Original Article

The Development of Phlebitis and Infiltration in Patients with Peripheral Intravenous Catheters in the Neurosurgery Clinic and Affecting Factors

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Abstract

Aims and objectives: The aim of the present study was to investigate the development of phlebitis and infiltration in patients with peripheral intravenous catheters in the neurosurgery clinic and affecting factors.
Background: IV catheter complications prolong the length of hospital stay of patients, cause patients to undergo unnecessary diagnostic procedures and treatments, expose patients and their relatives to stress, increase workload of medical staff and lead to economic losses.
Design: Descriptive and cross-sectional study.
Methods: The sample of the study consisted of 325 patients over the age of 18 who received drug and fluid therapy through peripheral catheter and 347 catheters. The study data were collected by examining the catheter insertion site in terms of phlebitis and infiltration findings every 24 hours using the survey and observation forms.
Results: Phlebitis development rate was found to be 17.6%. All of the phlebitis cases (100%) were Grade 1 and most phlebitis cases occurred on the second day (60%). Infiltration development rate was 6.3%. All of the phlebitis cases (100%) were Grade 1 and most infiltration cases occurred on the second day (81.8%).
Conclusions: Phlebitis and infiltration cases were mostly seen on the second day, and phlebitis occurred mostly in patients with cranial diseases, when catheter site was used multiple times, when catheter dwelt in vein for 49-72 hours and when catheter was inserted by a nurse with a bachelor's degree. It was identified that infiltration was mostly seen in patients between the ages of 50-59 and in catheterizations in the operating room.
Key words: Infiltration, Neurosurgery, Peripheral intravenous catheters, Phlebitis

Introduction

Intravenous (IV) catheter is one of the most commonly used ways of treatment in patients admitted to the hospital (Groll *et al.* 2010, Craven *et al.* 2013, Potter *et al.* 2013). Peripheral IV catheterization and IV fluid therapy, mainly used for the purpose of managing IV treatments, may cause several complications (Denat & Eser 2006). These complications may be thrombophlebitis, embolism, local infection, pulmonary edema, circulatory overload (Saini *et al.* 2011, Phillips & Gorski 2014), extravasation, ecchymosis, hematoma, nerve injury, venous spasm, infiltration and phlebitis (Craven *et al.* 2013, Potter *et al.* 2013, Phillips & Gorski 2014). Among these complications, the most common are phlebitis and infiltration (Frey 2000, Groll *et al.* 2010, Saini *et al.* 2011, Phillips & Gorski 2014).

Phlebitis rate has been reported to be 5% in 150 million peripheral intravenous catheters in the United States annually (Gallant *et al.* 2006). This rate has been reported to be 1.8% in Spain (Barbut *et al*. 2003) and 27-70% in Iran (Abadi *et al.* 2013). Phlebitis rate was reported to be 41.8% in a study conducted in the United States with non-granulocytopenic patients (Maki & Ringer 1991), 62% in a study conducted in Sweden with patients in surgery and internal diseases clinics (Lundgren *et al.* 1993), 29.8% in a study conducted in Chandigarh with emergency patients (Saini *et al*. 2011), 16.7% in a study conducted in Brazil with neonatal (Gomes *et al.* 2011), 11.9% in a study conducted in an internal

diseases clinic in Portugal (Anabela *et al.* 2012), 44% in study conducted in Iran with patients in a surgery clinic who received catheterization for at least 72 hours (Abadi *et al*. 2013). Infiltration rate, on the other hand, was reported to be 31.5% in a study conducted in Chandigarh with emergency patients (Saini *et al.* 2011), 79.2% in study conducted in Brazil with neonatal (Gomes *et al.* 2011), 16% in a study conducted with children (Jacinto *et al*. 2011). In Turkey, phlebitis rate was reported to be 67.2% in a study conducted with patients in surgery, gynecology, and pediatrics clinic (Karadeniz *et al*. 2003) and 54.5% in a study conducted with patients in a surgery clinic (Uslusoy & Mete 2008). We could not find a study conducted in Turkey in which infiltration rate was investigated.

IV catheter complications prolong the length of hospital stay of patients, cause patients to undergo unnecessary diagnostic procedures and treatments, expose patients and their relatives to stress, increase workload of medical staff and lead to economic losses (Kagel & Rayan 2004, Denat & Eser 2006, Abadi 2013).

In hospitals, IV catheterization is carried out and followed-up by nurses. For this reason, nurses ought to know about factors that lead to phlebitis and infiltration, practices that will prevent phlebitis and infiltration and take necessary precautions, and inform patients and their relatives about IV applications if the treatment is to be continued at home (Kagel & Rayan 2004, Hadaway 2007, Nursing Regulation 2010, Abadi *et al*. 2013, Craven *et al.* 2013).

There is a limited number of studies investigating phlebitis and infiltration rates in different clinics and patient groups specific to that clinic, whereas we could not find any studies conducted with neurosurgery patients. Peripheral intravenous catheterization is applied many times to patients in neurosurgery clinic for various reasons such as pre- and post-operation intravenous fluid therapy and intravenous drug administration. Especially patients with cranial diseases are hospitalized for prolonged periods of time and receive peripheral intravenous catheterization multiple times. This research is believed to shed light to the development of phlebitis and infiltration in patients receiving peripheral intravenous catheter in the neurosurgery clinic and affecting factors, hence pave the way for better nursing interventions.

Methods

Aim

This research was performed in order to investigate the development of phlebitis and infiltration in patients receiving peripheral intravenous catheter in the neurosurgery clinic and affecting factors.

Design

This study was designed as a descriptive and cross-sectional study.

Study Sample

The study population was made up of patients with peripheral intravenous catheter in the neurosurgery clinic of a Education and Research Hospital in the capital of Turkey. The sample of the study consisted of 325 patients with peripheral intravenous catheter in the neurosurgery clinic who met the inclusion criteria and 347 catheters. The study was conducted between March-June 2013 (4 months). Patients under the age of 18, obese patients, and patients who received chemotherapy or immunosuppressive therapy were excluded from the study.

Power analysis was used in order to determine the size of the sample. With a 5% margin of error between catheter site used for the first time and catheter site used for multiple times, the power of the study was 68.1% according to findings in terms of infiltration rate and 80.9% in terms of phlebitis rate. NCSS & PASS 2000 softwares were used for power analysis.

Research Instrument

The survey form and the observation developed through reviewing the literature were used for data collection (Maki & Ringer 1991, Lundgren *et al*. 1993, Macklin 2003, Uslusoy & Mete 2008, Groll 2010).

Survey form

The survey form involved personal information of the patient (age, gender, diagnosis) and information such as the catheter dwell time, the catheter size, the body side which catheter was inserted, the site where catheter was inserted, the frequency of insertion on the same site, drugs administered to the patient, the way drugs were given, the educational status and experience of the applicator.

Observation form

In order to determine the development and grade of infiltration and phlebitis, the Phlebitis Scale (Table 1) and the Infiltration Scale (Table 2) developed by Infusion Nurses Society (INS 2006) were used. The psychometric properties of the scales were evaluated by Groll et al (2010).

Data Collection

The patients were interviewed face-to-face in order to collect data. The IV catheter insertion sites of the patients were assessed by the researcher every 24 hours using both scales. The patients included in the sample group were followed up during the catheterization and for 24 hours after the IV catheter was removed. Assessment results were recorded in the observation form. When phlebitis or infiltration was observed on the insertion site, the size of the site was measured with a single-use paper ruler. When phlebitis or infiltration symptoms were detected or the patient reported a symptom, the catheter site was assessed using the scales, the catheter was removed and appropriate care and treatment were applied in accordance with clinical procedures.

Data Analysis

Statistical Package for the Social Sciences (SPSS) for Windows 11.5 was used for data analysis. Kolmogorov Smirnov test was used in order to check if the distribution of continuous and discrete numeric variables was close to normal distribution. Descriptive statistics for continuous and discrete variables were presented as mean ± standard deviation or median (minimum - maximum) and categorical variables were presented as number of cases and percentage (%).

The significance of the difference between groups in terms of average values was investigated with Student's t test and the significance of the difference between groups in terms of median values was investigated with Mann Whitney U test. Categorical variables were analyzed with Pearson Chi-square Test, Fisher's Exact Chi-square Test or Likelihood Ratio Test.

Results were accepted to be statistically significant for $p<0.05$.

The Ethical Aspect of the Study

The approval of the Ethics Board of the Diskapi Yildirim Beyazit Education and Research Hospital was taken and the necessary permit was obtained from the General Secretariat of Public Hospitals, Ankara 1st Region, Turkish Public Hospitals Agency, Ministry of Health. The patients were informed about the aim of the study and their written consent was received.

Results

The mean age of the patients included in the study was 47.1±12.1. 59.3% of the patients were male and 40.7% were female. Out of 347 catheter sites, phlebitis was seen in 17.6% and infiltration was seen in 6.3% (Figure 1). All of the phlebitis cases and majority of the infiltration cases were Grade 1. Both phlebitis and infiltration were seen in 0.6% of catheter sites. All of the phlebitis cases occurred during the peripheral IV catheterization and no cases occurred after the catheter was removed.

It was found that no phlebitis cases occurred on the 1st day of peripheral IV catheterization. 60.7% of phlebitis cases occurred on the 2nd day and 39.3% occurred on the 3rd day (Figure 2). 4.4% of the infiltration cases occurred on the 1st day of peripheral IV catheterization, 81.8% occurred on the 2nd day and 13.8% occurred on the 3rd day (Figure 2).

It was found in this study that age ($p=0.392$) and gender ($p=0.406$) did not influence the development of phlebitis ($p<0.05$). It was determined that a higher number of phlebitis cases was seen on IV catheter site in patients with cranial diseases ($p<0.001$) ($p>0.05$). While gender ($p=0.584$) and present diseases ($p=0.892$) did not influence the development of infiltration, it was found that the number of infiltration cases was higher in patients between the ages of 50-59 ($p=0.002$) ($p>0.05$) (Table 3).

It was found in this study that there was no significant difference between catheter size ($p=0.371$), anatomical region ($p=0.911$), body parts ($p=0.939$), and experience of the applicator ($p=0.225$) in terms of their effect on phlebitis development ($p<0.05$). It was observed that more phlebitis cases occurred in catheters inserted in neurosurgery clinic ($p=0.014$), duration in vein for 49-72 hours ($p<0.001$), when catheter was inserted on the same site multiple times ($p=0.006$) and in catheters inserted by applicators with a bachelor's degree ($p=0.025$) ($p>0.05$) (Table 4).

While there was no significant difference between catheter size ($p=0.112$), catheter dwell time in vein ($p=0.252$), anatomical region

(p=0.085), body parts (p=0.772), catheter insertion frequency on the same site (p=0.476), educational status of the applicator (p=0.817) and experience of the applicator (p=0.942) in terms of their effect on infiltration development (p>0.05), it was found that more infiltration cases occurred in catheters inserted in operating room (p=0.005) (p<0.05) (Table 4).

There was no significant difference between way of drug administration and therapy procedure applied through the catheter in terms of phlebitis and infiltration development (p>0.05) (Table 5).

Table 1: The Scale of Phlebitis *

Phlebitis Grade	Phlebitis Symptoms
Grade 0	• No symptoms
Grade 1	• Erythema at access site with or without pain
Grade 2	• Pain at access site with erythema and/or edema
Grade 3	• Pain at access site with erythema and/or edema, streak formation, palpable venous cord
Grade 4	• Pain at access site with erythema and/or edema, streak formation, palpable venous cord greater than one inch in length and purulent drainage

* Infusion Nurses Society 2006.

Figure 1. The distribution of phlebitis and infiltration rate

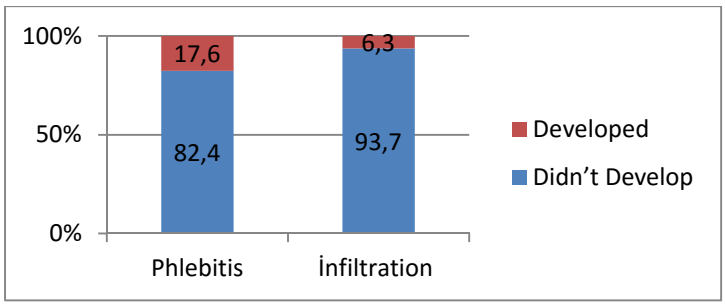

Figure 2. The distribution according to phlebitis and infiltration development time

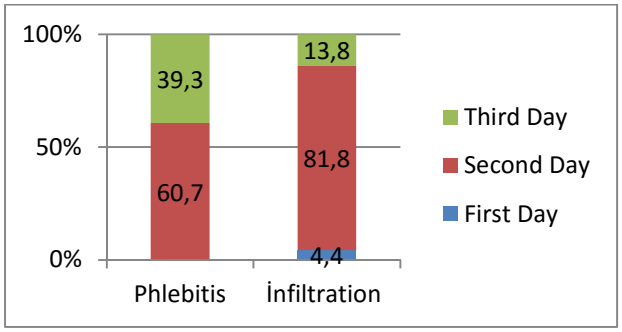

Table 2: The Scale of Infiltration *

Infiltration Grade	Infiltration Symptoms
Grade 0	• No symptoms
Grade 1	• Skin blanched • Edema less than 1 inch in any direction • Cool to touch • With or without pain
Grade 2	• Skin blanched • Edema 1 to 6 inches in any direction • Cool to touch • With or without pain
Grade 3	• Skin blanched, translucent • Gross edema greater than 6 inches in any direction • Cool to touch • Mild to moderate pain • Possible numbness
Grade 4	• Skin blanched, translucent • Skin tight, leaking • Skin discolored, bruised, swollen • Gross edema greater than 6 inches in any direction • Deep pitting tissue edema • Circulatory impairment • Moderate to severe pain • Infiltration of any amount of blood product, irritant, or vesicant

* Infusion Nurses Society 2006.

Table 3. The distribution of phlebitis and infiltration development according to descriptive properties (n:347)

Descriptive Properties	Phlebitis				Infiltration			
	developed		didn't develop		developed		didn't develop	
Age	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
29 Years and Below	5	20.8	19	79.2	2	8.3	22	91.7
30-39 Years	15	22.4	52	77.6	_	_	67	100.0
40-49 Years	13	11.9	96	88.1	8	7.3	101	92.7
50-59 Years	18	17.6	84	82.4	12	11.8	90	88.2
60-69 Years	8	25.8	23	74.2	_	_	31	100.0
70 Years and Above	2	14.3	12	85.7	_	_	14	100.0
χ^2/p	χ^2=5.202, **p**=0.392 [a]				χ^2=19.092 **p=0.002** [b]			
Gender								
Female	30	19.5	124	80.5	11	7.1	143	92.9
Male	31	16.1	162	83.9	11	5.7	182	94.3
χ^2/p	χ^2=0.691, **p**=0.406 [a]				χ^2=0.301, **p**=0.584 [a]			
Present Diseases								
Spinal Diseases	35	13.3	229	86.7	17	6.4	247	93.6
Cranial Diseases	26	31.3	57	68.7	5	6.0	78	94.0
χ^2/p	χ^2=14.227, **p<0.001** [a]				χ^2=0.018, **p**=0.892 [a]			
Total	**61**	**17.6**	**286**	**82.4**	**22**	**6.3**	**325**	**93.7**

a. Pearson's Chi-square Test, b. Likelihood Ratio Test

Table 4. The distribution of phlebitis and infiltration development according to catheter application properties (n:347)

Catheter Application Properties	Phlebitis				Infiltration			
	developed		didn't develop		developed		didn't develop	
The place where catheters were first inserted	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Neurosurgery Clinic	16	29.1	39	70.9	5	31.2	11	68.8
Operating room	45	15.4	247	84.6	32	71.1	13	28.9
χ^2/p	χ^2=5.978, **p=0.014**[a]				χ^2=7.859, **p=0.005**[a]			
Catheter Size								
22 G	32	19.5	132	80.5	14	8.5	150	91.5
20 G	29	15.8	154	84.2	8	4.4	175	95.6
χ^2/p	χ^2=0.802, **p**=0.371[a]				χ^2=2.527, **p**=0.112[a]			
Duration in situ								
0-24 Hours	18	14.2	109	85.8	7	5.5	120	94.5
25-48 Hours	15	11.1	120	88.9	12	8.9	123	91.1
49-72 Hours	28	32.9	57	67.	3	3.5	82	96.5
χ^2/p	χ^2=18.759, **p<0.001**[a]				χ^2=2.754, p=0.252[a]			
Anatomical region								
Hand	26	17.0	127	83.0	7	4.6	146	95.4
Wrist	18	17.0	88	83.0	12	11.3	94	88.7
Forearm	15	20.3	59	79.7	2	2.7	72	97.3
Antecubital Area	2	14.3	12	85.7	1	7.1	13	92.9
χ^2/p	χ^2=0.537, **p**=0.911[a]				χ^2=6.615, **p**=0.085[b]			
Body parts								
Right	15	6.1	231	93.9	15	6.1	231	93.9
Left	7	6.9	94	93.1	7	6.9	94	93.1
χ^2/p	χ^2=0.006, **p**=0.939[a]				χ^2=0.006, **p**=0.939[a]			
Catheter Insertion Frequency on the Site								
First-Time Use	49	15.7	263	84.3	19	6.1	293	93.9
Repeated Use	12	34.3	23	65.7	3	8.6	32	91.4
χ^2/p	χ^2=7.499, **p=0.006**[a]				**p**=0.476[c]			
Educational Status of the Applicator								
Associate's Degree	39	14.9	222	85.1	17	6.5	244	93.5
Bachelor's Degree	22	25.6	64	74.4	5	5.8	81	94.2
χ^2/p	χ^2=5.053, **p=0.025**[a]				χ^2=0.053, **p**=0.817[a]			
Experience of the Applicator (Years)								
< 5 years	46	19.2	193	80.8	15	6.3	224	93.7
≥ 5 years	15	13.9	93	86.1	7	6.5	101	93.5
χ^2/p	χ^2=1.474, **p**=0.225[a]				χ^2=0.005, **p**=0.942[a]			
Total	**37**	**60.7**	**24**	**39.3**	**22**	**6.3**	**325**	**93.7**

a: Pearson's Chi-square Test, b: Likelihood Ratio Test, c: Fisher's Exact Chi-square

Table 5. The distribution of phlebitis and infiltration development according to therapies applied through catheters (n:347)

Therapy Properties	Phlebitis				Infiltration			
	Seen		Not Seen		Seen		Not Seen	
Method of Drug Administration	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Push	9	21.4	33	78.6	1	2.4	41	97.6
Push + Infusion	52	17.0	253	83.0	21	6.9	284	93.1
χ^2/p	χ^2=2.353, p=0.308[b]				χ^2=2.304, p=0.316[b]			
Therapy Procedure Applied Through Catheter								
Patients Who Receive Group A Therapy	60	35.9	107	64.1	21	12.6	146	87.4
Patients Who Do Not Receive Group A Therapy	1	0.6	179	99.4	1	0.6	179	99.4
	p=0.700[c]				p=0.550[c]			
Patients Who Receive Group B Therapy	59	36.6	102	63.4	21	6.4	140	93.6
Patients Who Do Not Receive Group B Therapy	2	1.1	184	98.9	1	0.5	185	99.5
	p=0.747[c]				p=1.000[c]			
Patients Who Receive Group C Therapy	3	15.8	16	84.2	1	5.3	18	94.7
Patients Who Do Not Receive Group C Therapy	58	17.7	270	82.3	21	6.4	307	93.6
	p=1.000[c]				p=1.000[c]			
Total	**37**	**60.7**	**24**	**39.3**	**22**	**6.3**	**325**	**93.7**

b: Likelihood Ratio Test, c: Fisher's Exact Chi-square Test,
Group A Therapy: Eqiceft and Epanutin and Dekort and Nevofam and Naga
Group B Therapy: Eqizolin and Nevofam and Novalgine, Group
C Therapy: Prednol or Nimotop or Keppra or Zyvoxid or Tazoper or Cipro or Sulbaksit

Limitations of the Study

The limitations of the study were the cross-sectional design of the study, the limited size of the sample, the inability to include each drug administered through peripheral IV catheter separately, and the fact that phlebitis and infiltration cases were assessed by the researcher.

Discussion

This study was performed in order to investigate the development of phlebitis and infiltration in patients receiving peripheral intravenous catheter in the neurosurgery clinic and affecting factors. A total of 325 patients and 347 peripheral IV catheters inserted to these patients were observed in the study. Analyses were performed using the number of peripheral IV catheters used for patients.

Rates of Phlebitis and Infiltration: In studies performed in different countries with various samples, phlebitis rate was reported to be 41.8% in the United States (Maki & Ringer 1991), 62% in Sweden (Lundgren *et al*. 1993), 29.8% in Chandigarh (Saini *et al.* 2011), 16.7% in Brazil (Gomes *et al.* 2011), 11.9% in Portugal (Anabela *et al*. 2012), 44% in Iran (Abadi *et al*. 2013). In Turkey, phlebitis rate was reported to be 67.2% in a study conducted with patients in surgery, gynecology, and pediatrics clinic (Karadeniz *et*

al. 2003) and 54.5% in a study conducted with patients in a surgery clinic (Uslusoy & Mete 2008). As can be seen above, the phlebitis rate varies between 11.09% and 67.2% in different studies. The phlebitis rate found in our study is within this range, however it is quite low.

Only Grade 1 phlebitis was observed in our study. It was found in studies conducted by Lundgren *et al*. (1993) (37.8%) and Uslusoy & Mete (2008) (44.5%) that majority of phlebitis cases were Grade 1, which is similar to our findings.

Among 347 peripheral IV catheters inserted in our study, infiltration was observed in 6.3% (n:22). Infiltration rate, on the other hand, was reported to be 31.5% in a study conducted in Chandigarh with emergency patients (Saini *et al.* 2011), 79.2% in study conducted in Brazil with neonatal (Gomes *et al.* 2011), 16% in a study conducted with children (Jacinto *et al.* 2011). We could not find a study conducted in Turkey in which infiltration rate was investigated. Studies on this subject shows differences in terms of age groups included in the sample. The infiltration rate found in our study is quite lower compared to other studies (Saini *et al.* 2011, Gomes *et al.* 2011, Jacinto *et al*. 2011). Only Grade 1 infiltration was observed in our study. The majority of infiltration cases were Grade 2 (72%) in the conducted by Saini *et al.* (2011). We believe that the reason why only Grade 1 phlebitis and infiltration occurred in our study is because phlebitis and infiltration development was assessed by the researcher every 24 hours using the scales. This finding points out the importance of regular assessments in terms of early diagnosis of phlebitis and infiltration, which makes it possible to take necessary measures.

Factors Affecting The Development of Phlebitis and Infiltration

Age and Gender: It was found that age did not affect phlebitis development, whereas infiltration was mostly observed in patients between the ages of 50-59 (11.8%). In some studies, a significant relation was not found between age and phlebitis (Karadag 1999, Uslusoy & Mete 2008), whereas it was reported in some studies that phlebitis occurred more frequently in elderly patients than in young patients (Maki & Ringer 1991, Saini *et al*. 2011).

It was found in our study that gender did not affect phlebitis and infiltration. In the study conducted by Saini *et al.* (2011), no significant relation was found between gender and phlebitis/infiltration. On the other hand, Karadag (1999) reported that phlebitis was more common in women, while Ringer (1991) and Lundgren *et al*. (1993) reported that phlebitis was more common in men.

Present Diseases: It was found in our study that phlebitis was more common in patients with cranial diseases and infiltration was more common in patients with spinal diseases in the neurosurgery clinic. In the clinic where the study was performed, therapies of patients with cranial diseases are usually given intravenously and a IV catheter is kept available in order to maintain vascular access. Patients with spinal diseases, on the other hand, is only inserted IV catheter on the operation day and the catheter is removed on the first post-operative day. This procedure is believed to be effective on the higher rate of phlebitis cases in patients with cranial diseases. Similarly, the higher mobility of patients with spinal diseases is believed to be effective on higher rate of infiltration.

The place where catheters were first inserted: It was found in our study that phlebitis occurred more frequently in catheters inserted in the neurosurgery clinic, whereas infiltration occurred more frequently in catheters inserted in the operating room. In the study conducted by Uslusoy & Mete (2008), it was reported that the unit in which catheter is inserted had no effect on phlebitis development. We believe that the reason why phlebitis was observed less frequently in catheters inserted in the operating room is because the operating room has more sterile conditions and most patients in the operating room receive IV insertion for the first time. On the other hand, we believe that the reason why infiltration was observed more frequently in catheters inserted in the operating room is because IV insertion is applied to most patients in a quick manner and there is a higher risk of vascular access trauma while patients are being moved from the operating room to their beds under anesthesia after the operation.

Catheter Size: In some studies in the literature, it was reported that catheter size had no effect on phlebitis development (Uslusoy & Mete 2008, Saini *et al*. 2011), while some studies reported that large catheters had a higher phlebitis risk compared to small catheters (Maki & Ringer 1991, Carson *et al*. 2012, Phillips & Gorski

2014). In addition, it was reported that catheter choice affected infiltration development (Hadaway 2009, Saini *et al.* 2011, Jacinto *et al.* 2011, Phillips & Gorski 2014). Naomi *et al.* (2011) recommends that 22 Fr. peripheral IV catheter is used for adults. It was found in our study that catheter size did not affect phlebitis and infiltration. This is believed to be due to the fact that smaller catheters of similar sizes (20 G and 22 G) are used in both the neurosurgery clinic and the operating room, as recommended in the literature.

Time to removal catheters: It was found in our study that more phlebitis cases occurred in catheters that remained in vein for 49-72 hours. In the study conducted by Maki and Ringer (1991), it was reported that phlebitis rate increased after the second day, while some studies reported that phlebitis rate increased after the first 24 hours (Lundgren *et al*. 1996, Karadağ 1999, Homer & Holmes 1998, Uslusoy & Mete 2008). In the study conducted by Lundgren *et al.* (1993), it was reported that phlebitis was not observed in catheters which remained in vein less than 12 hours, phlebitis rate increased between 24-48 hours, and phlebitis rate reached up to 90-100% after 96 hours. In another study conducted by Abadi *et al.* (2013) it was reported that phlebitis was mostly seen in the first 40-49 hours. Our results show similarities with results of other studies.

In terms of the effects of time to removal of catheters on infiltration development, it was found that infiltration mostly occurred between 25-48 hours (8.9%), however this finding was not statistically significant. In some studies (Hadaway 2009, Jacinto *et al.* 2011), it was reported that intravenous therapies longer than 5 days affected infiltration development. In another study (Ascoli *et al.* 2012), it was found that more infiltration cases developed in catheters that remained in place for more than 96 hours compared to those that remained for 72-96 hours. In our study, peripheral IV catheter insertion sites were regularly and continuously assessed by the researcher, the follow-up of infiltration development status was ended when phlebitis was observed and IV catheterization was ended or peripheral IV catheters inserted to patients remained for 72 hours at most in accordance with clinical application procedures.

Anatomical region: It was found in our study that the catheter insertion site did not affect phlebitis development. In the study conducted by Lundgren *et al.* (1993), it was reported that phlebitis was mostly observed in catheters inserted in the back of the hand, while other researchers reported that phlebitis was most frequently seen on forearm (Maki & Ringer 1991, Karadeniz *et al.* 2003, Saini *et al.* 2011). In some studies, it was reported that phlebitis rate was higher in the antecubital area (Uslusoy & Mete 2008, Saini *et al.* 2011). Our findings are similar to those of Maki and Ringer (1991), Karadeniz *et al*. (2003) and Saini *et al* (2011).

It was indicated in the literature that the choice of catheter insertion site had a significant effect on infiltration development (Anabela *et al.* 2012, Phillips & Gorski 2014). It was found in our study that the catheter insertion site did not affect infiltration development. In a study conducted by Kagel & Rayan (2004), it was reported that infiltration was most frequently observed on the back of the hand, whereas it was found by Saini *et al.* (2011) that infiltration was more common on forearm and antecubital area. It was stated in the literature that risk of infiltration development increased when catheter was inserted in the vein close to the joint (Karadag 1999). Even though there was no statistically significant difference, it was observed that infiltration was most commonly seen in catheters on wrist.

Catheter Insertion Frequency on the Site: Catheters in our study were mostly inserted on the site for the first time (89.9%) and it was found that insertion frequency of peripheral IV catheters on the same site did not affect infiltration rate, however phlebitis rate was higher in multiple catheter uses on the same site. It was found in other studies that risk of phlebitis development increased in case of multiple uses of the same arm (Maki & Ringer 1991, Uslusoy & Mete 2008). Our findings are similar to those of Maki and Ringer (1991) and Uslusoy & Mete (2008). Repeated use before mechanical or chemical traumas caused by previously inserted catheters fully heals is believed to increase risk of phlebitis development in vein. It is indicated in the literature that repeated use of the same vein may lead to infiltration and it is recommended for this reason that the repeated use of the same vein is avoided if possible and in cases where the repeated use is unavoidable, the proximal of the insertion site should be preferred (Phillips & Gorski 2014). Our findings support this recommendation.

Educational Status and Experience of the Applicator: In this study, phlebitis rate was higher in catheters inserted by nurses with a bachelor's degree compared to those with a associate's degree. In a study conducted by Woody and Davis (2013), it was reported that a 50% reduction in phlebitis was observed with increased knowledge level of nurses. Our findings are in contrast with those of Woody and Davis (2013) In our study, catheters were inserted by anesthesia technicians in the operating room. Anesthesia technicians (associate's degree) insert more catheters throughout the day compared to nurses in the clinic and catheters are inserted in the operating room setting. It is believed that higher catheterization experience of anesthesia technicians increases the success rate. In terms of the effects of experience level of the applicator on phlebitis rate, it was found that phlebitis rate was higher when catheter was inserted by applicators with less than 5 years of experience (19.2%), however the difference was not statistically significant. In a study conducted by Vandenbos *et al.* (2003), it was reported that phlebitis rate was higher in catheters inserted by those with lower levels of experience. Our findings are similar to those of Vandenbos *et al.* (2003).

It was found that educational status and experience of the applicator did not affect infiltration rate. In a study conducted by Woody and Davis (2013), it was reported that a 50% reduction in infiltration was observed with increased knowledge level of nurses. In our study, only one-fourth of the applicators had a bachelor's degree and the remaining had an associate's degree. In addition, infiltration most frequently occurred in IV catheters inserted in the operating room setting, which were inserted by anesthesia technicians.

Method of Drug Administration and Therapy Procedure: It was found in the method of drug administration and therapy procedure did not affect phlebitis and infiltration development. Generalizability of the results are limited by the fact that mostly isotonic solutions were used in infusion therapies applied to patients and multiple therapy procedures were used at the same time for most of the patients.

Conclusıon and Recommendatıons

This study was performed in order to investigate the development of phlebitis and infiltration in patients receiving peripheral intravenous catheter in the neurosurgery clinic and affecting factors and phlebitis and infiltration rates were found to be lower compared to other studies. It was found in our study that most phlebitis and infiltration cases were Grade 1 and it is believed that this finding was affected by the regular assessment of the IV catheterization site by the researcher. It was found that phlebitis and infiltration cases were seen mostly on the second day, and phlebitis occurred mostly in patients with cranial diseases, in catheter applications in the neurosurgery clinic, when catheter site was used multiple times, when catheter dwelt in vein for 49-72 hours and when catheter was applied by a nurse with a bachelor's degree. It was identified that infiltration was mostly seen in patients between the ages of 50-59 and in catheterizations in the operating room.

For applicators, it can be recommended that peripheral IV catheter site is assessed using the phlebitis scale and the infiltration scale every 24 hours and more frequently for patients with fluid monitoring, the use of the same arm is avoided when inserting catheters, the vein is assessed for phlebitis development when the patient reports pain in the catheter site since pain is a Grade 1 phlebitis symptom, patients over the age of 50 are assessed for infiltration more frequently, IV catheters inserted to patients are replaced after 48-72 hours at most, asepsis principles are strictly followed during peripheral IV catheterization, application guidelines are strictly followed and regular assessments are not neglected for patients with cranial diseases in neurosurgery clinics since phlebitis rate is higher in these patients.

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