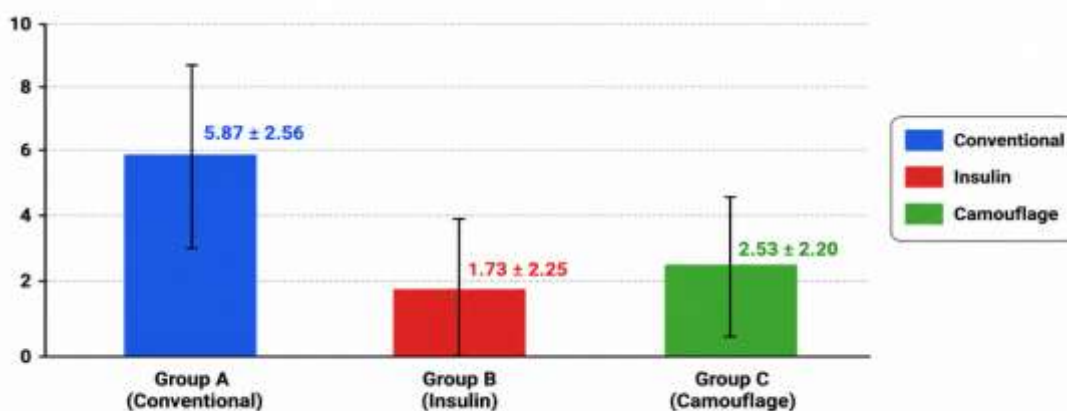
Wong-Baker Faces Pain Rating Scale (Pain Perception)

Table 4 and Graph 3: Comparison of post-operative Wong-Baker FACES Pain Rating Scale scores across three groups (Tukey's multiple post-hoc test)

Time		Group A	Group B	Group C	A vs B	A vs C	B vs C
Post administration	Mean $\pm$ SD	5.87 $\pm$ 2.56	1.73 $\pm$ 2.25	2.53 $\pm$ 2.20	<0.01*	<0.02*	0.621

*P < 0.05 is statistically significant; SD = standard deviation.

Observations from table 4 and graph 3: Post-operative pain perception scores were significantly higher in Group A (Mean: 5.87 $\pm$ 2.56) compared to Group B (1.73 $\pm$ 2.25; p <0.01) and Group C (2.53 $\pm$ 2.20; p <0.02). The difference between Group B and Group C was not statistically significant (p =0.621), suggesting comparable pain reduction with both alternative syringe types.



Wong-Baker faces pain rating scale scores after LA administration - Graph 3

DISCUSSION

Anxiety during local anesthetic administration continues to be a major concern in pediatric dentistry, as many children perceive dental injections as a threatening experience. It can often heightens the child's emotional response, making the procedure appear more painful than it actually is. This interaction between anxiety and pain can negatively influence cooperation, treatment acceptance, and the overall dental experience.¹⁻³ Therefore, reducing injection-related anxiety is an essential component of pediatric behavior management and may contribute to a more comfortable and positive treatment outcome.

The present study compared the efficacy of conventional, insulin, and camouflaged syringes in managing anxiety and pain during local anesthesia administration in children aged 6–12 years, using validated subjective (VPS and WBFPRS) and objective (pulse rate) outcome measures. The findings demonstrate that both insulin and camouflaged syringes were significantly more effective than conventional syringes in reducing anxiety and pain across all three assessment tools, with no significant difference observed between the two alternative syringe types. The age group of 6–12 years was specifically selected as middle childhood represents a period of significant cognitive development.⁵

In the present study, post-operative VPS scores increased markedly in Group A compared with significant reductions in Groups B and C, confirming that the sight and experience of the conventional syringe provokes substantially greater subjective anxiety. These findings are consistent with the results of Kohli et al. (2022), who reported significantly lower anxiety (measured by FLACC scale and pulse rate) in children who received local anesthesia via insulin and deception syringes compared with a conventional syringe in a three-arm randomized study of 45 children.⁴

The objective anxiety data derived from pulse rate measurements corroborated the subjective findings. The mean increase in pulse rate was significantly greater in Group A compared with Groups B and C, indicating higher

sympathetic arousal during conventional syringe administration. Pulse rate measured by pulse oximetry has been well established as a reliable, non-invasive, objective indicator of procedural anxiety in pediatric dental patients.¹⁰ A number of studies have employed pulse oximetry to objectively quantify anxiety during LA administration in children, and the elevated post-injection pulse rate observed in the conventional syringe group in the present study is consistent with this body of literature.

The insulin syringe, fitted with a finer 30-gauge needle compared with the 26-gauge needle of the conventional syringe, causes less mechanical tissue trauma at the point of needle penetration. Tirupathi et al. (2020) demonstrated equivalent clinical efficacy of insulin and auto-controlled syringes for palatal anesthesia in children, while 96.5% of children preferred the visually appealing insulin syringe.¹¹ Similarly, Kour et al. (2017) found that insulin syringes offered clinically demonstrable advantages in reducing pain during infiltration anesthesia in the pediatric population.¹²

The camouflaged syringe operates primarily by concealing the needle and syringe from the child's visual field. Visually and psychologically, the conventional dental syringe is perceived as a threatening instrument. Bagher et al. (2023) evaluated the camouflaged syringe in a randomized controlled study of 6–10-year-old children and reported significantly lower behavioral pain scores (FLACC scale) and reduced anxiety with the camouflaged syringe compared with the conventional syringe.¹³ Darwish et al. (2026) conducted a recent randomized controlled clinical trial and confirmed that the camouflaged syringe significantly reduced both dental anxiety and pain during maxillary infiltration anesthesia in children aged 6–9 years.¹⁴ Melwani et al. (2018) also demonstrated that a camouflaged alligator-shaped syringe sleeve (Angelus™) significantly reduced anxiety and improved behavioral cooperation in 6–11-year-old children during LA injection compared to the conventional syringe.⁵ Similarly, Ahmad et al. (2024) reported that the use of a camouflaged syringe significantly reduced pain and fear during local anesthetic administration in children aged 6–12 years, with significant improvements in heart rate, VAS, and SEM scores compared with the conventional syringe. Furthermore, 64% of children in the camouflaged syringe group preferred the camouflaged syringe, suggesting that concealing the visually threatening appearance of the conventional syringe may contribute to improved acceptance of local anesthetic administration.¹⁵ Rajan et al. (2024) reported that camouflaged syringes significantly improved FLACC pain scores and reduced anxiety during local anesthetic administration, particularly in children aged 3–6 years, suggesting that syringe camouflage can act as an effective distraction and improve children's acceptance of LA.¹⁶

Pain perception data, assessed via the WBFRS, followed the same pattern. Post-operative pain scores were significantly higher in Group A compared to Group B and Group C, with no significant difference between Groups B and C ($p = 0.621$). The lower pain scores observed in the insulin and camouflaged syringe groups may be partly attributed to the use of a finer 30-gauge needle. Similar findings have been reported by Snehraj et al. (2024), who demonstrated significantly reduced pain perception with a 31-gauge needle compared with a 26-gauge needle during local anesthetic administration in pediatric patients. They further explained that thinner needles require less insertion force and produce less soft-tissue trauma, which may contribute to lower pain perception during local anesthetic administration.¹⁷ The lower pain scores in Groups B and C are therefore likely multifactorial, arising from both the reduced visual threat of the alternative syringe types (which attenuates anticipatory pain amplification) and the finer gauge needle employed. The pain score with the camouflaged syringe was slightly higher compared to the insulin syringe, although the difference was negligible and not statistically significant. This may be due to the discomfort caused by its bulky design.

The limitations of the present study merit consideration. The sample size, while determined by a prior power calculation, was modest ($n = 15$ per group), and future multicenter studies with larger cohorts would enhance the generalizability of findings. The study was restricted to buccal infiltration anesthesia in the maxillary arch; extension of these findings to inferior alveolar nerve blocks or palatal injections warrants separate investigation. Gender-wise distribution and its potential influence on anxiety and pain responses were not analyzed independently. Future research incorporating mixed injection techniques and gender-stratified analyses will further strengthen the evidence base for child-friendly LA delivery systems in pediatric dentistry.

Conclusion

In conclusion, the use of camouflage and insulin syringes for administration of anesthesia was demonstrated to be effective in alleviating the anxiety and pain of children. These findings support the clinical adoption of syringe modification strategies as simple, evidence-based, and accessible behavioral interventions capable of improving the

pediatric dental experience. Therefore insulin and camouflage syringes can be recommended as an alternative to the use of conventional syringes for buccal infiltration anesthesia.

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