BMC Nursing

RESEARCH

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Comparison of peripheral intravenous catheterization applied to different anatomical sites in terms of pain, phlebitis and infiltration

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Abstract

Aim This study was conducted to compare peripheral intravenous catheterization (PIVC) at different anatomical sites in terms of pain, phlebitis and infiltration.

Material and methods The study was a comparative-descriptive study. The population of the study consisted of all adult patients being treated and receiving intravenous drug therapy in a state hospital. The sample of the study consisted of a total of 154 patients who met the inclusion criteria for the study and were selected by non-probability sampling method. The "Patient Information Form" created by the researchers, "Phlebitis and Infiltration Scale" and "Visual Analogue Scale (VAS)" were used to collect data.

Results In the study, it was determined that there was no significant difference between the degree of phlebitis, time of phlebitis and degree of infiltration between the PIVC applied upper hand, forearm and antecubital regions ($p > 0.05$), but there was a significant difference between the regions in terms of pain ($p < 0.05$). It was determined that the severity of pain upper hand was significantly higher than the other groups.

Conclusion PIVC's applied at different anatomical sites were similar in terms of the risk of phlebitis and infiltration, but pain intensity was much higher upper hand. It has been determined that various factors related to the patient, nurse and other variables affecting the level of phlebitis, infiltration and pain are effective.

Keywords Infiltration, Nurse, Pain, Phlebitis, PIVC

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Introduction

The demand for peripheral intravenous catheterization (PIVC), which is used in the care of millions of patients worldwide, applied at least once to 80% of hospitalized patients, and used to administer intravenous (IV) therapy, is increasing day by day [1, 2]. Peripheral intravenous catheters are materials made of polyurethane and plastic, packaged in sterile packages for intravenous administration, produced in different diameters and lengths according to the patient's age, vascular structure and the treatment to be applied [3]. PIVC is a very advantageous technique that is frequently used to eliminate the fluid electrolyte imbalance of the individual, to administer medication, to meet the nutritional needs of the individual, to provide transfusion of blood and blood products, and to quickly demonstrate the effectiveness of the drug in critically ill patients [4, 5]. For PIVC application, it is recommended to prefer areas that do not restrict the patient's movement and enable participation in self-care when necessary, minimize the risk of catheter dislodgement or obstruction and pain [5].

PIVC application is the most frequently applied invasive interventions in health care systems under the responsibility of nurses, it also brings many complications [6]. Many complications such as phlebitis, infiltration, extravasation, pain, local infection, ecchymosis, haematoma, thrombophlebitis, embolism, pulmonary oedema may develop due to PIVC application [7, 8]. It is estimated that the complications related to PIVC are much more extensive and extensive than those mentioned; in addition, it is estimated that approximately 70–90% of individuals with PIVC may develop various complications that may prolong the hospital stay for approximately 22 days [6]. These complications disrupt the comfort of patients, causing unnecessary diagnostic procedures and treatment, delay in treatment, increased cost, stress of patients, and increased workload of healthcare personnel [7, 9]. In order to overcome these negative situations, current guidelines and evidence-based practice recommendations should be taken into consideration in care practices. In the guideline of the CDC, it is recommended that healthcare workers should be trained (IA) on the necessity/indications for the use of PIVCs, their application and care, side effects that may occur and infection control measures, and that trainings should be repeated and continuous according to current information [10].

The most common complications of PIVC application are phlebitis and infiltration and pain [11]. Looking at the literature on these complications, Abolfotouh et al., found that phlebitis occurred in the first place and pain in the second place [12]. Marsh et al., reported that phlebitis and infiltration developed very frequently [13]. Pain, which is among the complications of PIVC, is a condition caused by incorrect and repeated interventions [14]. It has been reported that especially metacarpal veins may cause a lot of pain, and antebrachial and basilic veins may also cause pain and disrupt the patient's comfort [15]. Infiltration and phlebitis are serious complications that negatively affect quality of life by causing pain, prolong the duration of care, increase cost and morbidity, and cause discomfort in patients [1]. These complications can be reduced by selecting the appropriate site for PIVC application and using evidence-based practice guidelines [16].

Within the framework of this purpose, this study was conducted to evaluate the comparison of peripheral intravenous catheterization applied to different sites in terms of pain, phlebitis and infiltration.

Material and methods

Study design

The research is a comparative-descriptive type study. The study was conducted in a state hospital in eastern Turkey between September and November 2022 with inpatients.

Participants and sampling

The population of the study consisted of all adult patients receiving intravenous drug therapy in a state hospital. All adult patients hospitalised in the relevant hospital constituted the population of the study. Power analysis was performed to determine the sample size to be included in the study. In the F test, ANOVA: Repeated measures, within factors test, it was determined that there should be 36 patients in each group (Effect size: 0.25, α err prob: 0.05, Power (1-ß err prob): 0.95, number of group: 3). Considering the possibility of loss during the research process, it was planned to include at least 50 patients in each group. The study sample consisted of 154 patients who met the inclusion criteria and were selected by non-probability sampling method, 51 of whom had peripheral intravenous catheters dorsum of the hand, 52 in the forearm and 51 in the antecubital region. Patients from emergency, internal services, surgical services, intensive care units were selected by simple random sampling method.

Inclusion and exclusion criteria

Inclusion criteria Patients who could be contacted, who did not have any psychiatric disorder, who did not have ecchymosis, haematoma, scar tissue or infection in the areas where PIVC application was performed, who continued IV treatment and who volunteered to participate in the study were included in the study.

Exclusion criteria Patients who left the hospital (discharged) before completing the 72-hour observation period required for the evaluation of pain, phlebitis, infiltration at the IV catheter site; patients receiving chemo-

therapy or immunosuppressive treatment; patients who withdrew from participation in the study while the study was ongoing were excluded from the study. 7 patients who were included in the study were excluded from the study because they left the hospital without completing the 72-hour observation period required for infiltration evaluation, and the study was completed with a final number of 154 people.

Data collection and instruments

The clinics where the data would be collected and the number of patients hospitalised (N:540) in these clinics were determined by contacting the statistics unit in the hospital where the study was conducted. Data collection continued until the sample size (n: 50 for each group) determined by power analysis was reached.

Data were collected from patients with peripheral intravenous catheters by face-to-face interviews and observation by the charge nurses and researchers. Intravenous peripheral catheter site was observed at the first moment of catheter insertion and for 72 h. In the clinics where the data were collected, charge nurses were informed and their help was obtained in observing the patients who underwent PIVC.

Data collection stages

- Information about the patient (age, gender, BMI) and intravenous catheter application (clinic, catheter type, application site, etc.) were collected by the researcher face-to-face and from patient files.
- The level of pain felt by the patients during PIVC was also evaluated by the researcher by asking the patients.
- The duration of professional experience of the nurses applying PIVC was also recorded by asking the nurses.
- For the evaluation of phlebitis and infiltration, co-operation was made with the charge nurses in the clinics. The researchers visited the clinics every 12 h and evaluated the PIVC area together with the clinic charge nurse. During the hours when the researchers was not in the clinics, we asked the responsible nurse to record the situations such as dislodgement and replacement related to PIVC.
- Patients who developed other complications such as catheter dislodgement, occlusion, etc. and who had a new catheter inserted were excluded from the study. While collecting the data, the patients were informed about the study and consent was obtained.

Data collection instruments

"Patient Information Form", "Phlebitis and Infiltration Scale" and "Visual Analogue Scale (VAS)" were used for data collection and each interview lasted an average of 10 min and observation lasted 72 h. The researchers evaluated the information of the patients in the patient information form by interviewing the patients face to face; the peripheral intravenous catheter characteristics, the materials used, the phlebitis and infiltration status in the peripheral intravenous catheter area were evaluated by observation. Data collection took approximately 2 months.

Patient information form It is a form developed by the investigators, consisting of a total of 9 questions questioning the descriptive characteristics of the patients and the characteristics related to peripheral intravenous catheter application (catheter number, dosiflow use, body part where the catheter is applied, area where the catheter is inserted). Questions 1–3 include questions about demographic characteristics of the patient and questions 4–9 include questions about peripheral IV catheter application. Within the 9 questions, there are fields that the patient will answer and the practitioner will fill in by observing. This form was prepared by the researchers in line with the relevant literature [5, 12, 13].

Phlebitis and infiltration scale Phlebitis and Infiltration Scale developed by the Intravenous Nurses Association was used to determine the status and degree of phlebitis and infiltration development [17]. The scales, whose psychometric properties were evaluated by Groll et al., are recommended for use worldwide [18]. In these scales, grading is made according to the symptoms at the catheter entry site. These rating values are between 0–4. As the symptoms increase, the grading values also increase. While '0' indicates that there are no symptoms for both scales, symptoms increase and diversify as the values increase. Grade "1" for the phlebitis scale: Redness and/or pain at the catheter entry site, Grade "2": Redness, pain and/or oedema at the catheter entry site, Grade "3": Redness, pain, red line, cable-like palpation of the vein at the catheter entry site, Grade "4": Redness, pain, red line, cable-like palpation of the vein at the catheter entry site and longer than 2.5 cm, purulent discharge.

Grade "1" for the infiltration scale: Blanching of the skin, diffuse oedema less than 2.5 cm at the catheter entry site, coldness of the skin, may/may not have pain at the site, Grade "2": Blanching of the skin, oedema between 2.5 and 15 cm in the area, coldness of the skin, may/may not have pain in the area, Grade "3": Whitening of the skin, translucent appearance, diffuse oedema greater than 15 cm in the catheter entry area, coldness of the skin, mild to moderate pain, numbness may be present, Grade "4": Skin whitening translucent appearance, tense, oozing skin, swollen, bruised, discoloured skin, diffuse oedema greater than 15 cm in the catheter entry

area, tissue oedema leaving deep pits, poor circulation, moderate to severe pain, blood, irritant or non-vesicant substance in the area [18].

Visual analogue scale (VAS) The scale is used to measure perceived pain on an individual basis. Price et al., developed it in 1983 to measure perceived pain. The VAS is a 10 cm ruler with 0 (0 = no pain) at one end and the most severe pain (10 = unbearable pain) at the other end. The patients participating in the study are told that they should mark the appropriate place on the ruler according to the severity of their pain. The distance between the no pain point and the point marked by the patient is recorded in centimetres [19].

Data analysis

The data were analysed using the IBM SPSS Statistics 23.0 program. The normality of the distribution of the data was tested using Shapiro Wilk test and Q-Q plots. The descriptive statistics included frequencies, percentages, means and standard deviations. The data were analysed using independent-samples t-test, Mann-Whitney U test, analysis of variance (ANOVA), Kruskal-Wallis test and Fisher Ki-square test. The level of statistical significance was accepted as $p < 0.05$.

In order to evaluate the reliability of the measurements made by two independent observers, Intraclass Correlation Coefficient (ICC) analysis was applied. Two-Way Random Effects Model was used for the analysis and the calculation was based on absolute agreement. ICC interpretation was based on the classification of Koo & Li (2016) '0.00–0.50: Poor agreement; 0.50–0.75: Moderate agreement; 0.75–0.90: Good agreement; 0.90–1.00: Excellent agreement' [20].

Ethical considerations

Before the start of the study, ethical approval was obtained from the Bingol University Health Sciences Scientific Research and Publication Ethics Committee and institutional permission (Decision number: 2022/15) was obtained from the relevant hospital. At the same time, the purpose of the research was explained to the patients, their verbal/written consent was obtained and they were informed that they could withdraw from the research at any time. Confidentiality of patient data and identity information was ensured. The research was conducted in accordance with the Principles of the Declaration of Helsinki.

Results

In the study, it was found that there was no significant difference between the socio-demographic (age, gender, BMI) and PIVC application-related characteristics of the patients according to the regions where the catheter was applied ($p > 0.05$). This result is important in terms of showing the similarity of the groups (Table 1).

It was found that there was no significant difference between the degree of phlebitis, time of phlebitis and degree of infiltration according to PIVC applied to different anatomical sites ($p > 0.05$). However, the pain level of the patients who underwent PIVC dorsum of the hand was significantly higher than the others ($p < 0.05$) (Table 2).

In the study, it was found that the degree of phlebitis varied significantly according to the unit where the patients were currently hospitalized, the duration of catheter stay in the vein and the duration of experience of the nurses applying the catheter ($p < 0.05$). It was found that the degree of infiltration varied significantly according to the unit where the patients were hospitalized and the frequency of catheter application ($p < 0.05$). When the pain associated with PIVC application was examined in the study, it was found that the pain level of those who had the catheter in the vein for 49–72 h, those who used dosiflow and those who had more than 3 years of experience ($p < 0.05$) (Table 3).

Intraclass Correlation Coefficient (ICC) values between two independent observers are presented in Table 4. According to the results of the analyses, the measurements show a high level of agreement for all treatments ($p < 0.001$).

The ICC values for the evaluation of the degree of phlebitis were 0.966 (95% CI [0.855–0.997]) in the above hand group, 0.945 (95% CI [0.888–0.999]) in the forearm group and 0.978 (95% CI [0.859–0.999]) in the antecubital region group.

ICC values for the evaluation of the degree of infiltration were calculated as 0.980 (95% CI [0.889–1.000]) in the on-hand group, 0.933 (95% CI [0.899–0.997]) in the forearm group and 0.978 (95% CI [0.85–0.999]) in the antecubital region group (Table 4).

Discussion

In this study, the risk of pain, infiltration and phlebitis development were evaluated between different regions where PIVC was applied and interregional comparison was made. According to the results of the study, it was determined that there was no significant difference between the dorsum of the hand, forearm and antecubital region in terms of infiltration and phlebitis risk, but there was a significant difference between the regions in terms of pain.

It was determined that the pain intensity was highest dorsum of the hand, followed by the forearm and antecubital region, respectively. When we look at the studies in the literature, Liu et al., it was determined that occlusion was most common on the dorsum of the hand and infiltration was found in the antecubital region [21]. In

Table 1 Comparison of the socio-demographic and PIVC application-related characteristics of the patients and the anatomical sites of catheterization

	Dorsum of the hand group % (*n*)	Forearm group % (*n*)	Antecubital region group % (*n*)	*Test and *p*-value
Age				
20–39 years	28.6 (8)	32.1 (9)	39.3 (11)	$x^2=8.277$ $p=0.219$
40–59 years	46.9 (23)	28.6 (14)	24.5 (12)	
60–79 years	29.5 (18)	36.1 (22)	34.4 (21)	
80 years and above	12.5 (2)	43.8 (7)	43.8 (7)	
Gender				
Male	34.8 (24)	36.2 (25)	29.0 (20)	$x^2=0.974$ $p=0.614$
Female	31.8 (27)	31.8 (27)	36.5 (31)	
BMI	23.41 ± 3.07	22.76 ± 4.31	22.21 ± 4.4	F = 0.598 $p=0.551$
The unit where the catheter is applied				
Emergency	36.4 (12)	42.4 (14)	21.2 (7)	Fisher $x^2=10.533$ $p=0.395$
Intensive care	-	66.7 (2)	33.3 (3)	
Surgical clinic	33.3 (11)	27.3 (9)	39.4 (13)	
Internal clinic	28.1 (18)	31.3 (20)	40.6 (26)	
Other	46.7 (10)	40 (13)	13.3 (2)	
Patient's hospitalization unit				
Intensive care	28.6 (8)	42.9 (12)	28.6 (8)	$x^2=1.905$ $p=0.753$
Surgical clinic	38.2 (13)	26.5 (9)	35.3 (12)	
Internal clinic	32.6 (30)	33.7 (31)	33.7 (31)	
Number of the catheter used				
20 G	43.1 (22)	26.4 (14)	32.1 (17)	$x^2=3.039$ $p=0.221$
22 G	28.7 (29)	37.6 (38)	33.7 (34)	
Length of catheter stay in the vein				
0–48 h	26.7 (16)	58.3 (35)	15 (9)	$x^2=28.547$ $p=0.051$
49–72 h	37.2 (35)	18.1 (17)	44.7 (42)	
Using dosiflow				
Yes	41.7 (30)	30.6 (22)	27.8 (20)	$x^2=0.102$ $p=0.102$
No	25.6 (21)	36.6 (30)	37.8 (31)	
Catheter insertion site				
Right upper extremity	30.8 (24)	38.5 (30)	30.8 (24)	$x^2=1.558$ $p=0.475$
Left upper extremity	35.5 (27)	28.9 (22)	35.5 (27)	
Frequency of catheter insertion				
First application	33.6 (43)	33.6 (43)	32.8 (42)	$x^2=0.08$ $p=0.961$
2 or more applications	30.8 (8)	34.6 (9)	34.6 (9)	
The way IV treatment is administered				
Infusion	47.4 (9)	36.8 (7)	15.3 (3)	Fisher $x^2=3.421$ $p=0.192$
Push infusion	31.1 (42)	33.3 (45)	35.6 (48)	
Professional experience of the nurse who applied the catheter				
< 3 years	35.3 (6)	23.5 (4)	41.2 (7)	$x^2=0.995$ $p=0.608$
≥ 3 years	32.8 (45)	35 (48)	32.1 (44)	

x^2: Chi-square test, F: ANOVA test, Fisher x^2: Fisher Chi-square test, *$p<0.05$

Table 2 Comparison of the Phlebitis-Infiltration scale and VAS results of the patients with the PIVC applied area

	Dorsum of the hand group % (*n*)	Forearm group % (*n*)	Antecubital group % (*n*)	Test and *p*
Degree of Phlebitis				
Grade 0	26.9 (21)	34.6 (27)	38.5 (30)	$x^2=3.321$ $p=0.506$
Grade 1	38.2 (13)	32.4 (11)	29.4 (10)	
Grade 2	40.5 (17)	33.3 (14)	26.2 (11)	
Time of phlebitis occurrence				
0–24 h	29 (9)	35.5 (11)	35.5 (11)	$x^2=2.761$ $p=0.599$
25–48 h	31.4 (16)	41.2 (21)	27.5 (14)	
Infiltration Degree				
Grade 0	33 (32)	34 (33)	33 (32)	$x^2=0.008$ $p=0.996$
Grade 1	33.3 (19)	33.3 (19)	33.3 (19)	
VAS	4.11 ± 2.33	3.57 ± 2.13	2.84 ± 1.97	F = 4.498 **$p=0.013$***

x^2: Chi-square test, F: ANOVA test,*$p<0.05$

contrast, Tan et al., found no significant difference in procedural pain and patient satisfaction during vascular access in the dorsum of the hand and forearm [23]. In addition, in the study conducted by Bakır and Yava, it was determined that the dorsum of the hand and forearm region was most frequently preferred for PIVC, but it was found that the anatomical region did not make a significant difference in terms of the risk of phlebitis development in patients [22]. It is thought that the fact that the pain is more on the hand may have increased due to the fact that the skin elasticity is less and the hand is exposed to external factors too much, although the less subcutaneous adipose tissue increases the vascular visibility.

In this study, it was observed that the risk of phlebitis development was similar between regions. In addition to the results indicating that the anatomical region (dorsum of the hand, forearm, wrist, antecubital fossa) does not create a significant difference in terms of phlebitis risk [22, 24], different results were also obtained. In the study conducted by Karaoğlan et al., it was stated that phlebitis developed mostly in catheters inserted in the antecubital fossa [25], while in some studies it was determined that PIVCs applied to the inner side of the forearm caused less phlebitis and could be used for a longer period of time [26, 27]. Marsh et al., found that flexion points (antecubital fossa, hand/wrist) were significantly associated with all-cause failure, infiltration/occlusion and catheter dislodgement compared to the forearm [27]. It is seen that different research results are obtained in the literature, and it is recommended that the issue should be resolved with experimental studies in order to better address the issue.

Table 3 Comparison of patients' socio-demographic and PIVC application characteristics with Phlebitis-Infiltration scale and VAS results

	Phlebitis Degree			**Infiltration Degree**		**VAS**
	Grade 0	**Grade 1**	**Grade 2**	**Grade 0**	**Grade 1**	**X ± SS**
Age						
20–39 years	53.6 (15)	17.9 (5)	28.6 (8)	82.1 (23)	17.9 (5)	3.14 ± 2.12
40–59 years	40.8 (20)	26.5 (13)	32.7 (16)	65.3 (32)	34.7 (17)	3.97 ± 2.11
60–79 years	55.7 (34)	21.3 (13)	23 (14)	54.1 (33)	45.9 (28)	3.32 ± 2.33
80 years and above	56.3 (9)	18.8 (3)	25 (4)	56.3 (9)	43.8 (7)	3.43 ± 2.03
	Fisher's $x^2 = 3.172$, $p = 0.8$			$x^2 = 6.899$, $p = 0.75$		KW = 3.958, $p = 0.266$
Gender						
Male	50.7 (35)	21.7 (15)	27.5 (19)	60.9 (42)	39.1 (27)	3.56 ± 2.25
Female	50.6 (43)	22.4 (19)	27.1 (23)	64.7 (55)	35.3 (30)	3.47 ± 2.16
	$x^2 = 0.01$, $p = 0.995$			$x^2 = 0.24$, $p = 0.624$		t = 0.264, $p = 0.792$
The unit where the patient is hospitalized						
Intensive care clinic	50 (14)	14.3 (4)	35.7 (10)	57.1 (16)	42.9 (12)	3.92 ± 2.91
Surgical clinic	82.4 (28)	14.7 (5)	2.9 (1)	88.2 (30)	11.8 (4)	3.51 ± 2.02
Internal clinic	39.1 (36)	27.2 (25)	33.7 (31)	55.4 (51)	44.6 (41)	3.90 ± 1.79
	$x^2 = 21.353$ **$p = 0.001$***			$x^2 = 11.958$ **$p = 0.003$***		KW = 1.107 $p = 0.128$
Number of the catheter used						
20 G	60.4 (32)	18.9 (10)	20.8 (11)	67.9 (36)	32.1 (17)	3.18 ± 2.26
22 G	45.5 (46)	23.8 (24)	30.7 (31)	60.4 (61)	39.6 (40)	3.68 ± 2.16
	$x^2 = 3.146$ $p = 0.207$			$x^2 = 0.845$ $p = 0.358$		x^2=-1.327 $p = 0.187$
Time of catheter stay in the vein						
0–48 h	35 (21)	25 (15)	19.1 (18)	55 (33)	45 (27)	3.01 ± 2.23
49–72 h	60.6 (57)	20.2 (19)	40 (24)	68.1 (64)	31.9 (30)	4.31 ± 1.92
	$x^2 = 10.934$ **$p = 0.004$***			$x^2 = 2.69$, $p = 0.101$		t = 3.685, **$p = 0.001$***
Using dosiflow						
Yes	61.1 (44)	18.1 (13)	20.8 (15)	70.8 (51)	29.2 (21)	3.06 ± 2.24
No	41.5 (34)	25.6 (21)	32.9 (27)	56.1 (46)	43.9 (36)	3.91 ± 2.23
	$x^2 = 5.969$ $p = 0.051$			$x^2 = 3.571$ $p = 0.059$		t=-2.677, **$p = 0.019$***
Catheter insertion site						
Right upper extremity	48.7 (38)	24.4 (19)	26.9 (21)	59 (46)	41 (32)	3.66 ± 2.24
Left upper extremity	52.6 (40)	19.7 (15)	27.6 (21)	67.1 (51)	32.9 (25)	3.35 ± 2.16
	$x^2 = 0.496$ $p = 0.78$			$x^2 = 1.092$ $p = 0.296$		t = 0.876 $p = 0.382$
Frequency of catheter insertion						
First application	53.1 (68)	19.5 (25)	26.9 (7)	68 (87)	32 (41)	3.41 ± 2.31
2 or more applications	38.5 (10)	34.6 (9)	27.3 (35)	38.5 (10)	61.5 (16)	4.0 ± 1.49
	$x^2 = 3.146$ $p = 0.207$			$x^2 = 8.071$ **$p = 0.004$***		t=-1.239 $p = 0.217$
The way IV treatment is administered						
Infusion	47.4 (9)	26.3 (5)	26.3 (5)	68.4 (13)	31.6 (6)	4.36 ± 2.21
Push infusion	51.1 (69)	21.5 (29)	27.4 (37)	62.2 (84)	37.8 (51)	3.39 ± 2.18
	Fisher's $x^2 = 0.359$, $p = 0.892$			$x^2 = 0.275$, $p = 0.623$		U = 959, $p = 0.071$
Professional experience of the nurse who applied the catheter						
< 3 years	46.7 (64)	24.8 (34)	28.5 (39)	70.6 (12)	38 (52)	3.63 ± 2.18
≥ 3 years	82.4 (14)	-	17.6 (3)	62 (85)	29.4 (5)	2.52 ± 2.12
	Fisher's $x^2 = 8.974$ **$p = 0.01$***			$x^2 = 0.474$, $p = 0.491$		U = 820.5, **$p = 0.043$***

x^2: Chi-square test, F: ANOVA test, Fisher x^2: Fisher Chi-square test, KW: Kruskal Wallis test, U: Man Whitney U test, *$p < 0.05$

Table 4 Evaluation of interobserver intraclass correlation coefficient (ICC)

	Dorsum of the hand group	Forearm group	Antecubital region group
	ICC Value (95% CI [Lower - Upper])	ICC Value (95% CI [Lower - Upper])	ICC Value (95% CI [Lower - Upper])
Phlebitis Degree	0.966* (0.855–0.997)	0.945* (0.888–0.999)	0.978* (0.859–0.999)
Infiltration Degree	0.980* (0.889–1.000)	0.933* (0.899–0.997)	0.978* (0.85–0.999)*

*$p < 0.001$

In this study, it was also observed that the risk of infiltration development was similar between regions. Contrary to our findings, Marsh et al. reported that PVCs implanted in joint flexion areas were more likely to have infiltration, inflammation, thrombus, occlusion and/or complete dislodgement [27]. It has been reported that the body site used for PIVC affects the infiltration rate and catheter movement is directly related to vessel wall trauma [28]. It has been reported that PIVCs placed in joint areas (e.g. wrist, antecubital fossa) may cause a higher rate of infiltration due to the movement of the vessel wall relative to the catheter tip. In addition, it has been determined that inadequate fixation of catheters placed in non-articular body sites may lead to increased movement of the catheter type, which may cause traumatic injury to the vessel wall and increase the risk of infiltration [27, 29]. It is thought that the fact that there was no difference between the three regions in terms of infiltration in this study may be related to these reasons.

In this study, it was determined that the risk of phlebitis was higher in patients hospitalised in internal clinics. It is thought that the follow-up and treatment of individuals with chronic diseases in internal clinics may be effective in this result. It is stated that chronic diseases increase the risk of phlebitis by increasing the fragility of the vessels. Erdoğan found that phlebitis developed in 13% of individuals with hypertension, 35.7% of individuals with diabetes mellitus, and 25% of individuals with both hypertension and diabetes mellitus and reported that chronic disease increased the risk of phlebitis [30]. In contrast to our study finding, Liu et al. found that patients in the surgical department had a higher risk of infiltration, phlebitis and occlusion [21]. It is thought that the increased incidence of phlebitis in patients hospitalised in internal clinics may be due to the presence of additional chronic diseases and exposure to frequent PIVC applications for their ongoing treatment, which may have reduced vascular quality. In this study, it was found that the duration of catheter stay in the vein was an important variable in terms of the risk of phlebitis development and the risk of phlebitis increased in individuals whose duration of stay in the vein was between 49 and 72 h. It was observed that different results were obtained in the studies conducted in the literature. In the study conducted by Bakır and Yava, it was found that PIVC had no significant effect on the risk of phlebitis development according to the duration of stay in the vein and the region of application [22]. Liu et al., also found that a higher incidence of complications was not observed in catheters left for longer than 96 h [21]. In some studies, it was found that the rate of phlebitis increased after the first hours [31, 32]. Wei et al., reported that the length of stay increased the risk of complications related to PIVC in the first 38 h, but the length of stay longer than >38 h did not contribute to increasing the risk of complications related to PIVC [32]. In the study conducted by Erdoğan and Denat, it was determined that the risk of phlebitis and infiltration increased within 49–72 h in patients undergoing PIVC [16]. Tosun et al., also found that increasing the duration of PIVC increased the risk of phlebitis [33]. According to our research results, it was determined that the increase in the duration of catheter stay in the vein was an important risk factor for the risk of phlebitis and was found to be consistent with the literature.

In the study, it was determined that the variables affecting the risk of infiltration in patients were the unit where PIVC was applied and the frequency of application. In patients hospitalised in internal clinics and intensive care units, it was also determined that application of more than one PIVC to the area increased the risk of infiltration. In the study conducted by Braga et al., it was determined that each increase in the number of PIVCs applied to patients increased the possibility of infiltration by 1.45 times [34]. In the study conducted by Uslusoy and Mete, it was determined that multiple catheterisation procedures to the same site increased the risk of phlebitis [35]. It is thought that shorter treatment and hospitalisation periods of patients hospitalised in surgical clinics and fewer repeated painful interventions may have reduced the risk of infiltration. In addition, it is thought that the fact that the number and variety of intravenous drugs administered through PIVCs to critically ill patients followed up in intensive care units may increase the catheter-related risks.

In the study, it was determined that the factors affecting the pain level of the patients were the duration of catheter stay in the vein, the status of using dosiflow and the duration of professional experience of the nurse who applied the catheter. It was determined that the pain felt increased as the duration of catheter stay in the vein increased. Studies show that the risk of phlebitis and thrombophlebitis increases in case of prolonged catheter stay in the vein [36, 37]. The level of pain associated with these complications also increases. It was

determined that the pain level was less in patients using dosiflow. Controlled and not too fast IV treatment rate may be effective on the pain felt. It is stated that rapid administration of the fluid accelerates haemodilution and more contact of the concentrated solution with the tunica intima layer of the vein increases the risk of complications [37]. Piper et al., found that increasing the infusion flow rate and positioning the catheter tip along the vessel wall increased the risk of phlebitis [36]. Simin et al., found that an increase in PVC catheter diameter, an increase in the length of PVC stay and an increase in the number of solutions given increased the risk of phlebitis development [38]. Another factor affecting the level of pain in patients was found to be the duration of professional experience of nurses. It was observed that the pain felt in PIVCs applied by nurses with more than 3 years of professional experience was less. In the literature, it was determined that the duration of experience of nurses affected the development of complications related to PIVC. It has been reported that the risk of phlebitis development decreases as the duration of experience of the individual applying the catheter increases [39, 40]. As the duration of the nurse's professional experience increases; the level of psychomotor skills also improves. It is important for more experienced nurses to be more professional during their care in terms of observing the complications that may develop and taking precautions. As a result of this study, it is thought that the fact that nurses with more professional experience encountered less pain while wearing PIVK may be related to these reasons.

Limitations of the study

The limitation of the study is that the patients included in the study were taken from a single centre and the results can be generalised to only one centre. In addition, the application of the vascular access to the patients by different nurses is a limitation in terms of the evaluation of pain related to the PIVC procedure. In addition, the inability to limit physiological changes in patients with different chronic diseases is another limitation of the study.

Conclusion and recommendations

In conclusion, in this study, it was determined that PIVCs applied to different sites were similar in terms of the risk of phlebitis and infiltration, but the severity of pain was much higher in catheters inserted above the hand. It is important that in-service training of nurses in line with current practice guidelines should be carried out regularly and newly recruited nurses and nursing students with insufficient experience should be supported during the period in which they can improve their psychomotor skills.

Abbreviations

PIVC Peripheral Intravenous Catheterization
VAS Visual Analogue Scale

Acknowledgements

The authors are grateful to the patients and nurses for participating in the study.

Author contributions

Conception: F.K, H.Ç, H.A., Design: F.K, H.A., Supervision: H.A. Fundings: H.A., S.Ç.A., Materials: H.A., S.Ç.A. Data collection and/or processing: F.K. H.Ç. Analysis- interpretation: H.A., S.Ç.A. Literature review: F.K., H.A., H.Ç. writing: F. K., H.Ç., H.A., S.Ç.A. Critical review: H.A., S.Ç.A.

Funding

None.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Before the start of the study, ethical approval was obtained from the Bingol University Health Sciences Scientific Research and Publication Ethics Committee and institutional permission (Decision number: 2022/15) was obtained from the relevant hospital. At the same time, the purpose of the research was explained to the patients, their verbal/written consent was obtained and they were informed that they could withdraw from the research at any time. Confidentiality of patient data and identity information was ensured. The research was conducted in accordance with the Principles of the Declaration of Helsinki.

Consent for publication

No, the results/data/figures in this manuscript have not been published elsewhere, nor are they under consideration (from you or one of your Contributing Authors) by another publisher.

Competing interests

The authors declare no competing interests.

Received: 3 January 2025 / Accepted: 13 March 2025
Published online: 08 April 2025

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