ORIGINAL RESEARCH

DOI: 10.4274/globecc.galenos.2023.30974
Glob Emerg Crit Care 2024;3(1):7-12

The Effect of Infrared Vein Finder on Fear of Pain During Peripheral Venous Catheterization at the Emergency Department

Cansu Uğraş Arıaslan[1], İlknur Çalışkan[2], Yunus Emre Arık[3]

[1]Bandırma Training and Research Hospital, Clinic of Emergency, Balıkesir, Türkiye
[2]İzmir Tınaztepe University Faculty of Health Sciences, Department of Nursing, İzmir, Türkiye
[3]University of Health Sciences Türkiye, Şişli Hamidiye Etfal Training and Research Hospital, Clinic of Emergency, İstanbul, Türkiye

Abstract

Objective: Peripheral venous catheterization (PVC) is one of the most common and invasive procedures performed in the emergency department (ED). The use of technologies to improve efficiency and reduce pain is important. This study aimed to reveal the effect of an infrared vein finder (IVF) on pain and fear of pain (FOP) during PVC.

Materials and Methods: This prospective randomized study was conducted with 200 patients who underwent PVC at the ED. The patients were randomized into two groups: IVF and control groups. PVC was applied to the control group using the conventional method. In the IVF group before PVC, patients were informed about IVF devices and PVC performed using them. The fear of pain-3 questionnaire (FPQ-3) before the procedure and the numerical pain scale (NRS) after the procedure were applied for both groups. FPQ-3, NRS scores, and PVC success rates were analyzed.

Results: Two hundred patients participated in the study. The mean age was, 33.3±11.2 for IVF and 32.5±10.2 for control group. The success rate in the first attempt was 92% (n=92) in the IVF group and 97% (n=97) in the control group (p=0.121). The mean total scores were; 78.8±21.5 8 in the IVF group and 85.8 ±22.0 in the control group (p=0.025). The groups were compared in terms of severe pain, minor pain, and medical pain scores, and there was only a difference in minor pain scores (p=0.021). The mean NRS score in the IVF group was 2.56±1.25, control group was 2.94±1.58 (p=0.121). The correlations between NRS and subgroups were; "severe pain" (r=0.407, p<0.001), "minor pain" (r=0.534, p<0.001) and "medical pain" scores (r=0.390, p<0.001) in the IVF group.

Conclusion: Although the use of IVF for venous catheterization reduces the FOP in adults but does not reduce pain and severe pain fear, it only reduces the fear of minor pain and does not affect the success of the procedure.

Keywords: Pain, fear of pain, vein, catheterization, infrared vein finder

Introduction

Peripheral venous catheterization (PVC) is one of the most common procedures in the emergency department (ED), and approximately 1.2 billion intravenous (IV) cannulation procedures are performed annually worldwide [1]. PVC is an invasive procedure that involves inserting a sterile catheter through the patient's skin into the peripheral vein. The peripheral venous catheter is crucial for fluid electrolyte therapy, blood and blood product transfusion, IV drug administration and nutritional support [2]. In addition, PVC has various complications such as phlebitis, dislodgement, occlusion, and pain [3]. One of the most important factors affecting complications in peripheral vein catheterization is the experience of the healthcare provider [4]. Rapid IV catheterization is important for effective resuscitation in patients with trauma, shock, and burns admitted to the ED. Conditions such as vascular problems due to IV drug use, age (elderly, child), peripheral edema, hypothermia, and dehydration can cause obstacles in the IV catheter procedure

Address for Correspondence: Yunus Emre Arık, University of Health Sciences Türkiye, Şişli Hamidiye Etfal Training and Research Hospital, Clinic of Emergency, İstanbul, Türkiye
Phone: +90 544 580 09 10 **E-mail:** dryunusemrearik@gmail.com **ORCID-ID:** orcid.org/0000-0002-4521-9546
Received: 24.06.2023 **Accepted:** 29.09.2023

[5,6]. In such patients, emergency team members may not be able to localize the vein and insert the catheter blindly. IV cannulation is a painful procedure that affects cognitive abilities by increasing pain and fear of pain (FOP), and this blind intervention may increase the number of attempts and increase the patient's pain [7,8]. Pain is a condition that negatively affects a person's physical, psychosocial, and social life. Therefore, controlling the patient's pain, increasing the patient's comfort, and minimizing the complications related to pain are important in reducing the length of stay in the ED [9]. FOP was evaluated as a condition affected by pain and can be defined as a verbal, behavioral, and physiological response to the possibility of current or potential pain [10]. In recent years, the use of technologies to improve efficiency and reduce pain in painful procedures such as PVC has become more important. In this regard, infrared vein finder (IVF) devices have been used, especially in patients in whom peripheral catheterization is difficult [11]. This study was conducted to reveal the effect of the IVF on pain and FOP in patients who underwent PVC in the ED.

Materials and Methods

Patients and Study Design

This prospective randomized observational study was conducted between June 2 and September 30, 2019 in the ED of University of Health Sciences Türkiye, İstanbul Şişli Hamidiye Etfal Training and Research Hospital, which is a tertiary hospital and has approximately 150,000 admissions to the ED annually. The study was approved by the Local Ethics Committee of University of Health Sciences Türkiye, İstanbul Şişli Hamidiye Etfal Training and Research Hospital (approval number: 2402, date: 14.05.2019). The inclusion criteria were; older than 18 years, patients with PVC indication in the ED, conscious, patients with at least one previous PVC experience, and no communication barrier. Exclusion criteria were; younger than 18 years old, infection, burn, vascular disorder, and neurological sequelae in the extremity planned for catheterization. Two groups were formed the IVF group and the control group according to simple randomization. The researchrandomizer.com website was used for randomization. Power analysis (G*Power 3.1.9.2) was used to determine the size of the sample. The α value was 0.05, the power of the study was 80%, and the effect size was between low and -medium (0.40) [12]. According to the power analysis, it was planned to include 100 patients in the IVF group and 100 patients in the control group. A total of 312 patients were evaluated for eligibility, and 112 patients were excluded because they did not meet the inclusion criteria or refused to participate in the study. A total of 200 patients participating in the study were analyzed.

Control Group

Peripheral catheterization was performed using the conventional method in patients in the control group. The following steps were applied according to the conventional method; the patient was informed about the procedure and informed consent was obtained. The fear of pain questionnaire-3 (FPQ-3) [13] and the numeric pain rating scale (NRS) [14] were explained to the patients, and the FOP 3 scale was administered. Antecubital skin antisepsis was provided. A tourniquet was applied 10-15 cm above the area where the procedure will be performed, and an appropriate peripheral venous catheter was placed. NRS was administered the patients after the procedure.

IVF Group

The following steps were performed; before intervention, the patient was informed about the procedure and informed consent was obtained. The use and function of the IVF are explained. The FPQ-3 and the NRS were explained to the patients, and the FOP 3 scale was administered. Then, routine peripheral venous catheter insertion was performed using the AccuVein AV400 IVF. NRS was administered the patients after the procedure. In both groups, PVC was administered by a nurse with 7 years of emergency room experience.

FPQ-3

The FPQ is a 30-item self-report measure of pain-related fear designed to tap fear related to severe pain (e.g. "breaking your leg"), minor pain (e.g. "getting a paper-cut on your finger"), and medical pain (e.g. "receiving an injection in your hip/buttocks"). Items are scored on a 5-point Likert scale ranging from 1 (not at all) to 5 (extreme) [13].

NRS

The NRS is one of the most preferred and easily applied scales in pain assessment. Absence of pain is scored 0 (zero), and extreme pain is scored 10 (ten). In this way, the patient is asked to express the appropriate pain score [15].

Statistical Analysis

Statistical analysis was performed using the SPSS 21 package program. Mean, standard deviation, median, minimum, and maximum values were used for descriptive statistics for continuous variables, and numbers and percentages were used for categorical variables. Compliance with normal distribution was checked using the Kolmogorov-Smirnov test. T-test (Student's t-test) was used in independent groups with normal distribution and Mann-Whitney U test was used in cases not showing normal distribution. Differences in three or more groups were used for ANOVA in the variables that provided the normality assumption and the Kruskal-Wallis test

in the variables that did not provide the normality assumption. Correlation analysis was performed while examining the relationship between continuous variables. Statistically, $p<0.05$ was considered significant.

Results

The flow chart of the study is shown in Figure 1 and the demographic characteristics of the patients participating in the study are given in the table below (Table 1).

Information about the PVC, patients' previous experience about PVC, inserted catheter sizes, discomfort with the idea of PVC, FOP during catheterization, and number of attempts are summarized in Table 2.

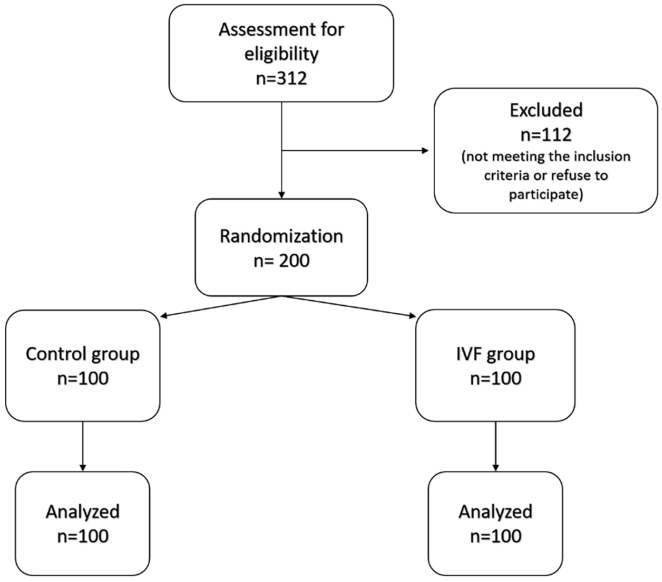

Figure 1. Flowchart of the study, IVF: Infrared vein finder

The total and subgroup FOP 3 scale scores of the patients were calculated. The mean total score of the patients were; 78.8±21.5 8 (minimum: 41.0-maximum: 148.0) in the IVF group and 85.8±22.0 (minimum: 44.0-maximum: 150.0) in the control group ($p=0.025$). The scale subgroup "minor pain" score was compared for all variables. When the groups were compared, this score was found to be different ($p=0.021$) and was higher in the control group. Although the "severe pain" score was lower in the IVF group, it was not statistically different ($p=0.088$) (Table 3).

The mean NRS score of the patients in the IVF group was 2.56±1.25 (minimum: 1.00, maximum: 6.00), and the mean score of the patients in the control group was 2.94±1.58 (minimum: 1.00, maximum: 7.00). Considering the NRS scores of the IVF and control groups, the IVF group score was lower but statistically similar to the control group ($p=0.121$) (Table 4).

The correlation between the patients' FPQ-3 scores and NRS scores were analyzed. There was a moderate positive correlation between the NRS score and the "severe pain" ($r=0.407$, $p<0.001$), "minor pain" ($r=0.534$, $p<0.001$) and "medical pain" scores ($r=0.390$, $p<0.001$) in the intervention group (Table 5).

According to the regression analysis; one-point increase in FPQ-3 total score increased NRS 0.03 points in the IVF group ($R^2=0.282$, $p<0.001$) and 0.05 points in the control group ($R^2=0.464$, $p<0.001$). Considering the subgroups of FPQ-3, it was found that a one-point increase in "severe pain" score

Table 1. Comparison of the descriptive characteristics of intervention and control group patients

		IVF group		Control group		Statistical test	
						χ^2 or t	p
Age		33.3±11.2		32.5±10.2		0.508*	0.612
		n	%	n	%		
Sex	Female	63	63.0	62	62.0	0.021	0.884
	Male	37	37.0	38	38.0		
Marital status	Married	50	50.0	52	52.0	0.080	0.777
	Single	50	50.0	48	48.0		
Comorbidities	Yes	19	19.0	30	30.0	3.271	0.071
	No	81	81.0	70	70.0		
Number of comorbidities	1	16	84.2	25	83.3	0.007	0.935
	>1	3	15.8	5	16.7		
Hospitalization history	Yes	58	58.0	62	62.0	0.333	0.564
	No	42	42.0	38	38.0		

Descriptive statistics are summarized as mean ± standard deviation, and other categorical variables as number (n) and percentage (%).

*T-test was applied, and chi-square (χ^2) test was used for other variables.

IVF: Infrared vein finder

increased NRS by 0.06 points in the IVF group (R^2=0.167, p<0.001) and 0.09 points in the control group (R^2=0.270, p<0.001). One-point increase in "minor pain" score increased NRS 0.09 in IVF group (R^2=0.297, p<0.001) and 0.11 points in control group (R^2=0.309, p<0.001). Also, one-point increase in "medical pain" score increased NRS 0.06 in IVF group (R^2=0.184, p<0.001) and 0.11 points in control group (R^2=0.388, p<0.001) (Table 6).

Discussion

Peripheral venous catheter intervention in the ED causes moderate pain and anxiety. There are several methods such as the use of local anesthetics, ultrasonography, and local ethyl chloride to reduce pain and anxiety and increase the success of the intervention [2,5,8]. Although most of the patients in our study had previous PVC experience, they were still afraid of this procedure. The demographic characteristics of the groups

Table 2. Information about peripheral venous catheterization

Parameters	IVF group		Control group		Statistical test	
	n	%	n	%	χ^2	p
Number of previous PVC experiences						
1	12	12.0	20	20.0	5.052	0.168
2	14	14.0	8	8.0		
3	5	5.0	9	9.0		
≥4	69	69.0	63	63.0		
Catheter size						
22 G-24 G	26	26.0	20	20.0	1.016	0.313
18 G-20 G	74	74.0	80	80.0		
Discomfort with the PVC idea						
Yes	48	48.0	44	44.0	0.322	0.570
No	52	52.0	56	56.0		
Fear of PVC pain						
Yes	59	59.0	52	52.0	0.992	0.319
No	41	41.0	48	48.0		
Number of PVC attempts						
1	92	92.0	97	92.0	2.405	0.121
≥1	8	8.0	3	3.0		

Variables are summarized as numbers (n) and percentages (%). Chi-square (χ^2) test was used for analysis. IVF: Infrared vein finder, G: Gauge, PVC: Peripheral venous catheterization

Table 3. FPQ-3 scores of the IVF and control groups

	IVF group		Control group		Statistical test	
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	t/U	p
Severe	32.5±8.7	33.0 (14.0-50.0)	34.4±8.8	35.0 (15.0-50.0)	-1.531	0.127*
Minor	21.7±7.7	21.0 (10.0-50.0)	24.3±8.2	23.0 (11.0-50.0)	4055.5	0.021**
Medical	24.7±8.8	23.0 (10.0-48.0)	27.0±9.4	27.5 (11.0-50.0)	4302.0	0.088**
Total	78.8±21.5	75.0 (41.0-148.0)	85.8±22.0	84.5 (44.0-150.0)	-2.261	0.025*

FPQ-3: Fear of pain-3 questionnaire, IVF: Infrared vein finder, SD: Standard deviation, min-max: Minimum-maximum

*T-test, **Mann-Whitney U test

Table 4. Comparison of the NRS scores of the groups

	IVF group	Control group	Statistical test	
	Mean ± SD	Mean ± SD	Mann-Whitney U	p
NRS score	2.6±1.3	2.9±1.6	4380.5	0.121

NRS: Numeric pain rating scale, IVF: Infrared vein finder, SD: Standard deviation

Table 5. Correlation between the NRS and FPQ-3 scores

Group		Severe	Minor	Medical	Total
IVF	r	0.407	0.534	0.390	0.494
(n=100)	p	<0.001	<0.001	<0.001	<0.001
Control	r	0.497	0.518	0.586	0.645
(n=100)	p	<0.001	<0.001	<0.001	<0.001

FPQ: Fear of pain questionnaire, NRS: Numeric pain rating scale, IVF: Infrared vein finder, r: Correlation coefficient

Table 6. Effect of the FPQ-3 scale subgroups on NRS scores

Group	Severe			Minor			Medical		
	a	b	R^2	a	b	R^2	a	b	R^2
IVF	0.626	0.06	0.167	0.628	0.09	0.297	1.050	0.06	0.184
Control	-0.288	0.09	0.270	0.313	0.11	0.309	0.09	0.11	0.388

FPQ: Fear of pain questionnaire, NRS: Numeric pain rating scale, IVF: Infrared vein finder a: Constant term, b: Regression coefficient

were similar in terms of age and gender. In a randomized controlled study conducted by Aulagnier et al. [16] in which the use of IVF devices in the emergency room was investigated, the average age of the participants was higher than that in this study, and the demographic characteristics were similar in the intervention and control groups.

Considering the effect of the IVF on the number of PVC attempts, the number of vascular accesses in the first attempt in the IVF group was 92 (92%); in the control group, the success of the first attempt was 97 (97%), and there was no statistically significant difference between them (p=0.121). In the study conducted by Aulagnier et al. [16], no significant difference was found between the intervention and control groups in terms of the number of interventions. Curtis et al. [17] showed that there was no significant difference in the number of interventions between ultrasonography, IVF, and the standard approach in the pediatric population. In the study of De Graaff et al. [18] with 1,913 pediatric patients, it was found that the IVF device had no effect on the number of interventions and PVC success. On the other hand, Demir and Inal [19] and Inal and Demir [20] have shown that IVF increases the success of PVC intervention in their studies in the 3-18 and 0-3 age groups. As mentioned above, IVF devices appear to be more effective in the pediatric population than in adults.

The total FPQ-3 scores and the minor pain scores were found to be lower in the IVF group. IVF devices are not effective enough to reduce the fear of severe pain but may help reduce the fear in those with a mild FOP. Therefore, although it is seen that IVF results in a decrease in the total pain scores, it is thought that it would not be appropriate to use them to reduce the fear and anxiety of the patients, especially in those who have severe FOP. A moderate positive correlation was found between the FPQ-3 subgroups (minor, severe, medical), total pain scores, and NRS scores. There was no strong correlation between the NRS and FPQ-3 scores.

There was no statistically significant difference between the control and IVF groups' NRS scores. Aulagnier et al. [16] also showed that IVF has no effect on pain. In a study with 450 patients with hemophilia, IVF reduced pain in patients with difficult vascular access but had no effect on pain in patients without difficult vascular access [21]. On the other hand, it has been shown that the use of IVF in the pediatric population reduces pain, especially in patients younger than 3 years of age [20,22,23]. Therefore, IVF devices seem to be more effective in reducing pain in the pediatric population than in adults.

Conclusion

Although the use of IVF for venous catheterization reduces the FOP in adults, it does not reduce the fear of severe pain; it only reduces the fear of minor pain and does not affect the success of the procedure. More studies are needed in adults because most of the studies were conducted in the pediatric population.

Ethics

Ethics Committee Approval: The study was approved by the Local Ethics Committee of University of Health Sciences Türkiye, İstanbul Şişli Hamidiye Etfal Training and Research Hospital (approval number: 2402, date: 14.05.2019).

Informed Consent: Required informed consent was obtained from the study participants.

Authorship Contributions

Surgical and Medical Practices: C.U.A., Y.E.A., Consenp: C.U.A., İ.Ç., Design: C.U.A., İ.Ç., Y.E.A., Data Collection or Processing: C.U.A., İ.Ç., Y.E.A., Analysis or Interpretation: C.U.A., İ.Ç., Y.E.A., Literature Search: C.U.A., İ.Ç., Y.E.A., Writing: C.U.A., İ.Ç., Y.E.A.

Conflict of Interest: No conflicts of interest were declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. van Loon FH, Puijn LA, van Aarle WH, Dierick-van Daele AT, Bouwman AR. Pain upon inserting a peripheral intravenous catheter: Size does not matter. J Vasc Access. 2018;19:258-65.
2. Patacsil EG, Patacsil AV. Method and apparatus for ultrasound guided intravenous cannulation. 2000; U.S. Patent No. 6,132,379. Chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://patentimages.storage.googleapis.com/74/0f/84/452adad7292240/US6132379.pdf.
3. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: An observational prospective study. J Clin Nurs. 2019;28:1585-99.
4. Dychter SS, Gold DA, Carson D, Haller M. Intravenous therapy: a review of complications and economic considerations of peripheral access. J Infus Nurs. 2012;35:84-91.
5. Witting MD, Schenkel SM, Lawner BJ, Euerle BD. Effects of vein width and depth on ultrasound-guided peripheral intravenous success rates. J Emerg Med. 2010;39:70-5.
6. Kuensting LL, DeBoer S, Holleran R, Shultz BL, Steinmann RA, Venella J. Difficult venous access in children: taking control. J Emerg Nurs. 2009;35:419-24.
7. Walker E. Piloting a nurse-led ultrasound cannulation scheme. Br J Nurs. 2009;18:854,856,858-9.
8. Aponte H, Acosta S, Rigamonti D, Sylvia B, Austin P, Samolitis T. The use of ultrasound for placement of intravenous catheters. AANA J. 2007;75:212-6.
9. Korkan EA, Uyar M. Ağrı kontrolünde kanıt temelli yaklaşım: Refleksoloji. Acıbadem Üniversitesi Sağlık Bilimleri Dergisi. 2014:9-14.
10. Durand G, Plata EM. The effects of psychopathic traits on fear of pain, anxiety, and stress. Pers Individ Differ. 2017;119:198-203.
11. Fadhil Al-Saadi S, Karimi Moonaghi H, Al-Fayyadh S, Bakhshi M. Vein Visualization Using Near Infrared (NIR) Vein Finder Technology in Nursing Care: A Review of the Benefits and Shortcomings. Med Edu Bull. 2022;3:393-400.
12. Sun CY, Lee KC, Lin IH, Wu CL, Huang HP, Lin YY, et al. Near-infrared light device can improve intravenous cannulation in critically ill children. Pediatr Neonatol. 2013;54:194-7.
13. McNeil DW, Rainwater AJ 3rd. Development of the Fear of Pain Questionnaire--III. J Behav Med. 1998;21:389-410.
14. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole MR. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. 2001;94:149-58.
15. Kahl C, Cleland JA. Visual analogue scale, numeric pain rating scale and the McGill pain Questionnaire: an overview of psychometric properties. Phys Ther Rev. 2005;10:123-8.
16. Aulagnier J, Hoc C, Mathieu E, Dreyfus JF, Fischler M, Le Guen M. Efficacy of AccuVein to facilitate peripheral intravenous placement in adults presenting to an emergency department: a randomized clinical trial. Acad Emerg Med. 2014;21:858-63.
17. Curtis SJ, Craig WR, Logue E, Vandermeer B, Hanson A, Klassen T. Ultrasound or near-infrared vascular imaging to guide peripheral intravenous catheterization in children: a pragmatic randomized controlled trial. CMAJ. 2015;187:563-70..
18. De Graaff JC, Cuper NJ, Mungra RAA, Vlaardingerbroek K, Numan SC, Kalkman CJ. Near-infrared light to aid peripheral intravenous cannulation in children: a cluster randomised clinical trial of three devices. Anaesthesia. 2013;68:835-45.
19. Demir D, Inal S. Does the Use of a Vein Visualization Device for Peripheral Venous Catheter Placement Increase Success Rate in Pediatric Patients? Pediatr Emerg Care. 2019;35:474-9.
20. Inal S, Demir D. Impact of Peripheral Venous Catheter Placement With Vein Visualization Device Support on Success Rate and Pain Levels in Pediatric Patients Aged 0 to 3 Years. Pediatr Emerg Care. 2021;37:138-44.
21. Guillon P, Makhloufi M, Baillie S, Roucoulet C, Dolimier E, Masquelier AM. Prospective evaluation of venous access difficulty and a near-infrared vein visualizer at four French haemophilia treatment centres. Haemophilia. 2015;21:21-6.
22. Chapman LL, Sullivan B, Pacheco AL, Draleau CP, Becker BM. VeinViewer-assisted Intravenous catheter placement in a pediatric emergency department. Acad Emerg Med. 2011;18:966-71.
23. Çağlar S, Büyükyılmaz F, Bakoğlu İ, İnal S, Salihoğlu Ö. Efficacy of Vein Visualization Devices for Peripheral Intravenous Catheter Placement in Preterm Infants: A Randomized Clinical Trial. J Perinat Neonatal Nurs. 2019;33:61-7.