Original Article

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Pain perception in 4–6-year-old children following intraoral dental injection with 26 and 31-gauge needles: a randomized controlled trial

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Background: Administering anesthesia in dentistry can be distressing for patients, especially those with dental fear and anxiety. Needle pain during local anesthesia is a common concern in intraoral procedures. This study aimed to compare pain perception in 4–6-year-old children following intraoral dental injections with 26- and 31-gauge needles.

Methods: Fifty healthy children were divided according to age into Group I (N = 25; 4–5 years) and Group II (N = 25; 5–6 years). Each group was further subdivided according to the needle gauge as follows: Group IA (26 gauge), Group IB (31 gauge), Group IIA (26 gauge), and Group IIB (31 gauge). Using a lottery method, the gauge of the needle to be used at the first visit for local anesthesia administration was selected. Children's reactions to pain were evaluated using a Modified Behavioral Pain Scale. Immediately after administration of local anesthesia, pain perception was evaluated using the Faces pain rating scale. In the subsequent visit, another needle gauge was used to administer local anesthesia, and the previously described evaluations were performed. At the third appointment, the child was shown both syringes and asked to choose one of the syringes they preferred, and the choice was noted.

Results: When local anesthesia was administered using a 31-gauge needle, pain perception was similar between the two groups. In group II, the children demonstrated significantly higher arm and leg movements ($P = 0.001$). However, the difference was significant in group I alone ($P < 0.001$).

Conclusion: Irrespective of age, anesthesia with a 31-gauge needle resulted in significantly lower pain perception than anesthesia with a 26-gauge needle.

Keywords: Anesthesia; Children; Local Anesthesia; Needles; Pain; Pain Perception.

INTRODUCTION

Intraoral anesthetic injections during dental procedures elicit the greatest negative response in children. Dentists primarily aim to perform dental procedures with minimal discomfort and pain. However, for a significant number of patients, dental anxiety and fear, particularly in relation to syringes and needles, medically referred to as "needle phobia" or "blenophobia," remain among the most distressing aspects of dentistry [1].

Anxiety is a disturbing experience, and childhood anxiety may require techniques beyond anesthesia for control [2]. Pediatric dentists need to assess children's behavior and manage their dental anxiety and fear, the major obstacles to successful treatment, accordingly [3]. Children often experience unfounded fear and anxiety. Needle pain during local anesthesia is a common concern

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in intraoral procedures. Pediatric dentists are trained in behavioral management techniques that minimize pain and discomfort when administering local anesthesia to children [4]. Therefore, dentists use topical anesthetic agents and needle gauges to minimize pain while administering local anesthesia. Hence, the aim of this study was to compare pain perception in 4–6-year-old children after intraoral dental injection with 26- and 31-gauge needles.

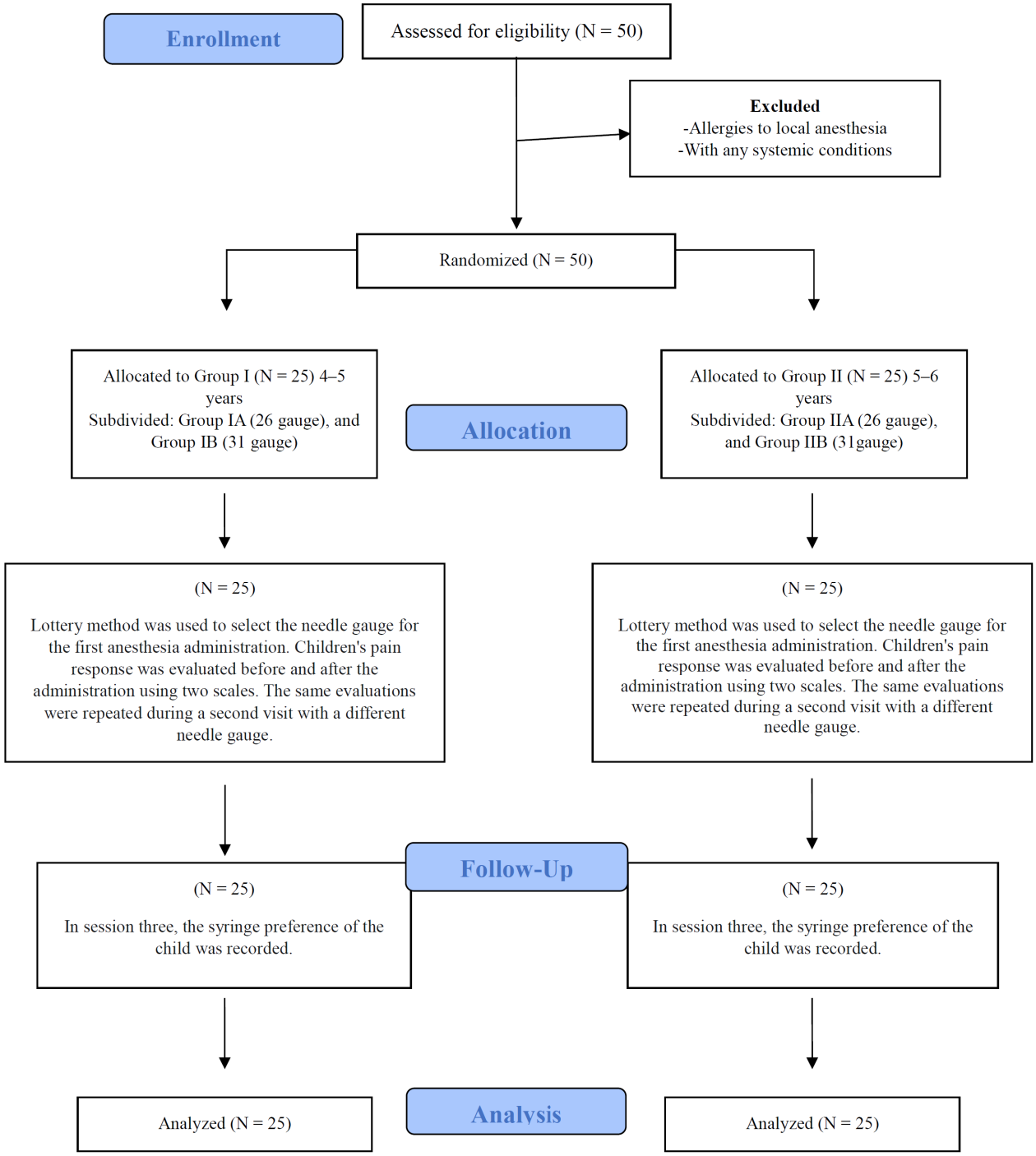

Fig. 1. Consolidated Standards of Reporting Trials (CONSORT) flow diagram. N, number.

METHODS

The present in vivo study was conducted at the Department of Pediatric and Preventive Dentistry and was approved by the Institutional Ethics Review Board (Ref. No.:192/2016-17). Healthy children aged 4–6 years, accompanied by their parents who visited the department, were considered for participation in the study. This clinical trial was registered in the CTRI registry (REF/2024/01/078005). The study was conducted between March and June. Children reporting to the department on their first dental visit; exhibiting positive dental behavior; and requiring multiple appointments for treatment under local anesthesia in the maxilla/mandible, anterior/posterior teeth, and buccal (labial) / lingual (palatal) infiltration were included in the study. Children with a history of allergies to local anesthesia; teeth with abscesses, infections, or inflammation; and those with any systemic conditions were excluded from the study. The sample size was estimated at a power of 80% and 5% of significance. Assuming 10% attrition, the required sample size was rounded off to 25 for each group.

Approximately 180 children were screened; among which, 50 fulfilled the inclusion criteria. Written informed consent was obtained from the participants' parents. Fifty healthy children were divided into two groups based on age: Group I (N = 25; 4–5 years) and Group II (N = 25; 5–6 years) (Fig. 1). Each group was further subdivided according to needle gauge as Group IA-26 gauge (Unolok®), Group IB-31 gauge (Dispovan® U-40), Group IIA-26 gauge, and Group IIB-31 gauge (Fig. 2). All methods and

Fig. 2. Dispovan® U-40 (31- gauge) and Unolok® (26- gauge)

Fig. 3. In the first visit, 26- gauge needles were used to administer local anesthesia.

Fig. 4. In the subsequent visit, 31- gauge needles were used to administer local anesthesia.

Table 1. Taddio's modified behavior pain scale

Objective evaluation	Subjective evaluation
• Code 1 = Crying, • Code 2 = Facial display (eyes' squeezing), • Code 3 = Arm movement, • Code 4 = Leg movement and • Code 5 = Torso movements	• Face 0: Does not hurt at all. • Face 2: Hurts just a little bit. • Face 4: Hurts a little more. • Face 6: Hurts even more. • Face 8: Hurts a whole lot. • Face 10: Hurts worst, although the child does not have to be crying to have this worst pain

Table 2. Distribution of objective evaluation of pain perception by group I and group II for 26 gauge needle using chi square test

Objective evaluation	Group I		Group II		P value
	n	%	n	%	
Crying (Code 1)	17	68%	13	52%	0.25
Eye squeezing (Code 2)	6	24%	11	44%	0.14
Arm movement (Code 3)	15	60%	23	92%	0.008*
Leg movement (Code 4)	6	24%	15	60%	0.01*
Torso movement (Code 5)	3	12%	0	0%	0.07

* Statistically Significant
n, number.

protocols were standardized between the two groups, and the trial was limited to infiltration anesthesia.

Using the lottery method, the gauge of the needle to be used in the first visit for local anesthesia (LOX 2% adrenaline 1:200000) administration was selected. The field of insertion of the needle was dried, and topical anesthesia (NUMMIT® lidocaine topical aerosol spray) was applied at the site of injection with an applicator swab for 3 min. Euphemisms such as "putting the tooth to sleep" were used to describe the administration of anesthesia injection to children. Distraction and behavioral management techniques were used during local anesthesia administration (Fig. 3). The modified Behavioral Pain Scale [5] was used to assess pain signs and reactions in the children (Table 1).

One assistant who was not part of the study recorded and scored each child's reactions throughout the study. Immediately following local anesthesia administration, the child was asked to complete the Wong-Baker Faces Pain Rating Scale (FPS) for the subjective evaluation of pain perception. The FPS has six faces that depict different pain levels. The child was verbally instructed on how to use it [6].

In the subsequent visit, another needle gauge was used to administer local anesthesia, and the previously described evaluations were performed (Fig. 4). At the third appointment, the child was shown both syringes and asked to choose one of the syringes they preferred, and the choice was noted. All methods and protocols were controlled between the two groups. Data were analyzed using SPSS version 22 (IBM SPSS Statistics for Windows, version 22.0; IBM Corp.). Chi-Square, McNemar's, paired Student's, and independent Student's t-tests were used for statistical analysis.

RESULTS

Of the 50 children, 28 were girls and 22 were boys. Local anesthesia administration using a 26-gauge needle showed no difference in crying, eye squeezing, or torso movement between the children in Groups I and II. However, the children in Group II demonstrated significantly higher arm and leg movements (P = 0.001),

Table 3. Distribution of objective evaluation of pain perception by group I and group II for 31 gauge needle using chi square test

Objective evaluation	Group I		Group II		P value
	n	%	n	%	
Crying	6	24%	10	40%	0.23
Eye squeezing	15	60%	13	52%	0.57
Arm movement	8	32%	14	56%	0.09
Leg movement	3	12%	7	28%	0.16
Torso movement	3	12%	0	0%	0.07

n, number.

Table 4. Distribution of objective evaluation of pain perception within group I for 26 and 31 gauge needles using McNemar's test

Objective evaluation	26 Gauge needle		31 Gauge needle		P value
	n	%	n	%	
Crying	17	68%	6	24%	0.001*
Eye squeezing	6	24%	15	60%	0.04*
Arm movement	15	60%	8	32%	0.07
Leg movement	6	24%	3	12%	0.25
Torso movement	3	12%	3	12%	1.00

* Statistically significant
n, number.

Table 5. Distribution of objective evaluation of pain perception within group II for 26 and 31 gauge needles using McNemar's test

Objective evaluation	26 Gauge needle		31 Gauge needle		P value
	n	%	n	%	
Crying	13	52%	10	40%	0.58
Eye squeezing	11	44%	13	52%	0.82
Arm movement	23	92%	14	56%	0.004*
Leg movement	15	60%	7	28%	0.10
Torso movement	0	0%	0	0%	..

* Statistically Significant
n, number.

Table 6. Comparison of mean scores for subjective evaluation of pain perception between 2 groups with 26 and 31 gauge needles using independent student t test

Needles	Group	N	Mean	SD	S.E.M	Mean diff	P value
26 G Needle	Group I	25	6.3	3.5	0.7	-1.2	0.21
	Group II	25	7.5	3.1	0.6		
31 G Needle	Group I	25	4.4	3.3	0.7	-2.0	0.02*
	Group II	25	6.4	2.4	0.5		

*Statistically significant
Diff, difference; N, number; S.E.M, Sound Eye Motor; SD, standard deviation.

as shown in Table 2.

No difference was observed in pain perception between the two groups when local anesthesia was administered using a 31-gauge needle, as shown in Table 3. Group I children experienced significantly more crying and eye squeezing during local anesthesia administration, regardless of the needle gauge used, as shown in Table 4. Children in Group II exhibited significantly more arm movements during local anesthesia administration, regardless of the needle gauge, as shown in Table 5.

Anesthesia administration using a 31-gauge needle resulted in lower pain perception than using a 26-gauge needle, as shown in Table 6. Regardless of age, anesthesia administered with a 31-gauge needle resulted in significantly lower pain perception than that administered with a 26-gauge needle. However, this difference was

Table 7. Comparison of mean scores for subjective evaluation of pain perception between 26 and 31 gauge needles within each study group using paired student t test

Groups	Needles	N	Mean	SD	S.E.M	Mean diff	P value
Group I	26 G	25	6.3	3.5	0.7	1.9	< 0.001*
	31 G	25	4.4	3.3	0.7		
Group II	26 G	25	7.5	3.1	0.6	1.1	0.06
	31 G	25	6.4	2.4	0.5		

* Statistically Significant
Diff, difference; N, number; S.E.M, Sound Eye Motor; SD, standard deviation.

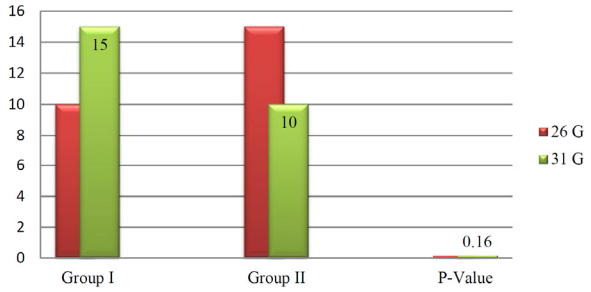

Fig. 5. Graph showing comparison of distribution of preference of 26- and 31- gauge needles between the study groups using chi squared test

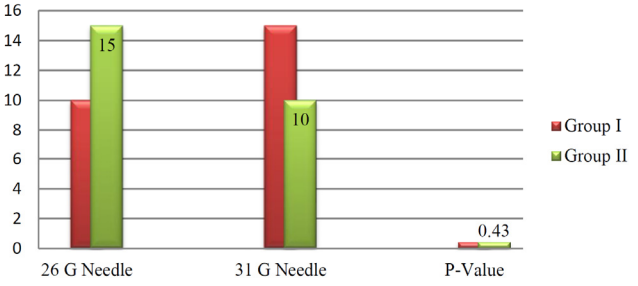

Fig. 6. Graph showing comparison of distribution of preference of 26- and 31- gauge needles between the study groups using McNemar's test

only significant in Group I ($P < 0.001$), as shown in Table 7.

There was no significant difference in the preference for 26 and 31 gauge needles between and within the study groups using Chi-square and McNemar's tests, as shown in Figures 5 and 6.

DISCUSSION

In dentistry, the administration of anesthesia is a distressing procedure for patients of all ages. Adult dental fear and anxiety often stem from negative childhood experiences. Therefore, techniques that alleviate pain and discomfort during injections must be implemented in children. Behavioral management prior to the administration of local anesthesia primarily determines pain perception during the procedure.

Factors that affect pain perception during needle injection include needle size, tissue consistency, anesthetic delivery speed, age, sex, and past experience [7]. Dental needles were available in three lengths (32, 20, and 10 mm) and 23–30 gauges. The most commonly used needles are the 30-, 27-, and 25-gauge needles. Needle gauge refers to the lumen diameter. A smaller gauge indicated a larger lumen. A 31-gauge needle had a smaller diameter than the 26-gauge needle. Smaller-diameter needles, which are less traumatic for patients, are gaining considerable attention [8]. Therefore, the present study was undertaken to compare pain perception in 4–6-year-old children after intraoral dental injections with 26- and 31-gauge needles.

In the present study, high-gauge needles showed promising results in terms of patient comfort and pain reduction. A lower force (69 mN) is required for injection, and the smaller diameter of the 30-gauge needle (which causes less trauma to soft tissues) could be the reason for its better acceptance. Similar observations have been reported by other authors [9,10]. Lehtinen et al. observed that a 30-gauge needle required 69 mN, which is significantly less force than a 27-gauge needle requiring 139 mN [11,12].

Other studies found no statistically significant differences in pain perception between different gauges [13-16]. In contrast, several studies have clearly stated the advantages of 30-gauge needles (thinner needles) over

25- and 27-gauge needles in providing painless local anesthesia in dentistry [5,9,10,17]. According to one study, the pain perception and unpleasantness of local dental anesthetic injections were reduced with the use of a smaller 30-gauge needle than with a 26-gauge needle [10]. Large-gauge needles offer several benefits, including a reduced risk of breakage/deflection and lower aspiration pressure [10,15]. In addition, the local anesthetic solution was administered slowly, and non-pharmacological behavior management techniques, such as euphemism, were used to explain the procedure. Distraction methods were used in the study.

In this study, we evaluated pain perception in children after injections using the Wong-Backer FACES pain rating scale, which features facial expressions that help children express their feelings. This scale is particularly beneficial for children who struggle with self-reporting. Several pain intensity scales such as the face, numerical rating, and visual analog scales are used to measure pain in children [18]. To assess pain signs and reactions in children, we used the modified Behavioral Pain Scale developed by Taddio et al. [5]. This aligns with Piaget's theory of cognitive development, suggesting that children under 6 years of age may struggle to understand abstract and logical concepts, making them less reliable for research purposes [19].

It should be noted that our study had some limitations. First, the sample included only 25 participants. Therefore, future studies with larger and more diverse sample sizes, as well as subgrouping, could increase the accuracy of the findings. Second, further research is required to support the role of physiological parameters in assessing pain and anxiety during injection procedures in children.

In conclusion, irrespective of age, anesthesia with a 31-gauge needle resulted in significantly lower pain perception than that with a 26-gauge needle in children during local anesthesia administration. We recommend that 31-gauge needles be considered a viable option for delivering local anesthesia using infiltration techniques, whereas block anesthesia requires thicker needles.

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CONFLICTS OF INTEREST: The authors declare no conflicts of interest.

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