

Comparing ethyl chloride and 10% lignocaine spray for pediatric intravenous cannulation pain relief

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Background: Intravenous cannulation (IVC) is a routine yet distressing procedure in pediatric patients, often provoking significant anxiety and procedural pain. Although eutectic mixtures such as eutectic mixture of local anesthetic cream are widely used, their delayed onset limits their applicability in time-sensitive settings. Ethyl chloride vapocoolant spray and 10% lignocaine spray have been proposed as rapid-onset alternatives, yet direct comparative evidence in children is scarce.

Purpose: This study aimed to compare the analgesic efficacy, onset of action, and ease of IVC between ethyl chloride vapocoolant spray and 10% lignocaine spray in pediatric patients undergoing elective surgery.

Methods: A prospective, randomized, double-blinded trial was conducted in a tertiary care hospital between 2022 and 2024 following ethics approval (IEC:279/2022) and trial registration (CTRI/2023/08/056580). Sixty children aged 8–17 years (American Society of Anesthesiologists [ASA] I–II) scheduled for elective procedures were randomized to receive either 3 sprays of 10% lignocaine (group L) or ethyl chloride spray (group E) before IVC. Pain was assessed using the visual analogue scale (VAS=0–100 mm), ease of cannulation with a 4-point Likert scale, and procedural time was recorded. Failed cannulations, adverse events, and rescue analgesia requirements were noted. Data were analyzed using IBM SPSS Statistics ver. 22.0 with a significance threshold of $P < 0.05$.

Results: Group E demonstrated significantly lower VAS scores (30.43 ± 0.9 mm) compared to group L (70.03 ± 1.07 mm, $P < 0.001$). Mean cannulation time was shorter in group E (16.07 ± 2.41 seconds) than group L (24.57 ± 4.42 seconds, $P < 0.001$). Ease of cannulation was superior in group E, with 100% of patients reporting no difficulty, whereas only 67.8% in group L reported the same ($P = 0.002$). No adverse effects or serious complications were observed in either group.

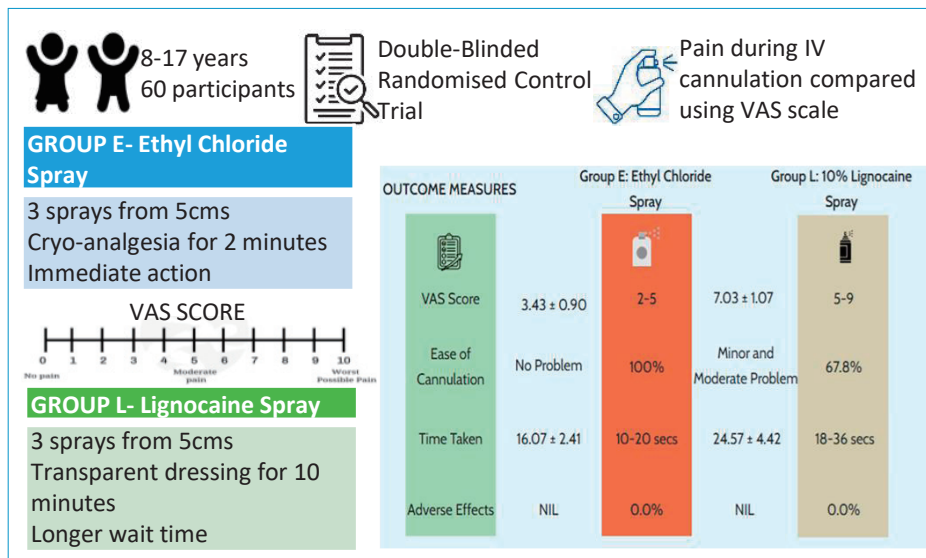
Conclusion: Ethyl chloride vapocoolant spray provides significantly superior dermal analgesia, faster onset, and improved ease of IVC compared to 10% lignocaine spray in children aged 8–17 years. Its rapid action and safety profile make it a valuable alternative in pediatric anesthesia practice, particularly in time-sensitive clinical settings.

Key words: Pediatrics, Catheterization, Ethyl chloride, Lidocaine, Procedural pain

Introduction

Pain is defined as 'an unpleasant sensory and emotional experience associated with, or resembling that associated with actual or potential tissue damage.'¹ It is a complex phenomenon involving the perception of noxious stimuli and the transmission of signals through specialised nerve fibres known as nociceptors.^{2,3} Pain pathways develop early in fetal life and mature throughout childhood and adolescence.⁴ Genetic, environmental, and experiential factors influence individual differences in pain perception and response. Genetic predispositions, cultural norms, social support, and past pain experiences can all shape how pain is perceived and expressed.⁵ Pain can significantly impact daily functioning, disrupting activities and leading to emotional distress, especially in children.^{6,7}

Intravenous cannulation (IVC) is particularly stressful for children and their parents, as the sight of needles and anticipation of pain can trigger anxiety and fear. This highlights the importance of addressing pain and anxiety during the procedure.⁸ Effective pain management during IVC can enhance patient comfort, facilitate the procedure, and promote trust between patients, parents, and healthcare providers.⁹ Various approaches have been



Graphic abstract. VAS, visual analogue scale.

used to decrease pain associated with IVC in children, including topical anesthetics, music, videos, interactive games, and non-pharmacological interventions like mindful breathing and guided visualization. Effective pain management promotes trust and cooperation between patients, parents, and healthcare professionals, leading to better outcomes and satisfaction.

This study emphasizes developing a painless and noninvasive means of providing time-saving and safe topical anesthesia. There have been attempts to find alternatives to the eutectic mixture of local anesthetic (EMLA) cream with ideal properties of ease of application, suitability across age groups, and without side effects. Many studies have compared topical agents like lignocaine spray, amethocaine, and ethyl chloride vapocoolant spray with EMLA cream, identifying various advantages. Currently, limited research is available on the dermal analgesic effect of 10% lignocaine spray and ethyl chloride spray. Therefore, a comparative study was conducted to assess the effectiveness of these 2 topical sprays in providing adequate analgesia for IV cannulation in children.

Lignocaine spray contains lignocaine 100 mg and polyethylene glycol which helps penetrate the stratum corneum better to effect analgesia in the area. It is used for IVC, minor surgical procedures, injections, and dental treatments requiring moderate to prolonged pain relief. It is particularly beneficial for patients with a low pain threshold and in cases involving multiple injections.

Vapocoolant ethyl chloride spray contains a volatile liquid refrigerant that decreases the skin temperature and disrupts the ion channel activation. Its rapid evaporation causes a short duration of analgesia for 2 minutes. The efficacy is limited to superficial cooling and is often perceived as less effective in preventing pain for deeper or longer

procedures. It is often used for superficial injections, needle punctures, and procedures requiring immediate, short-term pain relief particularly helpful in preparing patients for IVC by providing a quick, albeit brief, numbing effect to reduce the initial discomfort of needle insertion.

Methods

1. Study design

A tertiary care hospital's department of anesthesiology carried out a single-center double-blinded randomized study from 2022 to 2024 after institutional ethics committee clearance (IEC:279/2022) and Clinical Trials Registry of India (CTRI) registration (CTRI/2023/08/ 056580). Children between the age group of eight to 17 years undergoing elective surgery, such as superficial general surgery and orthopedic procedure where blood loss was not anticipated, were included. Informed consent from the parent, as well as the child, was obtained, and they were allocated to 2 groups, namely group E (for ethyl chloride) and group L (for 10% lignocaine spray), by computer-generated randomization. Those children undergoing emergency surgery, syndromic, with a decreased level of consciousness, intellectual disabilities, adverse allergic reactions to lidocaine or prilocaine, preexisting sensory/motor deficits, burns, local infection, skin lesions and broken skin in the limb to be cannulated were excluded.

1) Visual analogue scale

A straight horizontal line with a fixed length ranging from 0 mm to 100 mm, which represents the pain perceived by the patient during peripheral IVC. The endpoints of the scale denote the extremes of pain experience.

2) Likert scale

To express the extent of ease of cannulation with a statement using a 4-point rating scale with 1—not at all a problem, 2—minor problem which requires minor adjustments, such as vein collapse, vein rolling and mild irritation, 3—moderate problem which requires different site cannulation, such as accidental dislodgement due to movement, infiltration due to backwall puncture, hematoma formation and venous spasm and 4—serious problem requiring more than 2 attempts, such as severe vasovagal episodes and accidental arterial punctures.

2. Operational definitions

Time for cannulation time will be noted from the point of sterilization of the identified vein to successful cannulation as evidenced by a free flow of injectate.

Failed cannulation is termed when evidence of free flow is absent.

3. Methodology

There were 2 observers and a principal investigator (PI) for the study. The PI obtained the informed consent of children and parents after fulfilling the inclusion criteria, randomized subjects and ensured blinding in observer 1 and 2. Observer 1 was the consultant anesthesiologist who performed the IVC. Observer 2 noted the findings of ease of cannulation, time required for IVC and adverse effects. Subjects were premedicated with oral alprazolam based on their weight, with 0.125 mg for 25–40 kg and 0.25 mg for those above. Subjects were called to the premedication area 2 hours before surgery. The subjects were informed that either of the 2 sprays, which were covered with aluminium foils, were to be applied to them and were not allowed to communicate with observer 2 upon their arrival for the cannulation procedure. Observers 1 and 2 were kept waiting inside a room next to the premedication for 30 minutes as a standard time before being called of the cannulation process.

Subjects were briefed on using the visual analogue scale (VAS) scale from 0–100 mm (Fig. 1). The skin and veins on the dorsum of the nondominant hand were examined before cannulation. Group L received 3 sprays of 10% lignocaine from 5 cm, followed by a transparent dressing for 10 minutes, followed by cannulation. Group E received 3 sprays of ethyl chloride for 4–6 seconds

from 5 cm, resulting in a 2-minute cryo-analgesic state. A cannula size of 22G for under 12 years and 20G for over 12 years was decided. Vitals were monitored before and after. Venipuncture followed aseptic precautions, with an assistant stabilizing the limb. Once the drug was applied and the onset duration had elapsed, Observers 1 and 2 were called to perform the cannulation and subsequently record the findings related to ease of cannulation, VAS score, time required for cannulation, and any adverse effects observed respectively.

The child was asked to rate their pain using VAS after IVC. Ease of cannulation was graded on a Likert scale. If failed cannulation was due to inadequate pain control or if the attempts exceeded two, subjects were then given EMLA and cannulated, as it was the standard of care for the cannulation process in our hospital, and EMLA was provided free of cost. Adverse effects were monitored.

4. Outcomes

The primary outcome was to determine the efficacy of ethyl chloride vapocoolant spray in comparison to 10% lignocaine spray in facilitating analgesia for IVC and the secondary outcome was to assess the time taken, ease of IVC and occurrence of adverse effects.

5. Statistical analysis

The statistical analyses were conducted using the IBM SPSS Statistics ver. 22.0 (IBM Co., USA). Graphical representations, including box plots, line diagrams, and density plots, were employed to visualize the data where appropriate. Between-group comparisons for continuous variables were conducted using the independent samples *t* test when comparing 2 groups. Where data were determined to exhibit a nonnormal distribution, corresponding nonparametric tests such as the Mann-Whitney *U* test were employed. For group comparisons of categorical data, the chi-square test was employed. Where the contingency tables exhibited expected frequencies less than 5 in over 20% of the cells, the Fisher exact test was utilized instead. For paired analyses of continuous variables, a paired *t* test was employed when comparing 2 variables. In cases where the data exhibited a nonnormal distribution, the Mann-Whitney *U* test was used instead. When comparing more than 2 continuous variables, repeated measures analysis of variance was employed. The statistical significance threshold was set at $P < 0.05$.

Results

A total of 60 children between eight to 17 years were analyzed in our study (Fig. 2). Table 1 presents the baseline

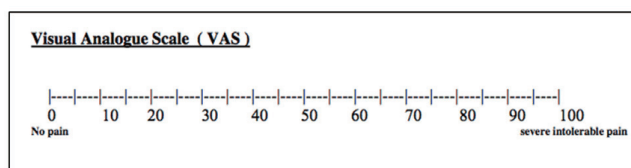


Fig. 1. Visual analogue scale (0–100 mm).

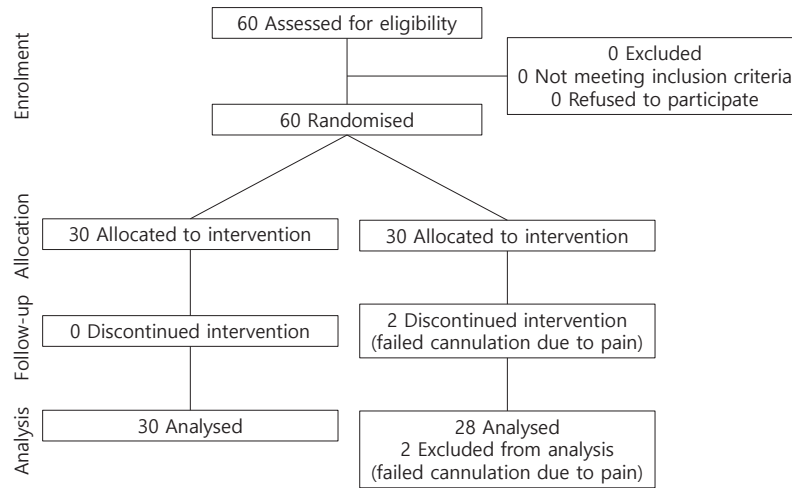


Fig. 2. Consort flow diagram.

Table 1. Baseline characteristics

Parameter	Group		P value
	E-ethyl chloride spray (n=30)	L-lignocaine spray (n=30)	
Age (yr)	12.03±2.81	13.10±2.94	0.156
Sex			
Male	21 (70.0)	23 (76.7)	0.559
Female	9 (30.0)	7 (23.3)	
Weight (kg)	37.33±12.91	40.77±14.75	0.411
Height (cm)	143.80±14.24	146.33±16.79	0.531

Values are presented as mean±standard deviation or number (%).

Table 2. Descriptive statistics (vitals)

Parameter	Group		P value
	E-ethyl chloride spray (n=30)	L-lignocaine spray (n=30)	
Precannulation			
Heart rate (bpm)	90.67±12.06	90.03±11.59	0.836
Systolic BP (mmHg)	96.67±12.95	104.33±9.71	0.018
Diastolic BP (mmHg)	58.13±10.56	60.00±8.30	0.535
Saturation (%)	98.80±0.96	98.70±0.75	0.637
Postcannulation			
Heart rate (bpm)	92.07±11.27	100.67±11.03	0.004
Systolic BP (mmHg)	99.66±10.52	110.00±7.43	<0.001
Diastolic BP (mmHg)	60.00±9.26	69.33±6.40	<0.001
Saturation (%)	98.97±0.61	98.87±0.82	0.537

Values are presented as mean±standard deviation.

BP, blood pressure.

Boldface indicates a statistically significant difference with $P<0.05$.

characteristics of the 2 study groups, E and L, each consisting of 30 participants. The mean age was slightly higher in group L (13.10±2.94 years) compared to group E (12.03±2.81 years), with comparable distributions across both groups.

Table 2 compares the hemodynamic parameters between groups E and L before and after cannulation. Precannulation heart rate, diastolic blood pressure (BP), and oxygen saturation were comparable between the groups

($P>0.05$). However, group L had a significantly higher precannulation systolic BP than group E (104.33±9.71 mmHg vs. 96.67±12.95 mmHg, $P=0.018$). Postcannulation, heart rate, systolic BP, and diastolic BP were significantly higher in group L compared to group E ($P<0.05$). Oxygen saturation remained similar between the groups at both time points ($P>0.05$).

Table 3 compares the association of body mass index (BMI) and ease of cannulation, and Table 4 compares the association of age groups and ease of cannulation. The 2 factors, age groups and BMI, have appeared to have no significant association with the ease of cannulation with probability values of more than 0.05. We have also assessed the vascular conditions of the patients so as to eliminate any differences among the 2 groups that may have occurred for whatever reason. The parameters assessed for this include the skin shade of patients according to the Fitzpatrick Skin Shade Scale, target vein visibility and target vein palpability with and without a tourniquet. Tables 5-7 illustrate the above-mentioned findings with probability values not being significant.

Table 8 illustrates the information on VAS scores, time required for cannulation, ease of cannulation and adverse effects. In our study, group E demonstrated significantly lower VAS scores (3.43±0.90) compared to group L (7.03±1.07) ($P<0.001$), indicating reduced pain during cannulation. The time required for cannulation was significantly shorter in group E (16.07±2.41 seconds) than in group L (24.57±4.42 seconds) ($P<0.001$). Ease of cannulation was superior in group E, with all patients experiencing no problems (100%), whereas 32.2% of group L faced minor to moderate difficulties ($P<0.001$). No adverse effects were observed in either group. However, 2 patients in group L experienced failed cannulation due to pain, requiring a rescue method. These findings suggest that group E offers a more efficient and comfortable cannulation experience.

Table 3. Association between body mass index (BMI) and ease of cannulation

BMI (kg/m ²)	Ease for cannulation			P value
	No problem	Minor problem	Moderate problem	
Mean±SD	18.22±6.16	18.83±5.92	12.97±1.86	0.183
Median (IQR)	17.47 (15.23–19.95)	17.31 (14.85–22.36)	12.97 (12.31–13.63)	
Range	5.9–49.84	11.49–28.57	11.65–14.29	

Table 4. Association between age group and ease of cannulation

Ease for cannulation	Age group (yr)			P value
	7–13	14–17	Total	
No problem	27 (87.1)	21 (80.8)	48 (84.2)	0.843
Minor problem	3 (9.7)	4 (15.4)	7 (12.3)	
Moderate problem	1 (3.2)	1 (3.8)	2 (3.5)	
Total	31 (100)	26 (100)	57 (100)	

Values are presented as number (%).

Table 5. Association between group and skin shade according to the Fitzpatrick scale

Skin shade according to the Fitzpatrick scale	Group			P value
	E-ethyl chloride spray	L-lignocaine spray	Total	
Type 2	6 (20.0)	5 (16.7)	11 (18.3)	0.825
Type 3	10 (33.3)	14 (46.7)	24 (40.0)	
Type 4	9 (30.0)	7 (23.3)	16 (26.7)	
Type 5	5 (16.7)	4 (13.3)	9 (15.0)	
Total	30 (100)	30 (100)	60 (100)	

Values are presented as number (%).

Table 6. Association between group and target vein visibility

Target vein visibility	Group			P value
	E-ethyl chloride spray	L-lignocaine spray	Total	
Visible	26 (86.7)	28 (93.3)	54 (90.0)	0.671
Only with tourniquet	4 (13.3)	2 (6.7)	6 (10.0)	
Total	30 (100.0)	30 (100.0)	60 (100.0)	

Values are presented as number (%).

Discussion

Vapocoolant sprays produce a localized cold effect on the skin, which may provide analgesia through the gate control theory of pain. They are faster-acting, require no pretreatment time, and are less messy than topical lignocaine.¹⁰⁾ Lignocaine is a well-established local anesthetic, but various studies have attributed its use to mitigate pain caused by venepuncture when applied topically due to its dermal penetrative characteristic. Lignocaine spray has a relatively rapid onset of action, ease of application, and the ability to provide effective analgesia for a longer duration than vapocoolants.¹¹⁾

While the age range of eight to 17 years is broad, we ensured that both groups (E and L) were randomly assign-

Table 7. Association between group and target vein palpability with and without a tourniquet

Target vein palpability	Group			P value
	E-ethyl chloride spray	L-lignocaine spray	Total	
Palpable without tourniquet	17 (56.7)	18 (60.0)	35 (58.3)	0.793
Palpable with tourniquet	13 (43.3)	12 (40.0)	25 (41.7)	
Total	30 (100.0)	30 (100.0)	60 (100.0)	

Values are presented as number (%).

Table 8. Descriptive statistics (outcomes)

Parameter	Group		P value
	E-ethyl chloride spray (n=30)	L-lignocaine spray (n=30)	
VAS score	3.43±0.90	7.03±1.07	<0.001
Time required for cannulation (sec)	16.07±2.41	24.57±4.42	<0.001
Ease of cannulation			<0.001
No problem	30 (100)	19 (67.8)	
Minor problem	0 (0)	7 (25.9)	
Moderate problem	0 (0)	2 (7.4)	
Adverse effects	30 (100)	30 (100)	-

Values are presented as mean±standard deviation.

VAS, visual analogue scale.

Boldface indicates a statistically significant difference with $P<0.05$.

ed, which helps balance any potential age-related differences in maturity and understanding of the procedure. This randomization ensures that age-related factors do not significantly skew the observed outcomes. Additionally, the study design did not specifically aim to assess the influence of age on the outcomes, but rather the comparative efficacy of the 2 interventions in minimizing pain during cannulation. We agree that age could potentially influence the child's experience and understanding of the procedure. However, given the nature of our study and the randomization process, the impact of age differences should be minimal across the 2 groups. Notably, the type of surgery did not influence the cannulation process, as the cannula size was standardized for the subjects.

Blinding in our study was meticulously ensured through multiple measures. The drug bottles were concealed with aluminium foil to prevent identification of the agent used. Neither the study participants nor observers 1 and 2 were exposed to the drug application process or the appearance of the drug. Observers 1 and 2 were only involved after the designated drug action time had elapsed, arriving solely to perform and assess the cannulation process. Additionally,

the children were unaware of the significance of the extra plaster and were explicitly instructed not to discuss the method or technique used with the consultant anesthesiologist before cannulation. This approach was the most effective in maintaining blinding despite different application methods, ensuring that both participants and primary evaluators remained blinded, thereby preserving the integrity of the study design.

The provider performing the cannulations in the study is a highly experienced anesthesiologist with extensive expertise in pediatric IVC. The observer's proficiency ensures consistency and minimizes variability in the technique, reducing potential bias in the time and ease of cannulation thus strengthening the reliability of the observed outcomes, as they are less likely to be influenced by differences in provider skill.

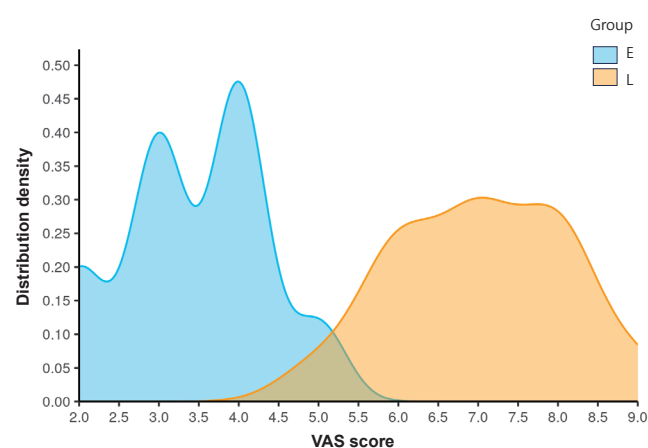


Fig. 3. Density plot distribution of visual analogue scale (VAS) score in the 2 groups. Group E, ethyl chloride spray; group L, lignocaine spray.

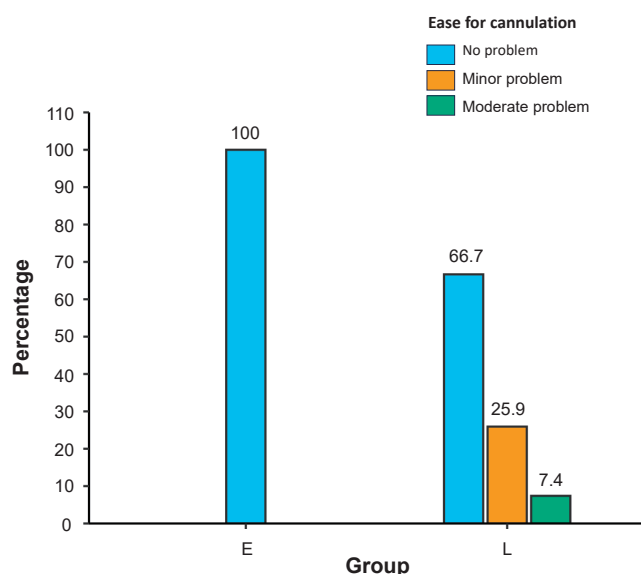


Fig. 4. Box graph representing the 2 groups with ease of cannulation. Group E, ethyl chloride spray; group L, lignocaine spray.

The VAS scores were significantly lower in group E (mean: 3.43) compared to group L (mean: 7.03), indicating better pain control in group E (Fig. 3). To assess vascular conditions, we evaluated skin shade, vein visibility, and palpability with and without a tourniquet. These factors were considered beforehand to determine their potential impact on the outcomes. However, comparisons showed no significant differences between the groups regarding vascular conditions, the cannulation process, or the spray used. This suggests that the improved ease of cannulation was primarily due to adequate pain control, which in turn contributed to a smoother procedure and reduced cannulation time (Fig. 4). The ease of cannulation was better in group E, with no failed attempts, compared to group L where 7 patients experienced minor difficulties and 2 had failed cannulation. No adverse effects were noted (Fig. 4).

The limited research comparing ethyl chloride and 10% lignocaine sprays does not undermine the study's significance. Both sprays have been extensively studied for their safety and efficacy in clinical practice. However, the comparison between these 2 specific interventions in pediatric IVC settings is less explored, underscoring the novelty and importance of this study. The absence of direct comparative research until now highlights a gap in the literature.

The quicker onset and ease of use with ethyl chloride spray are clinically significant and contribute directly to improved patient outcomes, including reduced VAS scores. As these variables reflect the overall efficacy and patient comfort, they validate rather than undermine the conclusion.

In the study by Firdaus et al.,¹²⁾ one group received EMLA cream, while the other received vapocoolant spray. While both agents effectively reduced pain, the authors concluded that vapocoolant spray has a significant advantage in terms of faster onset, making it a more practical choice in time-sensitive situations and potentially improving the experience for patients and healthcare providers. A study by Koca et al.¹³⁾ investigated using ethyl chloride spray as a topical anesthetic for radial coronary angiography. The ethyl chloride spray group demonstrated significantly lower VAS scores, lower rates of radial cannulation failure and radial artery spasm, as well as lower rates of pain lasting over one week. The study concluded that the use of ethyl chloride spray can effectively reduce pain, lower the rates of complications, and improve patient comfort without major side effects.

In a study by Kulkarni et al.,¹⁴⁾ EMLA cream and 10% lignocaine spray were compared for pediatric cannulation. The 99 patients' pain, cannulation ease, and adverse effects were evaluated using VAS. The results showed no statistical difference in pain reduction, concluding that

lignocaine spray 10 minutes before IV cannulation is as efficient as EMLA cream applied an hour prior. Zhu et al.¹⁵⁾ conducted a randomized trial to evaluate the effectiveness, acceptability, and safety of 10% lignocaine spray in reducing pain from noncoring needle punctures in 84 totally implantable venous access port patients. The intervention group had significantly lower VAS pain scores, higher comfort, and greater willingness to use the spray again, demonstrating the lignocaine spray's efficacy and safety.

Despite concerns about ethyl chloride spray's sterility, a study by Sandrowski et al.¹⁶⁾ found the spray remained sterile, suggesting its use, duration, and amount did not affect sterility.

This study has several limitations. First, some of the objective parameters commonly used to assess vascular conditions include vein visibility, palpability, diameter, depth, compressibility, venous filling time, availability of other venous access sites, and the DIVA (difficult Intravenous access) score. In our study, we recorded only vein visibility and palpability (with and without a tourniquet), skin shade, and potential alternative sites for venous access. We did not include the other methods of vascular assessment. Second, additionally, the study did not compare the interventions to the standard IVC care used at our institution, which involves the application of EMLA cream. Third, the study population primarily consisted of older children, and therefore, the findings may not be generalizable to younger age groups such as infants and toddlers, where establishing intravenous access is often more challenging. Fourth, the study also used only 22G and 20G cannulas in the pediatric population and did not assess the outcomes with larger bore cannulas typically used in adults. Finally, we did not evaluate cutaneous vasodilation which could have occurred after drug application, which may have influenced the ease of cannulation.

In conclusion, our study showed that vapocoolant ethyl chloride spray provided a quicker onset of action, greater ease of cannulation and superior dermal analgesia when compared to 10% lignocaine spray during peripheral intravenous cannulation in children.

Footnotes

Conflicts of interest: No potential conflict of interest relevant to this article was reported.

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Author contribution: Conceptualization: MK; Data curation: SV, DS, MT; Methodology: MK, HDAK; Project administration: SV, DS, NBK; Writing - original draft: MK, DS; Writing - review & editing: MK, HDAK, VS

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