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Effects of 4% Lidocaine and EMLA in children undergoing venous procedures on vein caliber, pain, and child collaboration: Retrospective observational study

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ABSTRACT

Background: Topical anesthetics such as 4% Lidocaine and Eutectic Mixture of Local Anesthetics (EMLA) are used for venipuncture and intravenous (IV) cannulation. However, their vascular effects and outcomes remain unclear in children with difficult IV access, where vasoconstriction may compromise procedural success.
Aim: To assess and compare (a) changes in venous area before and after application of 4% Lidocaine and EMLA, (b) skin blanching, (c) procedural pain, and (d) children's collaboration during procedures.
Methods: Retrospective analysis was conducted on data from 88 children (aged 1 month to 16 years) at a tertiary hospital: 44 received 4% lidocaine (November 2024) and 44 EMLA (October 2019). Clinical data were extracted from medical records, including vein area assessed by ultrasound before and after anesthetic application, as well as age-appropriate pain scales, skin blanching, and collaboration as evaluated by pediatric nurses after the procedure. Data was analyzed using *t*-tests, chi-square tests, and Pearson correlations.
Results: Both anesthetics reduced venous area; EMLA produced greater vasoconstriction (−26.28% vs −3.27%, $p = .002$) and skin blanching (72.73% vs 25%, $p < .001$) than 4% Lidocaine. Pain was low in both groups ($p = .07$). Children who received EMLA showed higher collaboration (97.73% vs 75%, $p < .001$).
Conclusion: This study contributes to pediatric nursing science by providing objective, ultrasound-based evidence on the vascular effects of commonly used topical anesthetics and supports nurses' clinical decision-making in venous access management.
Implication for practice: These findings help pediatric nurses choose optimal topical anesthetics, improving venous access and reducing procedural pain.

Introduction

Pain management is a significant challenge in pediatric nursing care. Despite advances in clinical practice and research, pain control remains inadequate for many children (Atefeh, 2025). Children are especially vulnerable to pain because cognitive and developmental factors may limit their ability to communicate it, leading to inappropriate or delayed treatment (Di Sarno et al., 2023). Recent studies (Di Sarno et al., 2023; Sansone et al., 2023) report that approximately 80% of hospitalized children experience pain during their stay, often describing it as moderate to severe. Untreated pain can result in short- and long-term consequences, such as hyperalgesia, development of chronic pain, and increased risk of anxiety disorders and depression in adulthood (Gaglani & Gross, 2018). Ensuring effective pain prevention and management in pediatric populations is therefore both a clinical and ethical priority (Atefeh, 2025).

Needle-related procedures, such as venipuncture and intravenous cannulation, are among the most common causes of procedural pain and anxiety in pediatric care (Ustuner Top & Kuzlu Ayyıldız, 2021). These procedures are often repeated during hospital stays and can negatively affect children's emotional well-being, cooperation, and future responses to medical visits (Sørensen et al., 2020). Pediatric nurses

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play a key role in preventing, assessing, and treating procedural pain. They are responsible for preparing children and their families, performing or assisting with venous access, and monitoring children's responses during and after procedures (Bakir et al., 2023). Effective pain management in this context requires not only technical competence but also the integration of evidence-based pharmacological and non-pharmacological interventions tailored to the child's developmental stage and clinical condition (Jusufi et al., 2025).

Various approaches are available to reduce pain during needle-related procedures, including non-pharmacological and pharmacological interventions. Non-pharmacological methods such as distraction, hypnosis (Birnie et al., 2014), sweet solutions, and breastfeeding (Bembich et al., 2018; Kassab et al., 2012) are widely used and have been shown to improve children's experiences with procedures. Among pharmacological interventions, topical anesthetics have recently become common in pediatric settings (Di Sarno et al., 2023) as effective, non-invasive, well-tolerated methods for preventing procedural pain during needle procedures (Stavleu et al., 2025; Zhao et al., 2025). They work by diffusing through intact skin and blocking neuronal transmission from dermal receptors, providing superficial analgesia without significant systemic effects (Zhao et al., 2025).

The Eutectic Mixture of Local Anesthetics (EMLA) cream, containing 2.5% Lidocaine and 2.5% prilocaine per gram, is the most common topical anesthetic (Henkel et al., 2024). It is usually effective about 60 min after application, but the long latency period limits its use in clinical settings that require early intervention (Agenzia Italiana del Farmaco, 2018; Henkel et al., 2024). To address these limitations, alternative anesthetic formulations such as 4% Lidocaine have been developed to provide effective analgesia with a shorter application time. This formulation was designed to provide rapid anesthesia within 30 min while ensuring satisfactory skin tolerance (Agenzia Italiana del Farmaco, 2022; Zhao et al., 2025). The reduced latency of action could improve children's cooperation and reduce anxiety about the procedure (Henkel et al., 2024).

Although the analgesic efficacy of topical anesthetics is well documented, their potential effects on peripheral vascular characteristics have received less attention. Some researchers have questioned whether these methods may affect the success of procedures, particularly in difficult venipuncture (Schreiber et al., 2013). Furthermore, most available studies are based on subjective clinical assessments (Henkel et al., 2024; Stavleu et al., 2025), while objective measurements of venous changes using ultrasound are limited. In recent years, ultrasound-guided vascular access has been increasingly performed by pediatric nurses, as it is a valuable tool to improve first-attempt success rates and reduce pain-related stress (D'Alessandro et al., 2024; Davis et al., 2021). Despite the widespread use of topical anesthetics and the increasing utility of ultrasound, it remains unclear whether different topical formulations affect vein caliber and, consequently, the effectiveness of the procedure. This knowledge gap is particularly important for children with difficult intravenous access, in whom even small changes in vein caliber may influence procedural success, number of attempts, and overall care experience (Poulsen et al., 2023).

In pediatric settings, the topical anesthetics used for venipuncture may change over time as clinical practices evolve, allowing for comparisons of different anesthetics' effects on venous characteristics and procedural outcomes. In this study, two distinct periods corresponding to the routine use of different topical anesthetics were retrospectively compared. In 2019, routine analgesic care for venipuncture used EMLA, while in 2024, EMLA was replaced with a topical medication containing 4% lidocaine. Therefore, following the Evidence-Based Practice paradigm (Melnyk & Fineout-Overholt, 2015), which guides pediatric nurses to integrate vascular evidence with clinical expertise in ultrasound-guided access and family-centered care preferences, the aim of this study was to assess and compare (a) changes in venous area before and after the application of 4% Lidocaine and EMLA, (b) skin blanching after application of the anesthetics, (c) procedural pain using validated scales (Bailey et al., 2010; Voepel-Lewis et al., 2002; Wong & Baker, 1988), and (d) children's collaboration during the procedures. This study will contribute to pediatric nursing science and support evidence-informed decision-making to optimize procedural care for children and their families.

Methods

Study design and setting

A retrospective observational study was conducted in November 2024. The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al., 2008) (supplementary material ST1). The STROBE statement is an international reporting guideline intended to improve the transparency and completeness of observational study reports (von Elm et al., 2008). In this study, STROBE was used to ensure transparent and complete reporting of the study design, participants, variables, statistical analyses, and results.

The study took place in the Pediatric Department of a tertiary-level hospital in northeastern Italy, which cares for children aged one month to 16 years. In 2024, the hospital reported 18,000 emergency room admissions and 1724 hospitalizations for acute, elective, or follow-up medical needs.

Population and inclusion criteria

Eligible patients were admitted to the Department for non-life-threatening conditions. Included were (a) children aged one month to 16 years who required venipuncture or intravenous (IV) cannulation for diagnosis or treatment, and (b) those whose family members – and, when appropriate, the children themselves (considering their wishes based on age and maturity) – were willing to participate. Both children and family members were required to understand the study information in Italian; interpreters were provided when necessary.

Exclusion criteria were children younger than 30 days, those urgently admitted, or those with dermatological disease, vasculitis, oncologic disease, recent topical anesthetic application on the upper limbs (within 12 h), or known allergies or sensitivities to local anesthetics.

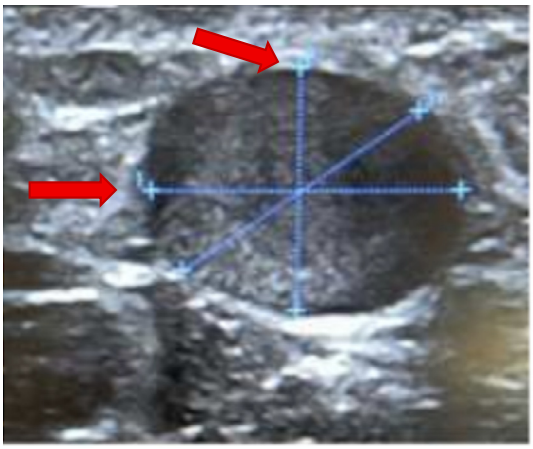
No a priori sample size calculation was performed; the sample size was based on all eligible cases available during the study periods.

Procedure

All procedures were performed by two pediatric nurses, each with more than ten years of experience and certification in vascular ultrasound scanning. During the procedure, parents were allowed to be present to provide comfort using non-pharmacological techniques.

After identifying the appropriate vein for venipuncture with a tourniquet, the tourniquet was removed, and the nurse used ultrasound to examine the identified vessel. To enhance data accuracy, three consecutive measurements were obtained for each vein in transverse projection, assessing the vein's area (Fig. 1) with an L10–22 MHz GE Healthcare VENUE GO ultrasonography device. The vein's area was measured in transverse projection by assessing the diameter both vertically and horizontally. The ellipse area of the vein was then calculated using the formula $A = \pi ab$. After recording the measurements, anesthetic cream was applied to the identified site and covered with a semi-transparent dressing, as indicated by the product instructions.

T_O: Measurement before the anesthetic's application



T_1: Measurement after the anesthetic's application

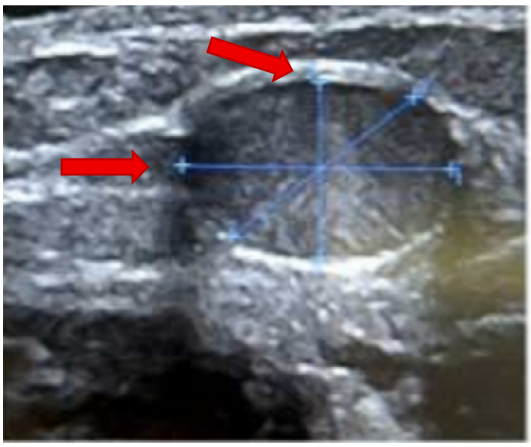


Fig. 1. Measurement to assess vein's area before and after anesthetics application.
T_O: Measurement before the anesthetic's application.
T_1: Measurement after the anesthetic's application.
The red arrows indicate the measurements that were used to calculate the vein area.
Legend: T_o, time before anesthetic's application; T_1, time after anesthetic application. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

For 4% lidocaine, vein caliber was measured before anesthetic application (T0) and after 30 min (T1), according to the expected application time of the product (Agenzia Italiana del Farmaco, 2022). For EMLA, vein caliber was measured before (T0) and after 60 min (T1), following the Agenzia Italiana del Farmaco (2018) guidelines. Procedural pain and skin blanching immediately after venipuncture, and the level of cooperation during the venipuncture were assessed by the pediatric nurse who performed the procedure. All data were routinely recorded in the child's clinical documentation.

Data collection

In 2019, routine analgesic care for venipunctures in the study setting involved the use of EMLA as a topical anesthetic. In 2024, routine clinical practice shifted to 4% lidocaine due to a change in the hospital's endowment. Therefore, data were retrospectively collected from two different periods: October 2019, when EMLA was used, and November 2024, when 4% lidocaine was used. Two researchers with nursing backgrounds retrospectively extracted data from medical and nursing records of 88 children who underwent vein punctures or intravenous cannulation.

Variables

The independent variable was the type of topical anesthetic used for venipuncture, categorized as EMLA or 4% Lidocaine. The dependent variables were:

(a) change in venous area following topical anesthetic application (yes/no) and type of venous area variation (constriction, dilatation, or none) assessed by ultrasound and expressed as changes in venous area measured before (T0) and after (T1) anesthetic application. Vein constriction was defined as a reduction in vein area as indicated by Salles-Cunha et al. (2003), dilatation as an increase in vein area, and none if no change occurred.

(b) skin blanching after application of the topical anesthetic (yes/no). Skin blanching was defined as visible whitening of the skin at the application site compared with the surrounding tissue and was assessed immediately after removal of the topical anesthetic by pediatric nurse.

(c) procedural pain using age-appropriate validated pain scales and defined as a pain score greater than zero. Specifically, the Face, Legs, Activity, Cry, Consolability (FLACC) scale was used for children under 3 years (Voepel-Lewis et al., 2002), the Wong-Baker Faces Scale for children 3–8 years (Wong & Baker, 1988), and the Numerical Rating Scale (NRS) for children over 8 years (Bailey et al., 2010).

(d) children's collaboration during the procedure (yes/no). Children's collaboration was assessed by the nurse performing the procedure based on the child's ability to remain still and follow verbal instructions throughout venipuncture or cannulation.

Additional variables extracted included demographic characteristics (age and gender); the setting where the procedure was performed (day hospital, ward, or emergency room); reason for hospital access (emergency room treatment, elective treatment, or clinical assessment); clinical data (presence of allergies, body mass index [BMI], mid-upper arm circumference [MUAC], triceps skinfold thickness [TST], and skin thickness); vital signs before the procedure (blood pressure, peripheral oxygen saturation, respiratory rate, temperature, and heart rate); type of procedure performed (IV cannulation or venipuncture); anesthetic application time before the procedure; and needle gauge.

Potential source of bias

Potential sources of bias included the retrospective data collection and the assessment of outcomes based on nurses' judgment, such as skin blanching and children's collaboration. To prevent information bias, two researchers extracted data from routinely documented medical and nursing records using a standardized data extraction grid and double-checked the data. For skin blanching and the level of collaboration, all nurses were routinely trained in assessment and data recording, suggesting standardized approaches that minimize inaccuracies.

Ethical considerations

The study followed the principles of the Declaration of Helsinki and was approved by the Internal Review Board of the University of Udine, Italy (Prot IRB: 158/2025, Tit III cl 13 fasc. 24/2025). All participants (children or family members) provided written informed consent for the use of their data. Personal information was anonymized, and strict confidentiality was maintained throughout the study process.

Statistical analysis

Data was summarized as numbers and percentages or means and standard deviations (SD).

Continuous variables included age, anthropometric measures (BMI, MUAC, TST, and skin thickness), anesthetic application time, needle gauge, vital signs, and venous area measurements before and after topical anesthetic application. Categorical variables included type of topical anesthetic, gender, clinical setting, reason for hospital admission, type of

procedure, skin blanching, presence of pain, children's cooperation, and type of venous area variation. Differences between the two groups were explored using Student's *t*-tests for continuous variables and chi-square for categorical variables. Correlations between variables were assessed using Pearson's correlation, values <0.3 were considered low, 0.3–0.5 moderate and > 0.5 high. Statistical significance was set at $p < .05$ and analyses were performed using R software.

Results

Sample and procedural characteristics

As shown in Table 1, data from 88 children were analyzed. Forty-four (50%) received 4% Lidocaine and forty-four (50%) received EMLA. The overall mean age was 9.18 years (SD 4.87); the Lidocaine group was younger than the EMLA group (7.40 ± 5.13 vs. 10.97 ± 3.89 years; $p < .001$). Of the total sample, 40 participants (45.46%) were female and 48 (54.54%) were male, with no significant difference in gender distribution between groups ($p = .29$).

Most procedures were performed in the day hospital (63.64% in the Lidocaine group vs. 58.82% in the EMLA group), followed by wards (25% in both groups) and the emergency room (11.36% vs. 18.18%), with no significant difference in setting distribution between the two groups ($p = .75$). The reasons for hospitalization differed between groups ($p = .05$): clinical assessment (65.91% vs. 43.18%), elective treatment (22.73% vs. 27.27%), and emergency room treatment for non-life-threatening conditions (11.36% vs. 29.55%).

Nine children (10.23%) had an allergy, with a higher proportion in the 4% Lidocaine group than in the EMLA group, although this difference was not statistically significant (15.91% vs. 4.55%; $p = .15$). Anthropometric characteristics were generally comparable between groups, except for TST, which was higher in the 4% Lidocaine group (14.59 ± 6.51 mm vs. 9.75 ± 3.43 mm; $p < .001$). Children's vital signs recorded before the procedures were all within normal ranges.

Half of the procedures were intravenous cannulations ($n = 44$, 50%) and half were venipunctures (n = 44, 50%). There were more cannulations in the 4% Lidocaine group than in the EMLA group (61.36% vs. 38.64%; $p = .06$).

The mean application time for the topical anesthetic was significantly shorter for 4% Lidocaine compared to EMLA (36.14 ± 15.84 min vs. 54.43 ± 6.58 min; $p < .001$). The mean size of the needle gauge used was comparable between the two groups, with no significant differences (22.75 ± 0.75 vs. 22.39 ± 1.22; $p = .10$).

Changes in venous area before and after anesthetic application

Changes in vein area after anesthetic application were observed in nearly all participants (98.86%), as shown in Table 2. However, the type of variation differed significantly between the two groups: area reduction occurred more frequently with EMLA (88.64% vs. 56.82%; $p < .001$). At baseline (T0), no significant differences were observed in mean vein area between the groups (7.02 ± 5.99 mm^2 for 4% Lidocaine vs. 6.18 ± 6.03 mm^2 for EMLA; $p = .52$). After application of the anesthetic (T1), a statistically significant reduction in vein area was reported in both groups, but this reduction was more evident with EMLA (6.12 ± 4.25 mm^2 vs. 4.30 ± 4.35 mm^2; $p = .05$). The percentage reduction in venous area was significantly higher in children treated with EMLA than in those treated with 4% Lidocaine (−26.28% ± 41.85 vs. −3.27% ± 24.45; $p = .002$).

The variation in vein area was significantly correlated with some clinical and procedural variables (Table 3). A weak negative correlation was found with BMI ($r = -0.21$ [95% CI: −0.40 to 0.00]; p = .05). Application time also showed a significant negative correlation with vein area variation ($r = -0.24$ [95% CI: −0.42 to −0.03]; $p = .03$). No

Table 1
Sample and procedural characteristics.

Variable	Total ($n = 88$)	4% Lidocaine ($n = 44$)	EMLA ($n = 44$)	*p*-value
Age, *mean (SD)*	9.19 (4.87)	7.40 (5.13)	10.97 (3.89)	< 0.00
Gender, *n (%)*				
Female	40 (45.46)	17 (38.64)	23 (52.27)	0.29
Male	48 (54.54)	27 (61.36)	21 (47.73)	
Setting, *n (%)*				
Day Hospital	53 (60.23)	28 (63.64)	25 (58.82)	0.75
Ward	22 (25.00)	11 (25.00)	11 (25.00)	
Emergency room	13 (14.77)	5 (11.36)	8 (18.18)	
Access reason, *n (%)*				
Emergency room treatment	18 (20.45)	5 (11.36)	13 (29.55)	0.05
Elective treatment	22 (25.00)	10 (22.73)	12 (27.27)	
Clinical assessment	48 (54.55)	29 (65.91)	19 (43.18)	
Allergies, *n (%)*				
Yes	9 (10.23)	7 (15.91)	2 (4.55)	0.15
No	79 (89.77)	37 (84.09)	42 (95.45)	
Body Mass Index (BMI), *mean (SD)*	17.25 (4.99)	16.61 (6.25)	17.89 (3.24)	0.23
Mid-Upper Arm Circumference (MUAC), *mean (SD)*	21.60 (4.89)	21.14 (5.62)	22.07 (4.05)	0.38
Tricipital skinfold thickness (TST), *mean (SD)*	12.17 (5.72)	14.59 (6.51)	9.75 (3.43)	< 0.00
Skin thickness, *mean (SD)*	1.93 (0.79)	2.04 (0.93)	1.83 (0.62)	0.23
Blood pressure systolic (mmHg), *mean (SD)*	104.88 (11.82)	102.09 (10.30)	107.66 (12.68)	0.02
Blood pressure diastolic (mmHg), *mean (SD)*	64.67 (7.96)	65.43 (6.75)	63.91 (9.03)	0.37
SpO2 (%), *mean (SD)*	98.84 (0.86)	98.52 (0.85)	99.16 (0.75)	< 0.00
Respiratory rate (breaths/min), *mean (SD)*	23.38 (5.46)	26.27 (5.63)	20.48 (3.37)	< 0.00
Temperature (°C), *mean (SD)*	36.41 (0.57)	36.48 (0.59)	36.34 (0.54)	0.25
Heart rate (bpm), *mean (SD)*	92.78 (22.17)	100.00 (19.02)	85.57 (22.93)	< 0.00
Procedures, *n (%)*				
Intravenous cannulation	44 (50)	27 (61.36)	17 (38.64)	0.06
Vein puncture	44 (50)	17 (38.64)	27 (61.36)	
Application time (minutes), *mean (SD)*	45.28 (15.17)	36.14 (15.84)	54.43 (6.58)	< 0.00
Needle gauge, mean *(SD)*	22.57 (1.03)	22.75 (0.75)	22.39 (1.22)	0.10

Legend: BMI, Body Mass Index; bpm, beats per minute; breaths/min, breath per minute; EMLA, Eutectic Mixture of Local Anesthetics; mmHg, millimeters of mercury; MUAC, Mid-Upper Arm Circumference; n, number; SD, standard deviation; SpO2, oxygen saturation; TST, Tricipital skinfold thickness; °C, degrees Celsius.

Table 2
Variations in venous area before and after the application of 4% Lidocaine and EMLA.

Variable	Total ($n = 88$)	4% Lidocaine ($n = 44$)	EMLA ($n = 44$)	*p*-value
Vein area variation, n (%)				
Yes	87 (98.86)	43 (97.73)	44 (100)	0.98
No	1 (1.14)	1 (2.27)	0	
Type of vein area variation, *n (%)*				
Constriction	64 (72.73)	25 (56.82)	39 (88.64)	< 0.00
Dilatation	23 (26.13)	18 (40.91)	5 (11.36)	
None	1 (1.14)	1 (2.27)	0	
T_0, *mean (SD)*	6.60 (5.99)	7.02 (5.99)	6.18 (6.03)	0.52
T_1, *mean (SD)*	5.21 (4.37)	6.12 (4.25)	4.30 (4.35)	0.05
Area variation in percentage, *mean (SD)*	−14.77 (35.99)	−3.27 (24.45)	−26.28 (41.85)	0.002
Skin Blanching, *n (%)*				
Yes	43 (48.86)	11 (25.00)	32 (72.73)	< 0.00
No	45 (51.14)	33 (75.00)	12 (27.27)	

Legend: EMLA, Eutectic Mixture of Local Anesthetics; n, number; mm^2, square millimeter; SD, Standard Deviation; T_0, time before anesthetic's application; T_1, time after anesthetic's application.

significant correlations were observed for age, MUAC, TST, skin thickness, or needle gauge.

Skin blanching after application of the anesthetics

Skin blanching was reported in 43 (48.86%) procedures, with a significantly higher proportion observed in the EMLA group than in the 4% Lidocaine group (72.73% vs. 25.0%; $p < .001$) (Table 2).

Procedural pain and children's collaboration

As shown in Table 4, procedural pain was reported by 29 (32.95%) children, with no significant difference between the two groups. Age-appropriate scales were used to assess pain: FLACC in 20.45% of children, Wong-Baker FACES in 15.91%, and NRS in 63.64%. The mean pain scores were low in both groups (0.77 ± 1.12 vs. 0.41 ± 0.66; $p = .07$).

Overall, children's collaboration during the procedure was high (86.36%), but significantly lower in the 4% Lidocaine group than in the EMLA group (75.0% vs. 97.73%; $p < .001$).

Discussion

This study showed that 4% lidocaine and EMLA were associated with different vascular responses, while both topical anesthetics were linked to low procedural pain and high levels of children's collaboration during venipuncture. These results highlight the importance of identifying anesthetic strategies that facilitate vascular access, reduce pain, and promote collaboration to improve the overall care experience for children and their families. These findings are clinically relevant for pediatric nursing practice, given the high frequency of painful and stressful procedures in this vulnerable population (Bakir et al., 2023).

Table 3
Pearson's correlations between individual and procedural variables and venous area variation.

Variables	Venous area variation correlation (CI 95%)	*p*-value
Age	−0.13 (−0.33–0.09)	0.24
Body Mass Index	−0.21 (−0.40–0)	0.05
Mid-Upper Arm Circumference	−0.15 (−0.35–0.06)	0.17
Tricipital skinfold thickness	0.06 (−0.16–0.26)	0.61
Skin thickness	0.03 (−0.18–0.24)	0.80
Application time (minutes)	−0.24 (−0.42 to −0.03)	0.03
Needle gauge	0.08 (−0.13–0.29)	0.45

Legend: CI, Confidence Interval.

Differences in vascular response between the two anesthetics are among the most relevant findings of this study. While previous studies on topical anesthetics have focused primarily on pain outcomes (Bakir et al., 2023; Schreiber et al., 2013), fewer have examined their effects on vascular characteristics. Our findings indicate that EMLA caused greater vasoconstriction and more frequent skin blanching, consistent with previous study (Schreiber et al., 2013). From a clinical perspective, vasoconstriction and skin blanching may negatively affect the visibility and palpability of veins, especially in children with difficult intravenous access. Moreover, longer anesthetic application times were associated with a greater reduction in vein area, in line with previous evidence showing that prolonged exposure to EMLA may induce vasoconstriction and skin blanching (Schreiber et al., 2013). These findings highlight the importance of selecting topical anesthetics based not only on their analgesic properties but also on their vascular effects, as vasoconstriction may potentially reduce the success rate of venipuncture. In this context, using ultrasound to visualize peripheral vessels may help mitigate the impact of vasoconstriction by improving vessel visualization and procedural success (Cerrone et al., 2024; D'Alessandro et al., 2024; Davis et al., 2021).

Procedural pain scores were low, with no differences between groups, suggesting that the children experienced minimal pain. These results are consistent with previous studies demonstrating the analgesic efficacy of topical anesthetics in pediatric populations (Birnie et al., 2018; Sørensen et al., 2020). However, pain perception in children is widely recognized as a multifactorial phenomenon influenced by pharmacological, contextual, and relational factors. Parental or family involvement is essential for effective pediatric pain management, as caregivers can prepare and comfort their children using non-pharmacological approaches (e.g., pictures, music, and games) that actively distract children from pain and procedures (Bakir et al., 2023; Goktas & Avci, 2023; Robinson et al., 2023). Moreover, collaboration between families and healthcare providers demonstrates that effective pain management is achieved when families are actively involved in the care process (Atefeh, 2025; Greenfield et al., 2022). A family-centered care model supports the integration of family involvement into clinical practice (Browne et al., 2020). In this study, contextual and relational aspects of care, including parental presence and supportive nursing strategies, were routinely applied in both groups. Because these factors were consistent across participants, they are unlikely to fully explain the observed pain outcomes. Within this care context, topical anesthetics appear to have contributed to pain control as part of a multimodal approach to pediatric procedural pain management, rather than serving as isolated determinants of pain reduction.

Although overall collaboration was high, differences observed between groups may reflect developmental (Ballard et al., 2022; Kasahun et al., 2023) and procedural factors (Davis et al., 2021) rather than the analgesic effect alone. Younger children are known to experience greater anxiety and demonstrate reduced cooperation during invasive procedures (Kasahun et al., 2023). Additionally, the longer application time required for EMLA may have contributed to higher levels of collaboration, suggesting that the extra time before the procedure may facilitate psychological preparation and adaptation (Davis et al., 2021). These findings are consistent with previous literature emphasizing that children's cooperation during invasive procedures is influenced by a combination of pharmacological support, adequate preparation, and supportive care (Davis et al., 2021; Kasahun et al., 2023). From a nursing perspective, the shorter application time represents a clinically relevant advantage, particularly in emergency or outpatient settings where rapid interventions are often necessary (Agenzia Italiana del Farmaco, 2022). Previous studies have highlighted the limitations of EMLA related to its longer latency, which may restrict its feasibility in acute care contexts (Henkel et al., 2024; Krauss et al., 2016). Reducing waiting time before venipuncture may decrease procedural anxiety, limit delays in care, and potentially improve the overall experience for children and their families (Davis et al., 2021).

Table 4
Procedural pain and children's collaboration: difference between groups.

Variables	Total ($n = 88$)	4% Lidocaine ($n = 44$)	EMLA ($n = 44$)	p-value
Procedural pain, *n (%)*				
Yes	29 (32.95)	15 (34.09)	14 (31.82)	1
No	59 (67.05)	29 (65.91)	30 (68.18)	
Pain scale, *n (%)*				
FLACC	18 (20.45)	15 (34.09)	3 (6.82)	< 0.00
FACES SCALE	14 (15.91)	6 (13.64)	8 (18.18)	
NRS	56 (63.64)	23 (57.37)	33 (75.00)	
Pain, *mean (SD)*	0.60 (0.93)	0.77 (1.12)	0.41 (0.66)	0.07
Children's collaboration, *n (%)*				
Yes	76 (86.36)	33 (75.00)	43 (97.73)	< 0.00
No	12 (13.64)	11 (25.00)	1 (2.27)	

Legend: EMLA, Eutectic Mixture of Local Anesthetics; FLACC, Faces, Legs, Activity, Cry and Consolability; n, number; NRS, Numerical Rating Scale; SD, Standard Deviation.

Implications for pediatric nursing practice and research

Pediatric nurses are responsible for preparing children and families for painful procedures. Evidence-based selection of local anesthetics can affect the technical success of venous access, influencing both the procedure and the child's experience. Pediatric nurses should consider the effects of different medications on vein and skin blanching to make the best evidence-based decisions. They should also be aware of the varying application times for anesthetics to choose the most appropriate option based on the child's needs and the medication's onset of action. At the organizational level, these findings may inform institutional protocols and policies regarding the selection of topical anesthetics in pediatric settings, supporting appropriate decisions about clinical impact on veins, procedural success, efficiency, and patient comfort.

Limitations

The study has several limitations. First, it was conducted at a single tertiary care department, and the relatively small sample size may limit the generalizability of the results. Additionally, data were collected retrospectively at two different time points, introducing the possibility of temporal or contextual confounding factors. The two groups also differed in age; children who received 4% Lidocaine were significantly younger, which may have influenced vascular responses and behavioral outcomes. Furthermore, vital signs were not collected after the procedures because they were routinely measured when the children were admitted to the hospital. If the initial measurements were normal, they were not repeated to prevent discomfort. In addition, skin blanching and children's cooperation were assessed by the pediatric nurse rather than with validated scales. Given these limitations, further observational studies with larger sample sizes are recommended.

Conclusion

Identifying anesthetic strategies that minimize pain and facilitate vascular access is essential in pediatric nursing practice to improve the care experience for children and their families. This study compared the effects of 4% lidocaine and EMLA cream on venous caliber and procedural outcomes in children undergoing venipuncture or intravenous cannulation. EMLA was associated with greater vasoconstriction and skin blanching. Despite these differences, procedural pain was low in both groups, indicating that both topical anesthetics may reduce procedural pain and improve the child's experience. Children's cooperation during the procedure was high in both groups but higher in the EMLA group, while 4% lidocaine offered the advantage of a shorter application time, making it particularly suitable for acute or emergency situations. This study contributes to pediatric nursing science by providing objective, ultrasound-based evidence on the vascular effects of commonly used topical anesthetics, supporting nurses' clinical decision-making in venous access management.

CRediT authorship contribution statement

Asia Semeraro: Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Sofia Cosattini:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Giorgia Cammarata:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Majda Clodig:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Gaia Dussi:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Stefano Fabris:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Luca Grassetti:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Formal analysis. **Alvisa Palese:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Data curation. **Gaia Magro:** Writing – review & editing, Writing – original draft, Visualization, Data curation. **Lara Vecellio:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Paola Cogo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization.

Patient consent statement

All participants provided written informed consent for the use of their data.

Ethics approval statement

The study was approved by the Internal Review Board of the University of Udine, Italy (Prot IRB: 158/2025, Tit III cl 13 fasc.24/2025).

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Declaration of competing interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pedn.2026.02.019.

Data availability

Data are available from the authors.

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