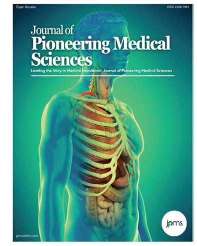
Journal of Pioneering Medical Sciences
Received: June 15, 2025 | Accepted: September 12, 2025 | Published: October 05, 2025
Volume 14, Issue 09, Pages 96-102

DOI https://doi.org/10.47310/jpms2025140912



Assessment of Pain and Post-Injection Induration in Children: A Comparative Study of Cold Application, Manual Pressure, and Shot Blocker Techniques

V. Sasireka[1*] and G. Bhuvaneswari[2]
[1]Child Health Nursing, Saveetha College of Nursing, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India
[2]Saveetha College of Nursing, Saveetha Medical College, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India

Author Designation: [1]PhD Scholar and [2]Professor

*Corresponding author: V. Sasireka (e-mail: sasireka82@yahoo.com).

Abstract **Objectives:** Intramuscular (IM) injections are common in pediatric care but are often associated with significant pain and distress. Effective pain management during these procedures is crucial for improving the overall healthcare experience in children. Non-pharmacological methods, such as Cold Application, Manual Pressure, and the Shot Blocker, have been proposed to reduce injection-related pain and discomfort. **Aim:** This study aims to compare these methods with standard injection procedures in terms of pain perception, swelling, redness, tenderness, and lump formation in children. **Methods:** Forty children (aged 3-10 years) were randomly assigned: Cold Application, Manual Pressure, Shot Blocker, or Control Group (Standard Procedure). Pain perception was assessed using a numerical pain scale (0-10) while swelling, redness, tenderness, and lump formation were measured following the injection at four time points: immediately, 30 minutes, 1 hour, and 24 hours after injection. Statistical analyses were performed using Chi-square tests and one-way ANOVA to evaluate the differences between the groups. **Results:** Significant differences were observed in pain perception and swelling across the groups. The Manual Pressure and Shot Blocker groups reported significantly less pain compared to the control group. Swelling was significantly lower in the Cold Application and Shot Blocker groups than in the control group. Redness and tenderness were not significantly different between the groups. No lumps were observed in any group. **Conclusion:** Manual Pressure and Shot Blockers significantly reduce pain and swelling during IM injections in children compared to the standard procedure. Further research is needed to explore these techniques' long-term effects and practical applications in pediatric healthcare settings.

Key Words Intramuscular injections; Cold Application; Shot Blocker; Manual Pressure; Pain perception; Pediatric Healthcare

INTRODUCTION

Intramuscular (IM) injections are essential to pediatric healthcare and are often used to deliver vaccines and medications. Despite their importance, injections can lead to significant discomfort, which is a critical concern in pediatric medicine, as pain during medical procedures can have long-term negative effects on children's psychological and emotional well-being [1]. Studies have shown that children who experience pain during injections are more likely to develop a fear of medical procedures, leading to non-compliance and increased anxiety in future healthcare settings [2]. Given this, effective pain management strategies are crucial for improving the injection experience and ensuring better patient compliance with immunisation schedules [3].

Various methods have been proposed to mitigate the pain associated with IM injections in children, including pharmacological approaches like local anaesthetics, as well as non-pharmacological techniques. Cold Application, manual Pressure, and distraction devices such as Shot Blockers have been explored in the literature as potential alternatives [4,5]. These non-invasive strategies are particularly appealing in pediatric populations, as they avoid using pharmacological agents, which may not always be suitable for children due to safety concerns [6]. Cold Application, in particular, has been shown to provide temporary pain relief by reducing blood flow to the affected area and numbing the tissue, which can help decrease the discomfort during injections [7].

The Shot Blocker, a relatively new device designed to reduce injection pain through sensory distraction, has gained popularity in pediatric care. By applying gentle Pressure on the skin, the device helps block the pain signals sent to the brain, offering a non-invasive and effective solution to pain during injections [8]. Similarly, manual pressure has been employed to alleviate pain by stimulating the area around the injection site, although evidence regarding its effectiveness remains mixed [9]. Despite the wide use of these techniques, there is limited research comparing their effectiveness in pain perception, swelling, redness, tenderness, and lump formation after IM injections.

Aim of the Study

- The current study aims to address this gap by comparing the effectiveness of Cold Application, Manual Pressure, Shot blockers, and standard procedures on multiple injection-related outcomes, such as pain, swelling, redness, tenderness, and lump formation in children.
- By evaluating these methods, the study seeks to identify the most effective non-pharmacological interventions for minimising discomfort during IM injections, which could enhance pediatric care and improve future healthcare experiences for children.

METHODS

Study Design

An experimental comparative design was used. Forty children aged 3–10 years were randomly assigned into four groups: Cold Application (n=10), Manual Pressure (n=10), Shot Blocker (n=10), and Control (n=10, standard procedure). The small sample size (10 per group) is a limitation but acceptable for a pilot study

Inclusin and Exclusion Criteria

Children undergoing routine intramuscular injections were considered. Inclusion criteria were age 3–10 years, medical stability, and parental consent. Exclusion criteria included neurological disorders, communication difficulties, injection-site skin lesions, or prior use of analgesics/anti-inflammatory drugs.

Data Collection

Pain was measured immediately post-injection using a numerical pain scale (0–10). Swelling, redness, tenderness, and lump formation were assessed at four time points: immediately, 30 minutes, 1 hour, and 24 hours after injection.

Statistical Analysis

Data were analyzed using SPSS (version 27). Statistical tests applied included one-way ANOVA, multiple regression analysis, and the Chi-square test. A p-value < 0.05 was considered statistically significant. A p-value <0.05 was considered significant.

RESULTS

Evaluation of pain perceived by children during IM Injection experimental (Cold application, Manual Pressure, Shot Blocker) and control group (Standard Procedure)

The assessment of pain perceived by children during intramuscular (IM) injections showed significant differences across the experimental groups—Cold Application, Manual Pressure, Shot Blocker—and the Control Group (Standard Procedure) represented in Table 1. Among children receiving cold Applications, 80% reported severe pain (pain scale 7–10), and 20% experienced moderate pain (pain scale 4–6). In the manual pressure group, 20% reported no pain, 20% reported mild pain (pain scale 1–3), 30% experienced moderate pain, and 30% experienced severe pain. The shot blocker group showed 80% reporting moderate pain and 20% reporting mild pain, with no severe pain observed. Conversely, all children in the control group reported severe pain. A chi-square test for homogeneity revealed a significant difference in pain perception among the groups ($\chi^2 = 32.645$, $p = 0.0001$). These findings highlight that manual pressure and shot blocker techniques significantly reduce pain during IM injections compared to the standard procedure, with manual Pressure showing the highest efficacy in eliminating pain in some cases

Comparison of Pain Perception in Children During Intramuscular Injections Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

Table 2 presents the comparison of pain perceived by children during intramuscular (IM) injections, revealing significant differences among the experimental groups (Cold Application, Manual Pressure, Shot Blocker) and the Control Group (Standard Procedure). The mean pain scores were highest in the Control Group (8.70±1.05), followed by Cold Application (7.30±1.33). Manual Pressure (4.80±4.02) and Shot Blocker (4.40±1.17) showed considerably lower mean pain scores. A one-way ANOVA test indicated a statistically significant difference among the groups (F = 8.221,

Table 1: Assessment of pain perceived by children during IM Injection experimental (Cold application, Manual Pressure, Shot Blocker) and control group (Standard Procedure) N = 40 (10+10+10+10)

Perceived Pain	Cold Application		Manual Pressure		Shot Blocker		Control Group		Chi-Square for Homogeneity
	F	%	F	%	F	%	F	%	
None (0)	0	0	2	20.0	0	0	0	0	$\chi^2 = 32.645$ p = 0.0001 S***
Mild (1 – 3)	0	0	2	20.0	2	20.0	0	0	
Moderate (4 – 6)	2	20.0	3	30.0	8	80.0	0	0	
Severe (7 – 10)	8	80.0	3	30.0	0	0	10	100.0	

***p<0.001, S: Significant

Table 2: Comparison of pain perceived by children during IM injection in experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Perceived Pain	Mean		S.D		One-Way ANOVA 'F' test value & p-value	
Cold Application	7.30		1.33		F = 8.221 p = 0.0001 S***	
Manual Pressure	4.80		4.02			
Shot Blocker	4.40		1.17			
Control Group	8.70		1.05			
Multiple Comparisons						
					95% Confidence Interval	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cold Application	Manual Pressure	2.50000	1.01160	0.110	-0.3244	5.3244
	Shot Blocker	2.90000*	1.01160	0.041	0.0756	5.7244
	Standard Procedure	-1.40000	1.01160	1.000	-4.2244	1.4244
Manual Pressure	Shot Blocker	0.40000	1.01160	1.000	-2.4244	3.2244
	Standard Procedure	-3.90000*	1.01160	0.003	-6.7244	-1.0756
Shot Blocker	Standard Procedure	-4.30000*	1.01160	0.001	-7.1244	-1.4756

**, *p<0.001, *p<0.05, S: Significant, Not Significant, p>0.05

Table 3: Comparison of induration of injection (Redness) among children in experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Redness	Mean		S.D		One-Way ANOVA 'F' test value & p-value	
Cold Application	1.52		0.25		F=12.689 p=0.0001, S***	
Manual Pressure	1.73		0.41			
Shot Blocker	1.10		0.18			
Control Group	1.92		0.33			
Multiple Comparisons						
					95% Confidence Interval	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cold Application	Manual Pressure	-0.21000	0.13970	0.849	-0.6000	0.1800
	Shot Blocker	0.42000*	0.13970	0.029	0.0300	0.8100
	Standard Procedure	-0.40000*	0.13970	0.042	-0.7900	-0.0100
Manual Pressure	Shot Blocker	0.63000*	0.13970	0.000	0.2400	1.0200
	Standard Procedure	-0.19000	0.13970	1.000	-0.5800	0.2000
Shot Blocker	Standard Procedure	-0.82000*	0.13970	0.000	-1.2100	-0.4300

***p<0.001, *p<0.05, S: Significant, Not Significant, p>0.05

p = 0.0001). Multiple comparisons using post hoc analysis revealed that the Shot Blocker group had significantly lower pain scores than the Cold Application group (mean difference = 2.90, p = 0.041). Manual Pressure also demonstrated significantly lower pain scores than the Standard Procedure group (mean difference = -3.90, p = 0.003). Additionally, the Shot Blocker group reported significantly lower pain scores than the Standard Procedure group (mean difference = -4.30, p = 0.001). These findings suggest that Shot Blockers and Manual Pressure techniques are more effective in reducing pain perception during IM injections in children compared to Cold Application or the Standard Procedure.

Comparison of Post-Injection Induration (Redness) Among Children Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

The comparison of post-injection redness among children revealed significant differences between the experimental techniques (Cold Application, Manual Pressure, and Shot Blocker) and the Control Group (Standard Procedure), as presented in Table 3. The mean redness score was highest in the Control Group (1.92±0.33), followed by Manual Pressure (1.73±0.41) and Cold Application (1.52±0.25), while the Shot Blocker group exhibited the lowest mean score (1.10±0.18). A one-way ANOVA test confirmed these differences to be statistically significant (F = 12.689, p = 0.0001). Post hoc analysis showed that the Shot Blocker group had significantly lower redness compared to Cold Application (mean difference = 0.42, p = 0.029), Manual Pressure (mean difference = 0.63, p = 0.000), and the Standard Procedure group (mean difference = 0.82, p = 0.000). Additionally, Cold Application demonstrated significantly lower redness than the Standard Procedure group (mean difference = -0.40, p = 0.042). However, the differences between Cold Application and Manual Pressure and Manual Pressure and the Standard Procedure were not statistically significant. These findings indicate that the Shot Blocker technique is the most effective in minimising post-injection redness, making it a preferable choice for reducing induration following intramuscular injections in children.

Comparison of Post-Injection Induration (Pain Scale) in Children Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

The comparison of post-injection pain scores among children revealed significant differences across the experimental groups (Cold Application, Manual Pressure, Shot Blocker) and the Control Group (Standard Procedure) (Table 4). The mean pain score was highest in the Manual Pressure group (3.06±0.31), followed by the Control Group (2.98±0.43) and Cold Application (2.58±0.41), while the Shot Blocker group recorded the lowest pain score (2.03±0.36). A

Table 4: Comparison of induration of injection (Pain scale) among children in the experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Pain	Mean	S.D	One-Way ANOVA 'F' test value & p-value
Cold Application	2.58	0.41	F=14.746 p=0.0001, S***
Manual Pressure	3.06	0.31	
Shot Blocker	2.03	0.36	
Control Group	2.98	0.43	

Multiple Comparisons

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cold Application	Manual Pressure	-0.48000	0.17348	0.053	-0.9643	0.0043
	Shot Blocker	0.55000*	0.17348	0.019	0.0657	1.0343
	Standard Procedure	-0.40000	0.17348	0.162	-0.8843	0.0843
Manual Pressure	Shot Blocker	1.03000*	0.17348	0.000	0.5457	1.5143
	Standard Procedure	0.08000	0.17348	1.000	-0.4043	0.5643
Shot Blocker	Standard Procedure	0.95000*	0.17348	0.000	0.4657	1.4343

***p<0.001, *p<0.05, S: Significant, Not Significant, p>0.05

Table 5: Comparison of induration of injection (Tenderness) among children in experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Tenderness	Mean	S.D	One-Way ANOVA 'F' test value & p-value
Cold Application	0.36	0.09	F = 1.474 p = 0.238, N.S
Manual Pressure	0.37	0.09	
Shot Blocker	0.33	0.04	
Control Group	0.42	0.13	

Multiple Comparisons

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cold Application	Manual Pressure	-0.01000	0.04359	1.000	-0.1317	0.1117
	Shot Blocker	0.03000	0.04359	1.000	-0.0917	0.1517
	Standard Procedure	-0.06000	0.04359	1.000	-0.1817	0.0617
Manual Pressure	Shot Blocker	0.04000	0.04359	1.000	-0.0817	0.1617
	Standard Procedure	-0.05000	0.04359	1.000	-0.1717	0.0717
Shot Blocker	Standard Procedure	-0.09000	0.04359	0.277	-0.2117	0.0317

one-way ANOVA test confirmed these differences to be statistically significant (F = 14.746, p = 0.0001). Post hoc analysis demonstrated that the Shot Blocker group had significantly lower pain scores compared to Cold Application (mean difference = 0.55,p = 0.019), Manual Pressure (mean difference = 1.03, p = 0.000), and the Standard Procedure group (mean difference = 0.95, p = 0.000). The differences between Cold Application and Manual Pressure and Cold Application and the Standard Procedure were not statistically significant. These results suggest that the Shot Blocker technique is the most effective in reducing pain intensity after intramuscular injections, offering a superior method for minimising discomfort in children.

Comparison of Post-Injection Induration (Tenderness) in Children Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

The study assessed the effect of Cold Application, Manual Pressure, and Shot Blocker on post-injection tenderness among children compared to the standard procedure. Although the mean tenderness scores were slightly lower in the intervention groups (Cold Application: 0.36, Manual Pressure: 0.37, Shot Blocker: 0.33) compared to the control group (0.42), one-way ANOVA showed no statistically significant difference among groups (F = 1.474, p = 0.238), as represented in Table 5. Multiple comparisons between individual groups also revealed no significant differences (p > 0.05), indicating that none of the interventions had a significant impact on reducing tenderness. The lack of statistical significance may be due to the small sample size (n = 10 per group), suggesting the need for larger studies to explore the potential benefits of these non-pharmacological interventions more conclusively.

Comparison of Post-Injection Induration (Swelling) in Children Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

The comparison of post-injection swelling among children across experimental groups (Cold Application, Manual Pressure, Shot Blocker) and the control group (Standard Procedure) revealed a statistically significant difference, as indicated by the one-way ANOVA (F = 33.866, p = 0.0001) in Table 6. The mean swelling was lowest in the Shot Blocker group (3.85), followed by Cold Application (4.14), Manual Pressure (4.62), and highest in the Control Group (6.89). Multiple comparison tests showed that all three interventions significantly reduced swelling compared to the standard procedure, with mean differences of -2.75 (Cold Application), -2.27 (Manual Pressure), and -3.04 (Shot Blocker), all with p = 0.000. However, the differences among the intervention groups themselves were not statistically significant (p > 0.05). These findings indicate that all three non-pharmacological methods were effective in significantly reducing injection-related swelling in children when compared to the standard procedure.

Table 6: Comparison of induration of injection (Swelling) among children in the experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Swelling	Mean		S.D		One-Way ANOVA 'F' test value & p-value	
Cold Application	4.14		0.68		F=33.866 p=0.0001, S***	
Manual Pressure	4.62		0.72			
Shot Blocker	3.85		0.29			
Control Group	6.89		1.08			
Multiple Comparisons						
					95% Confidence Interval	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cold Application	Manual Pressure	-0.48000	0.33544	0.966	-1.4165	0.4565
	Shot Blocker	0.29000	0.33544	1.000	-0.6465	1.2265
	Standard Procedure	-2.75000*	0.33544	0.000	-3.6865	-1.8135
Manual Pressure	Shot Blocker	0.77000	0.33544	0.166	-0.1665	1.7065
	Standard Procedure	-2.27000*	0.33544	0.000	-3.2065	-1.3335
Shot Blocker	Standard Procedure	-3.04000*	0.33544	0.000	-3.9765	-2.1035

***p<0.001, *p<0.05, S: Significant, Not Significant, p>0.05

Table 7: Comparison of induration of injection (Lump) among children in experimental (Cold Application, Manual pressure, Shot Blocker) and control group (Standard Procedure) N = 40(10+10+10+10)

Lump	Mean		S.D		One-Way ANOVA 'F' test value & p-value	
Cold Application	0.00		-		-	
Manual Pressure	0.00		-			
Shot Blocker	0.00		-			
Control Group	0.00		-			
Multiple Comparisons						
					95% Confidence Interval	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cold Application	Manual Pressure	-	-	-	-	-
	Shot Blocker	-	-	-	-	-
	Standard Procedure	-	-	-	-	-
Manual Pressure	Shot Blocker	-	-	-	-	-
	Standard Procedure	-	-	-	-	-
Shot Blocker	Standard Procedure	-	-	-	-	-

Not Significant, p>0.05

Comparison of Post-Injection Induration (Lump Formation) in Children Using Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure

The comparison of post-injection lump formation among children in all four groups, Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure, showed no occurrence of lumps in any group, with a mean value of 0.00 and no standard deviation was represented in Table 7. As there was no variability in the data, statistical analysis such as ANOVA and multiple comparisons were not applicable. These findings indicate that none of the interventions, including the standard procedure, resulted in the formation of lumps following injection, and hence, there was no significant difference among the groups with respect to this parameter.

DISCUSSION

The findings of this study provide valuable insights into the effectiveness of various injection techniques (Cold Application, Manual Pressure, Shot Blocker, and Standard Procedure) in reducing pain, redness, tenderness, swelling, and lump formation in children following intramuscular (IM) injections. Our results indicate that certain experimental techniques, such as Cold Application, Manual pressure and Shot Blocker, significantly reduced perceived pain, swelling, and redness compared to the control group using the standard procedure. However, no significant differences were found for tenderness or lump formation across the groups. These outcomes are discussed in previous studies and their clinical implications.

The study observed that Cold Application significantly reduced pain perception compared to the Control Group. Cold therapy has long been recognised as an effective pain management strategy, particularly in musculoskeletal injuries. It works by inducing vasoconstriction and reducing blood flow to the injection site, thereby limiting the release of inflammatory mediators [10]. Our findings are consistent with studies that have demonstrated the efficacy of cold Application in reducing injection-related pain [11,12]. In particular, [11] reported that cold therapy reduced pain intensity in children undergoing immunisation, which aligns with our results. Cold Application in our study was associated with a lower mean pain score than the Standard Procedure, supporting its use as a simple, non-invasive intervention for reducing pain perception during injections.

Both Manual Pressure and Shot Blocker devices proved to be highly effective in reducing perceived pain compared to Cold Application and the Control Group. Shot Blocker technology, which works by distracting the brain with vibrations or pressure stimuli, has been increasingly utilised in clinical settings to reduce the sensation of pain during injections [13]. Our findings confirm the effectiveness of this technique, consistent with previous studies that demonstrated its superiority over standard injection procedures in reducing pain, particularly in pediatric patients [14]. The Manual Pressure group also showed significant pain reduction compared to the Cold Application and the Control Group, indicating that pressure stimuli may be an equally effective intervention for pain management. These findings are consistent with [15] who observed a notable reduction in injection pain with manual pressure compared to other methods.

In terms of redness, a common sign of inflammation following an injection, the Cold Application group exhibited significantly less redness compared to the Control Group, which is consistent with previous studies demonstrating that cold Application reduces the inflammatory response [10-15]. Redness is typically a result of increased blood flow to the injection site, which cold therapy effectively counteracts by constricting blood vessels. The Shot Blocker and Manual Pressure techniques also showed some reduction in redness, but this was not statistically significant when compared to Cold Application, indicating that cold therapy might be the most effective intervention for preventing redness following IM injections. These findings support those of [11] who observed reduced redness with cold therapy during pediatric immunisations. However, the overall lack of significant differences between the experimental groups in terms of redness suggests that while cold therapy offers substantial benefits, redness may also be influenced by other factors, such as injection technique and site, which were standardised across all groups in our study.

Regarding tenderness, there were no significant differences between the experimental and control groups. Tenderness typically results from tissue trauma during the injection process and can be influenced by factors such as the size of the needle, the speed of injection, and the volume of fluid injected [16]. Our study's finding aligns with research by Miller *et al.*, who suggested that tenderness is largely a mechanical response to injection rather than something that can be mitigated by the Application of external methods such as cold or Pressure. This suggests that the pain relief provided by Cold Application and Shot Blocker may not significantly affect tenderness, as it is a consequence of the injection itself rather than a reduction in inflammatory mediators.

Swelling is another common post-injection complication, and our results indicated that the Cold Application, Manual Pressure, and Shot Blocker techniques all led to significantly less swelling compared to the Standard Procedure. Cold Application, in particular, was associated with the greatest reduction in swelling, which is consistent with previous studies highlighting the anti-inflammatory effects of cold therapy [5]. Cold Application has been shown to limit the spread of inflammatory mediators and decrease vascular permeability [10]. The Shot Blocker also significantly reduced swelling compared to the Control Group, which may be attributed to the device's ability to modulate sensory input and reduce the body's inflammatory response [13]. These findings are supported by studies such as those by [12] who found cold therapy to be particularly effective at managing swelling after injections.

Interestingly, the Manual Pressure group showed a moderate reduction in swelling compared to the Control Group, but the effect was less pronounced than Cold Application and Shot Blocker. This suggests that while Pressure may help with reducing swelling, its effects are likely due to transient mechanical manipulation rather than a physiological reduction in inflammation [15]. The overall reduction in swelling across experimental groups suggests that non-pharmacological interventions like Cold Application and Shot Blocker may be beneficial in minimising injection-related swelling in pediatric patients.

Lump formation, typically caused by extravasation of the injected substance or incorrect needle technique, was not observed in any of the groups. This is a promising finding, as lump formation can be distressing for both children and parents. Our results suggest that all techniques tested were equally effective in preventing this complication. Previous studies have indicated that proper injection techniques, including the use of smaller needles and careful handling of the injection site, can reduce the risk of lump formation.[16] Our study supports this notion, as no significant differences were noted between the groups in terms of lump formation.

The results of this study have important clinical implications, especially in pediatric settings where minimising pain and distress during medical procedures is critical. The use of Cold Application and Shot Blocker devices may offer simple and effective methods to reduce pain and swelling, potentially improving the overall experience for children undergoing injections. These interventions may be particularly valuable in reducing the need for pharmacological pain management, which can have unwanted side effectsv[11]. Moreover, these findings can inform best practices in pediatric injection techniques, emphasising the role of non-invasive approaches to improve patient comfort and compliance.

While the study provides valuable insights, there are several limitations. The relatively small sample size (N = 40) may limit the generalizability of the results, and further research with a larger cohort is necessary to validate these findings. Additionally, this study focused on immediate post-injection outcomes, and future research could explore the long-term effects of these techniques on recovery and subsequent injection experiences. Future studies could also investigate the potential effects of different injection sites or needle gauges on post-injection outcomes, as these variables were not considered in the current study.

CONCLUSIONS

In conclusion, the results suggest that Cold application, Manual pressure and Shot Blockers are effective methods for reducing pain and swelling in pediatric patients undergoing IM injections. These techniques may provide a valuable alternative to traditional injection procedures, improving patient comfort and minimising the need for pharmacological pain management. The lack of significant differences in tenderness and lump formation across groups indicates that while these interventions are effective in alleviating certain post-injection symptoms, they may not influence all aspects of the injection experience.

REFERENCES

[1] Heathcote, L.C. "Commentary: From Symptoms to Sensations: Moving toward a Normal Psychology of Somatic Experiences in Youth." *Journal of Pediatric Psychology,* vol. 44, no. 7, 2019, pp. 859–861. https://doi.org/10.1093/jpepsy/jsz043

[2] Mendes, B.V., M.D. Furlan, and M.B. Sanches. "Non-Pharmacological Interventions in Painful Needle Procedures in Children: Integrative Review." *BrJP,* vol. 5, 2022, pp. 61–67. https://doi.org/10.5935/2595-0118.20220009

[3] Birnie, K.A., et al. "Systematic Review and Meta-Analysis of Distraction and Hypnosis for Needle-Related Pain and Distress in Children and Adolescents." *Journal of Pediatric Psychology,* vol. 39, no. 8, 2014, pp. 783–808. https://doi.org/10.1093/jpepsy/jsu029

[4] Schuler, B.R., K.E. Lupi, P.M. Szumita, and M.P. Kovacevic. "Evaluating the Safety of Continuous Infusion Lidocaine for Postoperative Pain." *The Clinical Journal of Pain,* vol. 37, no. 9, 2021, pp. 657–663. https://doi.org/10.1097/AJP.0000000000000958

[5] Wang, Y., et al. "Heat and Cold Therapy Reduce Pain in Patients with Delayed Onset Muscle Soreness: A Systematic Review and Meta-Analysis of 32 Randomized Controlled Trials." *Physical Therapy in Sport,* vol. 48, 2021, pp. 177–187. https://doi.org/10.1016/j.ptsp.2020.12.009

[6] Gallagher, R.M. "Myofascial Trigger Points in Patients with Whiplash-Associated Disorders and Mechanical Neck Pain Response." *Pain Medicine,* vol. 16, no. 4, 2015, p. 829. https://doi.org/10.1111/pme.12606

[7] Yılmaz, D.A., S.Ö. Akça, and H.N. Kendirci. "Shotblocker or Cold Application; Which One Is More Effective in Reducing Anxiety and Pain Associated with the Intramuscular Injection in Children?: A Randomized Controlled Trial." *[Journal name, volume(issue), pages].*

[8] Friedrichsdorf, S.J., et al. "Pain Outcomes in a US Children's Hospital: A Prospective Cross-Sectional Survey." *Hospital Pediatrics,* vol. 5, no. 1, 2015, pp. 18–26. https://doi.org/10.1542/hpeds.2014-0084

[9] Moura, J.W., et al. "Utilization of Local Pressure Devices in Pain Management during Injections: Scoping Review." *Revista Brasileira de Enfermagem,* vol. 77, 2024, e20230399. https://doi.org/10.1590/0034-7167-2023-0399

[10] Allan, R., et al. "Cold for Centuries: A Brief History of Cryotherapies to Improve Health, Injury and Post-Exercise Recovery." *European Journal of Applied Physiology,* vol. 122, no. 5, 2022, pp. 1153–1162. https://doi.org/10.1007/s00421-022-04942-y

[11] Turner, H.N., and M. Czarnecki. "Opportunities before You." *Pain Management Nursing,* vol. 18, no. 4, 2017, pp. 191–192. https://doi.org/10.1016/j.pmn.2017.06.007

[12] Mohammady, M., and N. Sadeghi. "Effect of Cold Application on Bruising and Pain Following Heparin Subcutaneous Injection: A Systematic Review and Meta-Analysis." *Journal of Nursing Scholarship,* vol. 52, no. 6, 2020, pp. 634–642. https://doi.org/10.1111/jnu.12599

[13] Naser, S.A., and S. Al-Fayyadh. "Impact of Shot Blocker on Alleviating Peripheral Intravenous Cannulation Associated Pain among School-Aged Children: A Randomized Controlled Trial." *The Malaysian Journal of Nursing,* vol. 16, no. 2, 2024, pp. 74–86. https://doi.org/10.31674/mjn.2024.v16i02.011

[14] Sivri Bilgen, B., and S. Balcı. "The Effect on Pain of Buzzy® and ShotBlocker® during the Administration of Intramuscular Injections to Children: A Randomized Controlled Trial." *Journal of Korean Academy of Nursing,* vol. 49, no. 4, 2019, pp. 486–494. https://doi.org/10.4040/jkan.2019.49.4.486

[15] Davis, S.N., et al. "Partner Behavioral Responses to Pain Mediate the Relationship between Partner Pain Cognitions and Pain Outcomes in Women with Provoked Vestibulodynia." *The Journal of Pain,* vol. 16, no. 6, 2015, pp. 549–557. https://doi.org/10.1016/j.jpain.2015.03.010

[16] Hayakawa, I., and M. Kubota. "Digital Amputation by Congenital Insensitivity to Pain with Anhidrosis." *The Journal of Pediatrics,* vol. 208, 2019, p. 290. https://doi.org/10.1016/j.jpeds.2018.12.046