Original Article

Noninvasive Vibratory Stimulation on Pediatric Pain Scores during Intravenous Cannulation in a Selected Hospital in the United Arab Emirates

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Abstract

Background: Pediatric patients often experience significant distress and discomfort during intravenous (IV) cannulation. The noninvasive vibratory buzzy device, which utilizes vibration technology, has emerged as a potential solution for mitigating procedural pain in children. However, its application and effectiveness have not been investigated in the United Arab Emirates. **Materials and Methods:** This quasi-experimental study was conducted among children (aged between two and six years) on admission. The children were selected consecutively and assigned to either the intervention group (IVG) or control group (CG). The IVG (n = 5) had the buzzy vibration applied proximal to the IV insertion site along with routine care, while the CG participants (n = 51) received only routine care. Pain level was assessed using the face, legs, activity, cry, and consolability (FLACC) scale before and during IV catheter insertion. **Results:** Results showed that 31 (62%) of children in the IV group were between four and six years old. The pre-intervention FLACC scores in the IVG indicated moderate pain in 21 (41%), mild pain in 20 (39%), and severe pain in 9 (18%). During the intervention, the IVG experienced mild-to-no pain, whereas the CG reported mild-to-moderate pain. A significant negative correlation between pain score and age was observed in the CG (r = −0.2, P = 0.037), indicating higher pain scores in younger children. **Conclusions:** Vibratory stimulation using a noninvasive buzzy device effectively reduced procedural pain during cannulation.

Keywords: *Catheters, child, control groups, pain, procedural, United Arab Emirates, vibration*

Introduction

Pain is a complex phenomenon, and effective management is considered a cornerstone of high-quality care.[1] The World Health Organization prioritizes effective pediatric pain management, affirming that children have the right to the best possible pain care.[2] Simoncini *et al*.[3] noted that children can experience anticipatory anxiety during needle procedures, leading to symptoms, such as vasovagal reactions, hypoxemia, tachycardia, and hormonal changes. Poor pain management increases anxiety, needle phobia, and can result in missed vaccinations.[4] Therefore, vibratory stimulation has gained attention as a method to reduce pain during needle procedures in children.[5] Based on the Gate Control Theory, which suggests that non-painful stimuli can block pain signals, the buzzy device uses vibration to activate large nerve fibers, which "close the gate" to pain signals from smaller fibers, effectively reducing pain.

Ueki and others[6,7] highlight that vibratory stimulation can significantly reduce pain in children aged between six and 12 years. In a quasi-randomized study of 60 hospitalized children in Taiwan,[8] those who received routine care reported moderate-to-severe pain during intravenous injections, whereas those who used the buzzy device had notably lower pain scores and behavioral pain responses. Research shows that effective pain-relieving distractions must outweigh the pain stimulus and use highly engaging elements. However, distraction techniques, like buzzy, may yield varying results in children.[9-11] Hashad's[12] protocol improved nurses' use of chewing gum as a distraction during IV cannulation, leading to reduced pain and anxiety in children over three months of age. Nurses can incorporate distraction techniques and affordable vibratory devices as effective additions to pediatric pain management.

This study is the first to evaluate the effectiveness of the buzzy device in

How to cite this article: Abushahada AM, Ilesanmi RE, Shine R. Noninvasive vibratory stimulation on pediatric pain scores during intravenous cannulation in a selected hospital in the United Arab Emirates. Iran J Nurs Midwifery Res 2026;31:607-11.

Submitted: 16-Mar-2025. **Revised:** 19-Nov-2025. **Accepted:** 20-Nov-2025. **Published:** 16-Jul-2026.

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Access this article online

Website: https://journals.lww.com/jnmr

DOI: 10.4103/ijnmr.ijnmr_94_25

Quick Response Code:

reducing pain during IV cannulation in children in the UAE. It compares pain scores between buzzy's noninvasive vibratory stimulation and standard care practices.

Materials and Methods

This quasi-experimental study was conducted from March 23 to May 3, 2023, at a hospital in the UAE, and involved 101 children aged between two and six years who were undergoing IV cannulation. Participants were assigned to the intervention or control groups based on eligibility using consecutive sampling. The sample size was calculated using G*Power (effect size 0.5, power 80%, α =0.05), requiring 51 participants per group. Children with neurological disorders, developmental delays, or pain-related admissions were excluded to ensure population homogeneity. Both groups received standard pain management (parent comforting and consoling and a friendly environment), whereas the intervention group (IVG) also received vibration with the buzzy device. Pain was assessed using the FLACC scale before and after the procedure in both groups to compare the outcomes. The study was submitted for retrospective registration on https://clinicaltrials.gov/) and currently under review.

Pain intensity was measured using the FLACC scale, which assesses five criteria: face, legs, activity, cry, and consolability. Demographic and clinical data, including medical history, were collected using a proforma. The buzzy device, a reusable handheld vibrating bee (8 × 5 × 2.5 cm), was secured near the venipuncture site using a Velcro strap. It was introduced to children in a friendly manner to reduce anxiety. The device vibrated at 200 Hz and was placed 2–5 cm from the cannulation site (approximately 15% of forearm length) and activated 45 seconds before and during the procedure. The placement was adjusted if needed for smaller children, with deviations recorded. Three trained research assistants followed a standardized protocol using the device as a distraction. FLACC pain assessments were performed before, during, and after the procedure by trained assessors, and the IV insertion time and immediate post-procedure pain were recorded.

Data were analyzed using IBM SPSS (Statistical Package for the Social Sciences) Statistics for Windows, version 22.0, with results expressed as frequencies, percentages, and mean (standard deviation). Fisher's exact test was used to assess categorical variables between groups, chosen for its suitability for small sample sizes and robustness in handling low cell counts. Paired *t*-tests were used to compare pre- and post-intervention pain scores within groups. Statistical significance was set at $P < 0.05$.

Ethical considerations

Ethical approval for this study was obtained from the institutional review boards (RAKMHSU-REC-027-2022/23-PG-N and MOHAP/REC/2023/15-203-PG-N). A detailed orientation about the study's purpose was provided to both children and their parents to ensure compliance with ethical standards for participation, and written consent was obtained. In Emirati culture, family is a key factor in making decisions about children's health, so family members were available to console their children.

Results

The distribution of demographic and clinical characteristics [Tables 1 and 2] revealed that the majority of the participants were aged between —four and six years, making up 62% of the IVG and 39.20% of the CG. The sex distribution did not differ significantly between the groups (P = 0.47). Historical data on hospitalization and previous cannulations indicated substantial prior exposure to medical procedures within both groups, without significant variance in the frequency of previous IV cannulations.

Pre-intervention pain evaluation in IVG

Categorization of pre-intervention pain levels within IVG is presented in Table 3. Before the intervention, a small fraction 1 (2%) reported no pain, whereas moderate 21 (41%) and mild 20 (39%) pain were more prevalent. Notably, 9 (18%) experienced severe pain, underscoring the need for effective pain management strategies.

Table 1: Respondents demographic characteristics

Demographic variables		Frequency (percentage) *n* (%)		*p*
Child information		Intervention group (*n*=50)	Control group (*n*=51)	
Age in years	<3	12 (24.00)	18 (35.00)	0.07
	3	7 (14.00)	13 (26.00)	
	4–6	31 (62.00)	20 (39.00)	
Gender	Male	30 (60.00)	27 (53.00)	0.47
	Female	20 (40.00)	24 (47.00)	
Educational status	1–3rd standard	49 (98.00)	51 (100.00)	0.495
	4–5th standard	1 (2.00)	0 (0.00)	
Order of the child	1	25 (50.00)	26 (51.00)	0.70
	2	17 (34.00)	17 (33.00)	
	3	6 (12.00)	8 (16.00)	
	4th and above	2 (4.00)	0 (0.00)	

Table 2: Participants' clinical variables (*n*=101)

Clinical variables		Frequency (percentage) *n* (%)		*p*
Child's clinical history		**Intervention group (*n*=50)**	**Control group (*n*=51)**	
History of previous hospitalization	Yes	22 (46.00)	28 (55.00)	0.40
	No	28 (54.00)	23 (45.00)	
History of previous cannulation	Yes	34 (68.00)	37 (73.00)	0.60
	No	16 (32.00)	14 (28.00)	
if yes, how many times has your child been IV cannulated	0 time	16 (32.00)	14 (29.00)	0.90
	1 time	10 (20.00)	12 (24.00)	
	2 times	13 (26.00)	10 (20.00)	
	3 times	6 (12.00)	7 (14.00)	
	4 times	3 (6.00)	4 (8.00)	
	5 times	2 (4.00)	1 (2.00)	
	6 times	0 (0.00)	2 (4.00)	
Present health issues/ diagnosis	Fever	9 (18.40)	11 (22.00)	0.35
	*SOB	3 (6.10)	1 (2.00)	
	Gastroenteritis	8 (16.30)	8 (16.00)	
	Tonsillitis	7 (14.30)	8 (16.00)	
	Bronchitis	8 (16.30)	1 (2.00)	
	Allergic reaction	1 (2.00)	1 (2.00)	
	Cough	2 (4.10)	3 (6.00)	
	Weakness	1 (2.00)	0 (0.00)	
	Neck swelling	1 (2.00)	0 (0.00)	
	**URTI	6 (12.20)	8 (16.00)	
	Sore throat	0 (0.00)	1 (2.00)	
	Febrile convulsion	1 (2.00)	2 (4.00)	
	Asthma	0 (0.00)	3 (6.00)	
	***LRTI	1 (2.00)	2 (4.00)	
	Hyperglycemia	1 (2.00)	0 (0.00)	
History of surgery	Yes	3 (6.00)	5 (10.00)	0.70
	No	47 (94.00)	46 (90.00)	

*SOB=Shortness of breath, **URTI=Upper respiratory tract infection, ***LRTI=Lower respiratory tract infection

Comparison of pain experiences

The CG registered a median pain score of 5 compared to the IVG's median of 2 ($P < 0.01$). This significant reduction in pain scores in the IVG signifies the efficacy of the intervention [Table 4]. While "Moderate Pain" was most common in the CG, IVG participants primarily experienced "Mild to No Pain."

Correlation between pain scores and demographics

There was a statistically significant correlation between participants' demographic characteristics (age, sex, and past painful experiences) and pain levels in both groups. Younger age was particularly associated with higher pain scores, a relationship that was consistently significant in both groups [Table 5].

Discussion

The need for effective management of pediatric pain, especially during cannulation and other procedures involving needles, is well established. The current study reinforces existing evidence, highlighting vibratory stimulation as a viable method for reducing pain perception during IV cannulation. A key finding of our study is the variance in pain experience based on age; younger children demonstrated higher pain levels than their older counterparts. This finding diverges from previous studies on children. A meta-analysis of 16 studies by Su *et al*.[13] found that every one-year increase in age starting at 2.5 years correlated with a 0.13-point reduction in pain scores when using cold-vibration devices. In our study, vibration with the buzzy device was used without ice. A systematic review on the use of vibration stimulus for the administration of intraoral dental injection-related procedures for children concluded that very young children perceive vibration as an unpleasant stimulus and subsequently reported more pain.[14] This suggests that the effectiveness of vibration using the buzzy device, with or without cold, for pain reduction in relation to age is still a matter of debate in the literature.[3,6,15]

Pederson *et al*.[16] on pressure pain thresholds (PPTs) in children found that PPTs increase with age, suggesting that younger children have lower pain thresholds and heightened

Table 3: The **FLACC scale for pain assessment in the experimental group and the control group pre-intervention

The FLACC scale variables		Frequency (percentage) *n* (%)		*p*
		Intervention group (*n*=50)	Control group (*n*=51)	
Total categorized score	No pain (0 score)	1 (2.00)	1 (2.00)	<0.01*
	Mild pain (1–4)	20 (39.00)	21 (41.00)	
	Moderate pain (5–7)	21 (41.00)	21 (41.00)	
	Severe pain (8–10)	9 (18.00)	8 (16.00)	
Face	No particular expression or smile=0	7 (14.00)	7 (14.00)	
	Occasional grimace or frown, withdrawn, disinterested=1	30 (59.00)	29 (57.00)	
	Frequent to constant quivering chin, clenched jaw=2	14 (28.00)	15 (29.00)	
Legs	Normal position or relaxed=0	13 (26.00)	13 (26.00)	
	Uneasy, restless, tense=1	21 (41.00)	22 (43.00)	
	Kicking or legs drawn up=2	17 (17.00)	16 (31.00)	
Activity	Lying quietly, normal position, moves easily=0	15 (29.00)	15 (29.00)	
	Squirming, shifting, back and forth, tense=1	22 (43.00)	22 (43.00)	
	Arched, rigid, or jerking=2	14 (28.00)	14 (28.00)	
Cry	No cry (awake or asleep) = 0	10 (20.00)	11 (22.00)	
	Moans or whimpers; occasional complaint=1	24 (47.00)	24 (47.00)	
	Crying steadily, screams, sobs, frequent complaints=2	17 (33.00)	16 (31.00)	
Consolability	Content, relaxed=0	16 (31.00)	16 (31.00)	
	Reassured by touching, hugging or being talked to, distractible=1	23 (45.00)	24 (47.00)	
	Difficult to console or comfort=2	12 (24.00)	11 (22.00)	

**FLACC-Face, legs, activity, cry, and consolability. *Statistical significance: $p<0.01$

Table 4: Difference in pain experience between the experimental and control groups during IV cannulation

The **FLACC scale variables		Frequency (percentage) *n* (%)		*p*
		Intervention group (*n*=50)	Control group (*n*=51)	
Total categorized score	No pain (0 score)	9 (18.00)	1 (2.00)	<0.01*
	Mild pain (1–4)	40 (80.00)	20 (39.00)	
	Moderate pain (5–7)	1 (2.00)	21 (41.00)	
	Severe pain (8–10)	0 (0.00)	9 (18.00)	

**FLACC-Face, legs, activity, cry, and consolability, *Statistical significance: $p<0.01$

Table 5: Correlation of total pain score with patient demographic variables

Correlation variables	Correlation coefficient	*p*
Intervention group/control group and total pain score	0.70	<0.01*
Age and total pain score	−0.20	0.037
Gender and total pain score	0.15	0.90
History of previous hospitalization and total pain score	−0.15	0.10
Previous **IV cannulation and total pain score	−0.13	0.20
History of surgery and total pain score	−0.37	0.70

**IV=Intravenous, *Statistical significance: $p<0.01$

pain sensitivity. Additionally, a comprehensive study by Schmitz[17] on pain tolerance in children and adolescents, revealing an age-dependent effect of sex on pain threshold, further supports the notion that younger children generally exhibit lower pain thresholds.

From a psychological perspective, Truffy *et al*.[18] explained that younger children's less developed cognitive abilities hinder their capacity to understand and contextualize pain experiences. This cognitive limitation can lead to increased pain sensitivity as patients struggle to rationalize or cope with painful stimuli. Moreover, younger children typically experience higher levels of anxiety and fear related to medical procedures or unfamiliar situations, and elevated anxiety levels may be associated with increased pain sensitivity and lower pain thresholds.[19] These factors may collectively contribute to the observed differences in pain perception across age groups in our study.

In another context, a systematic review by El-Tumi *et al*.[20] drew conclusion from three studies that younger children (6–8 years) were more sensitive to noxious stimuli than older children (9–14 years). Our study underscores the individual differences in children's responses to

painful stimuli, with a significant association between total pain scores and both previous cannulation experiences and hospitalizations. This emphasizes the significance of adopting a multifaceted approach to pediatric pain management. We found a statistically significant correlation between the use of the buzzy device and reduced total pain scores, which aligns with the literature on age-related gradients in pain sensitivity, where younger children are more susceptible to noxious stimuli.[20] A survey analysis involving children aged between three and 17 years found a higher incidence of moderate-to-severe pain during venipuncture among younger participants.[21] The efficacy of vibratory stimulation, as demonstrated in our study, positions it as a cost-effective, noninvasive pain relief method, potentially revolutionizing pediatric care practices by minimizing procedural pain, fear, and anxiety. We acknowledge that the small sample size and participant age (2–6 years) from a single hospital may limit the generalizability of our findings.

Conclusion

Noninvasive vibratory stimulation alone can reduce pain perception and improve the quality of care during painful procedures, thereby reducing fear during invasive procedures in the pediatric population.

Acknowledgements

The authors would like to thank parents of the children and the ward managers for supporting this research project. The study protocol received ethical approval from the Institutional Review Boards, IRB Approval No.(RAKMHSU-REC-027-2022/23-PG-N and MOHAP/REC/2023/15-203-PG-N). The study has been submitted for retrospective registration on https://clinicaltrials.gov/and is currently under review.

Financial support and sponsorship

Nil.

Conflict of interest

Nothing to declare.

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