Effects of Vibration and Cold Application on Pain and Anxiety During Intravenous Catheterization

Sevgi Pakiş Çetin, MD, Kıvan Çevik, PhD

Purpose: *To determine the effects of vibration and cold gel pack application on pain and anxiety levels of patients undergoing intravenous (IV) catheterization.*
Design: *A randomized controlled, pretest and post-test experimental study.*
Methods: *Catheterization was performed 60 seconds before the IV catheterization procedure was started by applying vibration and cold gel pack to patients in the experimental group. Patients in the control group underwent catheterization using standard procedures.*
Findings: *The mean pain scores of patients in the experimental group were lower than those of the patients in the control group. Intragroup analysis demonstrated that the mean scores obtained from the state anxiety and trait anxiety inventories after the study were not significantly different from those obtained before the study.*
Conclusions: *Vibration and cold gel pack application is suggested to relive pain during IV catheterization in adults.*

Keywords: *anxiety, cold application and vibration, intravenous catheterization, pain.*

DRUG APPLICATIONS ARE BECOMING more and more complex with these developments in technology impacting the knowledge and skills of basic nursing functions, where patient safety is given priority.[1-3] Many individuals who have acute or chronic health problems receive medications as part of their treatment.[1,2] Intravenous (IV) catheterization, one of the indispensable applications of modern medicine, enables practitioners to perform venous access in almost all patients admitted to the hospital for diagnosis or treatment. It is also one of the ways of providing drug treatment, fluid therapy, and peripheral nutrition.[4-7] Thanks to IV catheterization, the skin integrity of the patient is protected during repeated IV administration of medications within the day, and the patient does not feel pain during each administration.[1]

In IV treatments, nurses are responsible for the maintenance of peripheral IV catheterization, administration and maintenance of the treatment, and prevention of possible complications likely to develop during treatment.[4] Peripheral IV catheterization skills are difficult to acquire.[4,8] To ensure continuity of the acquired skill, the practitioner should frequently perform IV catheterization.[8] If not performed correctly, peripheral IV catheterization can lead to many life-threatening, widespread, and preventable complications.[4,9,10] Most of these complications can be avoided by carefully

Sevgi Pakiş Çetin, MD, Department of Nursing, Faculty of Health Sciences, Manisa Celal Bayar University, Manisa, Turkey; and Kıvan Çevik, PhD, Department of Nursing, Faculty of Health Sciences, Manisa Celal Bayar University, Manisa, Turkey.

Conflict of interest: None to declare.

Address correspondence to Sevgi Pakiş Çetin, Department of Nursing, Fundamentals of Nursing, Faculty of Health Sciences, Manisa Celal Bayar University, Manisa, Turkey; e-mail address: sevgis210188@hotmail.com.

1089-9472/$36.00
https://doi.org/10.1016/j.jopan.2018.12.005

evaluating the patient, taking various precautions before and after administration, and using an appropriate technique during the placement of the IV catheter.[4,10,11] Unavoidable IV catheterization complications lead to prolonged hospital stays and economic losses, cause patients to undergo unnecessary diagnostic procedures and treatment, increase patient and family stress, and increase health personnel's workload.[4,10] Therefore, nurses should have the ability to perform peripheral IV catheterization and know the complications likely to occur.[10]

IV catheterization is an application that causes pain and discomfort to many patients.[12,13] Reducing the pain of patients is important for nurses.[2] Pain control can be achieved in patients when nurses perform accurate assessment, apply pharmacologic and nonpharmacologic procedures rapidly, monitor the patient's response to these procedures, and implement precautions to relieve pain.[14,15]

The IV catheterization procedure, which frequently causes pain in patients, is also related to anxiety.[16] Anxiety and pain are phenomena that mutually affect each other and thus the severity of each increases.[17-19] Anxiety occurs because of patients' previous negative experiences and fear of harm, and interventions that occur outside their control. Controlling anxiety during interventions allows the patient and the nurse to be more comfortable during the procedure.[20,21] Using appropriate IV catheterization techniques, having the patient lie in supine position during catheterization, informing the patient about the procedure, drawing the patient's attention to something else, calming the patient down, and gaining the patient's confidence are the factors that reduce their pain and anxiety.[1,2,8]

One of the factors causing pain during the IV catheterization is the method used for catheterization.[1] Several methods have been used to prevent or reduce the pain experienced during IV catheterization.[13,22] Buzzy is a device developed to reduce pain associated with IV catheterization. It combines cold and vibration, two nonpharmacologic methods. It is reusable, cost effective, and fast and easy to use. It helps patients who have injection or needle phobia.[23] It is possible to explain the effects of vibration therapy and cold application on pain with the gate control theory.[24,25] This theory suggests that pain is transmitted from the peripheral nervous system to the central nervous system, where it is modulated by a gating system in the dorsal horn of the spinal cord. It has been suggested that the afferent pain-receptive nerves (A-delta fibers and slower C fibers carrying pain messages) are blocked by faster non-noxious motion nerves (A-beta fibers).[25-27] Prolonged cold stimulates the C fibers and may block the A-delta pain signals. Cold may also result in enhanced activation of supraspinal mechanisms, increasing the body's overall pain threshold.[25,28]

This study was designed to determine the effects of vibration and cold gel pack application on pain and anxiety levels of patients undergoing IV catheterization.

Materials and Methods

This randomized controlled trial was conducted between September 2015 and March 2016 in the cardiology, internal medicine, chest diseases, and neurology departments of a university hospital in Turkey. A pretest and post-test model was used. The study sample consisted of 100 18- to 64-year-old patients who underwent IV catheterization for the study, who did not have an IV catheter from a previous hospitalization, were conscious, had the appropriate vascular structure, were able to understand and speak Turkish, were able to understand the visual analog scale (VAS), did not have a psychiatric problem, and agreed to participate in the study. Patients with an even protocol number were assigned to the experimental group (Buzzy group) (n = 50) and those with an odd protocol number were assigned to the control group (n = 50) using a random sampling method. Power analysis was performed to determine the required sample size by using the following values: α = 5%, effect size (d) = 0.30, and 1 − β (power) = 0.100 (100%).

Data Collection Tools

The "Patient Identification Form," "State-Trait Anxiety Inventory" (STAI), "VAS," and VAS for satisfaction were used as data collection tools.

PATIENT IDENTIFICATION FORM. This form contained questions regarding the patient's sociodemographic characteristics and procedure-related pain expectancy. Pain expectancy and level of satisfaction were assessed after IV catheterization. Pain expectancy was categorized into the following three types: expected, less than expected, and more than expected.

STAI. Öner and Le Compte[29] reported that the inventory developed by Spielberger, Gorsuch, and Lushene consists of two subscales: state anxiety and trait anxiety. Each subscale has 20 items. The State-Trait Anxiety Scale was adapted into Turkish by Öner and Le Compte.[29] They also conducted the validity and reliability study of the Turkish version of the scale. State and trait anxiety scores are calculated separately.

The State Anxiety Inventory has 10 reversed items, which were scored in reverse. The remaining 10 items were scored without reversing the scores. The possible total score of both scales ranges from 20 to 80. Higher scores indicate higher anxiety levels and lower scores refer to lower anxiety levels. Öner and Le Compte[29] reported that in Spielberger et al, scores between 0 and 19 indicate the absence of anxiety, between 20 and 39 indicate mild, between 40 and 59 indicate moderate, between 60 and 79 indicate severe anxiety, and 80 points too severe, at panic level anxiety. They also report that individuals whose score is 60 or more need professional assistance.[29]

In the present study, the reliability coefficient for the state anxiety was 0.92 before IV catheterization and 0.92 after IV catheterization. For the trait anxiety, it was 0.91 before IV catheterization and 0.92 after IV catheterization.

VAS FOR PAIN. This scale was used to assess pain severity. It is usually a 10-cm long horizontal line with the expressions "no pain" at one end, and "the worst imaginable pain" at the other end. A score of "0" indicated the absence of pain, whereas "10" indicated the most severe pain. The participants are told to mark any figure between "0" and "10."

VAS FOR SATISFACTION. This scale was also used for satisfaction assessment, too. The severity of satisfaction was scored between 0 and 100 points. A score of "0" indicated that "I am not satisfied at all," whereas "100" indicated that "I am very satisfied." The patients were told to mark any figure between "0" and "100."

Ethical Consideration

To carry out the study, written permissions were obtained from the Clinical Research Ethics Board of the university (No: 85.252.386-20) and the University Hospital Administration where the study was to be conducted. Written and verbal consent was obtained from the patients to participate in the study.

Implementation of the Procedure

After consent forms were obtained from the patients, the Patient Identification Form and STAI were filled in and patients' pulse rates were recorded. The researcher performed all catheterizations to avoid any factors that might lead to differences resulting from the fact that there might be differences between the techniques used by different people to perform IV catheterization. In addition, we used a single type (20 gauge) IV catheter to prevent differences that might stem from the effects of different IV catheters. IV catheterization in the experimental group was initiated 60 seconds after applying vibration and cold gel pack to patients and with the device still working (with the stimulations of cold and vibration). To comply with the standard procedure, we used only a tourniquet (that did not include use of local anesthetic, cold, or distraction) to perform catheterization in patients in the control group. The participants' pain, anxiety, and satisfaction levels and pulse rates related to IV catheterization were assessed immediately after the procedure in both groups.

"Buzzy," a recently developed reusable device, is 7.2 cm × 4.8 cm × 2.2 cm in size (MMJ Labs, Atlanta, GA) and combines cooling and vibration. Buzzy was invented by Amy Baxter, MD, and has been applied in an adult population during cannulation attempts (https://buzzyhelps.com).

Data Analysis

Data analysis was performed using SPSS 21. To analyze the data, number-percentage distribution,

Table 1. Distribution of Patient Sociodemographic Characteristics and Pain-Related Experiences

	Groups			
	Experimental (n = 50)	Control (n = 50)	Total (N = 100)	
Features	**n (%)**	**n (%)**	**n (%)**	**Test/*P***
Group of age				
18-33 y	6 (12.0)	13 (26.0)	19 (19.0)	$\chi^2 = 4.232$
34-49 y	14 (28.0)	8 (16.0)	22 (22.0)	$P = .120$
50-64 y	30 (60.0)	29 (58.0)	59 (59.0)	
Mean age (y)	52.12 ± 12.47	47.04 ± 14.73	49.58 ± 13.82	
Gender				
Female	20 (40.0)	22 (44.0)	42 (42.0)	$P = .840$
Male	30 (60.0)	28 (56.0)	58 (58.0)	
Marital status				
Married	39 (78.0)	42 (84.0)	81 (81.0)	$\chi^2 = 0.597$
Single	8 (16.0)	6 (12.0)	14 (14.0)	$P = .742$
Divorced	3 (6.0)	2 (4.0)	5 (5.0)	
Educational status				
İlliterate	7 (14.0)	5 (10.0)	12 (12.0)	$\chi^2 = 3.032$
Primary school graduate	27 (54.0)	25 (50.0)	52 (52.0)	$P = .552$
Secondary school graduate	2 (4.0)	6 (12.0)	8 (8.0)	
High school graduate	6 (12.0)	4 (8.0)	10 (10.0)	
University graduate	8 (16.0)	10 (20.0)	18 (18.0)	
Occupation				
Employee	6 (12.0)	8 (16.0)	14 (14.0)	$\chi^2 = 1.762$
Government official officer	4 (8.0)	5 (10.0)	9 (9.0)	$P = .779$
Self-employed	7 (14.0)	4 (8.0)	11 (11.0)	
Housewife	16 (32.0)	19 (38.0)	35 (35.0)	
Retired	17 (34.0)	14 (28.0)	31 (31.0)	
Chronic disease state				
Yes	25 (50.0)	28 (56.0)	53 (53.0)	$\chi^2 = 0.361$
No	25 (50.0)	22 (44.0)	47 (47.0)	$P = .548$
Current medical diagnosis				
Respiratory system diseases	5 (10.0)	6 (12.0)	11 (11.0)	$\chi^2 = 3.992$
Digestive system diseases	10 (20.0)	13 (26.0)	23 (23.0)	$P = .678$
Endocrine system diseases	4 (8.0)	3 (6.0)	7 (7.0)	
Joint and connective tissue diseases	3 (6.0)	4 (8.0)	7 (7.0)	
Nervous system diseases	8 (16.0)	3 (6.0)	11 (11.0)	
Diagnostic procedures	16 (32.0)	14 (28.0)	30 (30.0)	
Others*	4 (8.0)	7 (14.0)	11 (11.0)	
Cigarettes and/or alcohol use				
Yes (cigarette/alcohol)	16 (32.0)	17 (34.0)	33 (33.0)	$P = 1.000$
No	34 (68.0)	33 (66.0)	67 (67.0)	
Body mass index				
Weak	1 (2.0)	3 (6.0)	4 (4.0)	$\chi^2 = 2.828$
Normal weight	25 (50.0)	19 (38.0)	44 (44.0)	$P = .587$
Overweight	16 (32.0)	18 (36.0)	34 (34.0)	
First degree obese	5 (10.0)	8 (16.0)	13 (13.0)	
Second degree obese	3 (6.0)	2 (4.0)	5 (5.0)	

(Continued)

Table 1. Continued

	Groups			
	Experimental (n = 50)	Control (n = 50)	Total (N = 100)	
Features	**n (%)**	**n (%)**	**n (%)**	**Test/*P***
Pain expectancy				$\chi^2 = 55.192$
As expected	6 (12.0)	37 (74.0)	43 (43.0)	$P = .000$
Less than expected	44 (88.0)	7 (14.0)	51 (51.0)	
More than expected	0	6 (12.0)	6 (6.0)	

*Others: Cardiovascular system diseases, kidney diseases, and immune system diseases.

arithmetic mean, χ^2 test, Fisher's exact test, and Mann-Whitney *U* test were used. Spearman's correlation analysis was used to examine the relationship between the mean scores for pain, anxiety, and satisfaction.

Results

There were no statistically significant differences between the participants in the experimental and control groups in terms of their sociodemographic characteristics ($P > .05$, Table 1). The mean age of the participants was 49.58 ± 13.82 years. Of them 58% were male, 81% were married, 52% were primary school graduates, 35% were housewives, 53% had chronic diseases, 30% were hospitalized for diagnostic procedures, and 67% were neither smokers nor alcohol drinkers. It was found that the level of the pain experienced was less than the expected level in 88% of the patients in the experimental group. The level of the procedure-related pain was the same as the level they expected in 74% of the patients in the control group (Table 1).

The mean pain score of the patients was 1.04 ± 0.96 cm in the experimental group and 5.32 ± 1.64 cm in the control group. The mean satisfaction score of the patients was 95.30 ± 3.89 mm in the experimental group and 82.12 ± 7.48 mm in the control group. The difference between the experimental and control groups in terms of their mean pain and satisfaction scores was significant ($P < .001$; Table 2).

Before catheterization, the patients' mean state anxiety and mean trait anxiety scores were 38.80 ± 4.23 and 46.28 ± 6.19, respectively, and their mean pulse rate was 80.04 ± 12.45 beats/min in the experimental group, whereas their mean state anxiety and mean trait anxiety scores were 39.76 ± 3.90 and 45.98 ± 6.50, respectively, and their mean pulse rate was 76.44 ± 9.62 beats/min in the control group. After catheterization, the patients' mean state anxiety and mean trait anxiety scores were 40.82 ± 3.61 and 46.48 ± 6.44, respectively, and their mean pulse rate was 75.68 ± 11.98 beats/min in the experimental group, whereas their mean state anxiety and mean trait anxiety scores were 40.84 ± 3.80 and 45.98 ± 6.46, respectively, and their mean pulse rate was 75.56 ± 10.02 beats/min in the control group ($P > .05$; Table 3).

The relationship between the state-trait anxiety levels of the patients in the experimental and

Table 2. Patients' Perceived Intravenous Catheterization-Related Pain and Satisfaction Scores

	Experimental (n = 50)	Control (n = 50)		
	Mean ± SD	**Mean ± SD**	**Z**	***P***
Visual analog scale	1.04 ± 0.96	5.32 ± 1.64	−8.534	.000*
Satisfaction	95.30 ± 3.89	82.12 ± 7.48	−7.704	.000*

An asterisk indicates significance at $P < .001$.

Table 3. Pulse Rates and Mean State-Trait Anxiety Inventory Scores Obtained by the Patients Before and After Intravenous Catheterization

	Experimental group (n = 50)	Control group (n = 50)		
	Mean ± SD	Mean ± SD	*Z*	*P*
Before catheterization				
Mean state anxiety scores	38.80 ± 4.23	39.76 ± 3.90	−1.474	.116
Mean trait anxiety scores	46.28 ± 6.19	45.98 ± 6.50	−0.235	.814
Pulse rates	80.04 ± 12.45	76.44 ± 9.62	−1.261	.207
After catheterization				
Mean state anxiety scores	40.82 ± 3.61	40.84 ± 3.80	−0.277	.782
Mean trait anxiety scores	46.48 ± 6.44	45.98 ± 6.46	−0.370	.712
Pulse rates	75.68 ± 11.98	75.56 ± 10.02	−0.723	.470

Z, Mann-Whitney *U* test.

control groups and their pain severity and satisfaction scores before and after IV catheterization was not significant.

Although the correlation between the severity of pain and the level of satisfaction associated with IV catheterization was moderately negative in the patients in the experimental group ($r = -0.637$, $P < .001$), it was weakly negative in the patients in the control group ($r = -0.458$, $P < .05$; Table 4).

Discussion

IV catheterization causes pain and discomfort to many patients.[12,13] In the present study, the Buzzy device used to prevent pain during catheterization. It was found that the level of pain experienced was less than the expected level in 88% of patients in the experimental group but the same as the expected level in 74% of patients in the control group. The mean pain score of patients in the experimental group was significantly lower than that reported by the participants in the control group ($P < .001$). Baxter et al[23] compared the effect of the combination of cold application and vibration with that of a vapocoolant spray on 30 healthy adults and determined that the former intervention reduced the catheterization-related pain without affecting the success of catheterization. In Şahin's[2] study performed with adult patients and in a study by Russell et al[30] conducted with pediatric and adult patients, the Buzzy device was reported to be effective in reducing intramuscular injection-related pain. It seems that studies investigating the effect of the Buzzy device have been conducted mostly with pediatric patients rather than with adult patients. The Buzzy device was reported to reduce pain in studies conducted with children.[2,25,31-36] There are studies evaluating the effectiveness of vibration or ice application on pain. Nanitsos et al,[37] in their study of 62 adults aged between 18 and 72 years reported that vibration reduced the severity of pain experienced during local anesthetic injections used in dental treatment. Öztürk et al[13] conducted a study with 45 patients aged between 18 and 45 years to compare ice application with standard procedure during IV cannulation and found that ice treatment was effective in preventing pain. Aygün et al[38] conducted a study with 120 patients aged more than 18 years to compare the standard method, ice application, and lidocaine-prilocaine cream application with each other during IV catheterization and determined that the mean pain score of the ice-applied group was significantly lower than that of the standard procedure group and that of the lidocaine-prilocaine cream-applied group. The results of the present study were similar to other studies. The results of our study suggest that vibration and cold application are effective in reducing the pain felt during IV catheterization in adults.

Patient satisfaction is an important criterion in the assessment of the quality of health care.[39,40] Reducing the pain felt during IV catheterization can affect patient satisfaction. In a study by Şahin[2] carried out with adult patients, Buzzy increased patient satisfaction during intramuscular injection. Çelik[41] conducted a study on adult patients using ShotBlocker during intramuscular injection and found that ShotBlocker increased

Table 4. Comparison of the State-Trait Anxiety Levels of the Patients With Their Pain Severity and Satisfaction Scores

	Experimental						Control					
Scales	**Before STAI-I**	**After STAI-I**	**Before STAI-II**	**After STAI-II**	**VAS**	**Satisfaction Level**	**Before STAI-I**	**After STAI-I**	**Before STAI-II**	**After STAI-II**	**VAS**	**Satisfaction Level**
Before STAI-I												
r	—	0.485	−0.052	−0.056	0.081	0.007	—	0.646	−0.126	−0.096	−0.037	−0.087
P		.000*	.719	.698	.576	.960		.000*	.385	.508	.796	.546
After STAI-I												
r	—	—	−0.397	−0.438	−0.025	−0.029	—	—	−0.148	−0.113	−0.191	−0.037
P			.040†	.001†	.864	.841			.306	.433	.184	.797
Before STAI-II												
r	—	—	—	0.973	0.020	0.012	—	—	—	0.982	0.067	−0.093
P				.000*	.892	.933				.000*	.644	.519
After STAI-II												
r	—	—	—	—	0.025	−0.019	—	—	—	—	0.071	−0.087
P					.861	.894					.623	.550
VAS												
r	—	—	—	—	—	−0.637	—	—	—	—	—	−0.458
P						.000*						.001†

STAI-I, State-Trait Anxiety Inventory; VAS, visual analog scale.

r = Spearman correlation.

*$P < .001$.

†$P < .05$.

patient satisfaction. Öztürk et al[13] conducted a study to compare the effect of ice application with that of the standard procedure during IV catheterization and found that ice application improved patient satisfaction. The results of the present study were similar to these previously reported results.

Pain experienced during IV catheterization is also associated with anxiety.[16] Controlling anxiety during the interventions allows the patient and the nurse to be more comfortable during the procedure.[20,21] In the present study, no statistically significant difference was found between the experimental and control groups in terms of their state-trait anxiety scores before and after IV catheterization ($P > .05$). The mean pre-IV and post-IV catheterization trait anxiety scores in the experimental group were similar to those of the control group. The anxiety levels were likely not very different from each other because they reflected the general thinking and personality traits of the participants.

Studies investigating the relationship between IV catheterization and anxiety levels have generally been performed with children. In the study by Baxter et al[25] investigating the anxiety levels caused by IV catheterization in children aged between 4 and 18 years, by Canbulat et al[31] in children aged 7 to 12 years, by Russell et al[30] in children and adults, by Inal and Kelleci[32] in children aged between 6 and 12 years, and by Şahiner et al[35] in 7-year-old children, the Buzzy device was reported to be effective in reducing anxiety level. The results of the present study were not similar to the results of other studies, likely because the anxiety assessment methods used in the latter studies were different and their sample groups comprised only children. The level of anxiety related to IV catheterization in adults has been investigated only in one study. Baxter et al[23] conducted a study with 30 healthy adults and compared the combination of cold application and vibration with vapocoolant spray, which can produce immediate skin anesthesia. They assessed the preprocedural anxiety level with a scale 5 cm in length and determined no significant difference between the groups, similar to the findings of the present study.

Limitations

The present study had some limitations. First, because the number of studies on the effectiveness of the Buzzy device is limited and because the present study was conducted with only 100 patients admitted to one hospital, the results obtained from this study are applicable only to the patients surveyed and cannot be generalized to other patients. Another limitation of the study was that because pain- and anxiety-related data are subjective, their assessment was based on the participants' statements.

Conclusions

During IV catheterization, the pain score decreased, and the satisfaction score and state anxiety level increased, but the trait anxiety level did not change. It is recommended that to reduce pain during IV catheterization, vibration and cold gel pack application be used in adult patients. It is also recommended that the effects of the vibration and cold gel pack application be compared with those of other nonpharmacologic methods used to reduce pain with IV catheterization, particularly in larger adult sample groups. It is also recommended that in future studies, IV catheters of different sizes should be used, because it is not known whether Buzzy is effective in all catheter sizes.

Acknowledgments

The authors would like to thank all the participants for their support and contribution to the study.

References

1. Karabacak GB. Parenteral drug applications. In: Sabuncu N, Ay AF, eds. *Klinik Beceriler Sağlığın Değerlendirilmesi Hasta Bakım ve Takibi*. İstanbul: Nobel Tıp Kitabevleri; 2010:250-300.

2. Şahin M. *Effect of Buzzy on pain and injection satisfaction in adult patients who received intramuscular injection*. İzmir: Ege University Institute of Medical Sciences, Department of Fundamentals of Nursing, Master's Thesis; 2013 (Advisor: Prof. Dr. İsmet Eşer).

3. Pamela L. *Taylor's Clinical Nursing Skills: A Nursing Process Approach*. Translator: KorkmazF, InceS, KorhanEA, Sağkal, T, 3rd ed. Ankara: Nobel Akademik Yayıncılık Eğitim Danışmanlık Tic. Ltd. Şti; 2015:151-276.

4. Denat Y, Eşer İ. Peripheral intravenous catheterization in elderly. *Cumhuriyet Üniversitesi Hemşirelik Yüksekokulu Dergisi*. 2006;10:43-49.

5. Fujita T, Namiki N. Replacement of peripheral intravenous catheters. *J Clin Nurs*. 2008;17:2509-2510.

6. Karadağ A. Dressing materials which are used in intravenous catheter insertion. *Cumhuriyet Üniversitesi Hemşirelik Yüksekokulu Dergisi*. 1999;3:35-39.

7. Richet H, Hubert B, Nitemberg G, et al. Prospective multicenter study of vascular-catheter-related complications and risk factors for positive central catheter cultures in intensive care unit patients. *J Clin Microbiol*. 1990;28:2520-2525.

8. Rosenthal K. Tailor your IV insertion techniques for special populations. *Nursing*. 2005;35:36-41.

9. Boyd S, Aggarwal I, Davery P, Logan M, Nathwani D. Peripheral intravenous catheter: The road to quality improvement and safer patient care. *J Hosp Infect*. 2011;77:37-41.

10. Avşar G, Özlü ZK, Gümüş K, Özer N, Aytekin A. Determination of the situation of nurses related to the application of peripheric venous catheter. *Gümüşhane Univ J Health Sci*. 2013; 2:499-507.

11. Ovayolu N, Güner CI, Karadağ G. Santral venöz kateter uygulanan hastalarda uygulama öncesi ve sonrası alınan önlemlerin belirlenmesi [The determination the precautions taken before and after application of central venous catheter]. *Atatürk Üniversitesi Hemşirelik Yüksekokulu Dergisi*. 2006;9:26-35.

12. Agarwal A, Sinha PK, Tandon M, Dhiraaj S, Singh U. Evaluating the efficacy of the valsalva maneuver on venous cannulation pain: A prospective, randomized study. *Anesth Analg*. 2005;101:1230-1232.

13. Öztürk E, Erdil AF, Begeç Z, Yücel A, Şanlı M, Ersoy MÖ. The effects of ice on intravenous cannulation pain. *Fırat Tıp Dergisi*. 2009;14:108-110.

14. Houston S, Jesurum J. The quick relaxation technique: Effect on pain associated with chest tube removal. *Appl Nurs Res*. 1999;12:196-205.

15. Plaisance L, Logan C. Nursing students' knowledge and attitudes regarding pain. *Pain Manag Nurs*. 2006;7:167-175.

16. Barr RG. Pain in children. In: Wall PD, Melzack R, eds. *Textbook of Pain*, 2nd ed. NewYork: Churchill Livingstone; 1989:569-588.

17. Beesdo K, Jacobi F, Hoyer J, Low NCP, Höfler M, Wittchen HU. Pain associated with specific anxiety and depressive disorders in a nationally representative population sample. *Soc Psychiatry Psychiatr Epidemiol*. 2010;45:89-104.

18. Kuğuoğlu S. Factors affecting the perception of pain. In: Aslan EF, ed. *Ağrı Doğası ve Kontrolü*, 1st ed. İstanbul: Avrupa Tıp Kitapçılık Ltd. Şti; 2006:51-59.

19. Tel H. Pain, applications for pain and patient care. In: Sabuncu N, Ay AF, eds. *Klinik Beceriler: Sağlığın Değerlendirilmesi Hasta Bakım veTakibi*. İstanbul: Nobel Tıp Kitabevleri; 2010:652-674.

20. Carleton RN, Abrams MP, Kachur SS, Asmundson GJG. Waddell's symptoms as correlates of vulnerabilities associated with fear-anxiety-avoidance models of pain: Pain-related anxiety, catastrophic thinking, perceived disability, and treatment outcome. *J Occup Rehabil*. 2009;19:364-374.

21. Muğlalı M, Kömerik N. Oral surgery and anxiety. *Cumhuriyet Üniversitesi Diş Hekimliği Fakültesi Dergisi*. 2005;8:83-88.

22. Başaranoğlu G, Başaranoğlu M, Erden V, Delatioğlu H, Pekel AF, Saitoğlu L. The effects of valsalva manoeuvres on venepuncture pain. *Eur J Anaesthesiol*. 2006;23:591-593.

23. Baxter AL, Leong T, Mathew B. External thermomechanical stimulation versus vapocoolant for adult venipuncture pain: Pilot data on a novel device. *Clin J Pain*. 2009;25:705-710.

24. Melzack R, Wall PD. Pain mechanisms: A new theory. *Science*. 1965;150:971-979.

25. Baxter AL, Cohen LL, McElvery HL, Lawson ML, Von Baeyer CL. An integration of vibration and cold relieves venipuncture pain a pediatric emergency department. *Pediatr Emerg Care*. 2011;27:1151-1156.

26. Kakigi R, Shibasaki H. Mechanisms of pain relief by vibration and movement. *J Neurol Neurosurg Psychiatry*. 1992;55: 282-286.

27. Özyalçın S, Dinçer S. Neuromodulation. *Klinik Gelişim*. 2007;20:195-200.

28. Nahra H, Plaghki L. Innocuous skin cooling modulates perception and neurophysiological correlates of brief CO_2 laser stimuli in humans. *Eur J Pain*. 2005;9:521-530.

29. Öner N, Le Compte A. *Durumluk Sürekli Kaygı Envanteri El Kitabı*. 1st ed., 333. İstanbul: Boğaziçi Üniversitesi Yayınları; 1983:1-26.

30. Russell K, Nicholson R, Naidu R. Reducing the pain of intramuscular benzathine penicillin injections in the rheumatic fever population of counties Manukau District Health Board. *J Pediatr Child Health*. 2014;50:112-117.

31. Canbulat N, Ayhan F, Inal S. Effectiveness of external cold and vibration for procedural pain relief during peripheral intravenous cannulation in pediatric patients. *Pain Manag Nurs*. 2015;16:33-39.

32. Inal S, Kelleci M. Relief of pain during blood specimen collection in pediatric patients. *Am J Matern Child Nurs*. 2012;37:339-345.

33. Moadad N, Kozman K, Shahine R, Ohanian S, Badr LK. Distraction using the Buzzy for children during an IV insertion. *J Pediatr Nurs*. 2015;31:64-72.

34. Schreiber S, Cozzi G, Rutigliano R, et al. Analgesia by cooling vibration during venipuncture in children with cognitive impairment. *Acta Paediatr*. 2016;105:e12-e16.

35. Şahiner CN, Inal S, Akbay AS. The effect of combined stimulation of external cold and vibration during immunization on pain and anxiety levels in children. *J Perianesth Nurs*. 2015; 30:228-235.

36. Whelan HM, Kunselman AR, Thomas NJ, Moore J, Tamburro RF. The impact of a locally applied vibrating device on outpatient venipuncture in children. *Clin Pediatr (Philadelphia)*. 2014;53:1189-1195.

37. Nanitsos E, Vartuli R, Forte A, Dennison PJ, Peck CC. The effect of vibration on pain during local anaesthesia injections. *Aust Dental J*. 2009;54:94-100.

38. Aygün H, Armağan E, Özdemir F, et al. Comparison of ice and lidocaine-prilocaine cream mixture in the reduction of pain during peripheral intravenous cannulation in emergency department patients. *J Acad Emerg Med*. 2013;12:27-29.

39. Arslan S, Nazik E, Tanrıverdi D, Gürdil S. Determining the level of satisfaction of patients in nursing care and health services. *TAF Prev Med Bull*. 2012;11:717-724.

40. Uzun Ö. Patient satisfaction with nursing care at a university hospital in Turkey. *J Nurs Care Qual*. 2001;16:24-33 (Abstract).

41. Çelik N. *Investigation of the effect of "Shotblocker" on reducing pain and anxiety associated with intramuscular injection*. Doctoral Thesis. İzmir: Ege University Institute of Medical Sciences, Department of Fundamentals of Nursing; 2012 (Advisor: Prof. Dr. Leyla Khorshid).