Effect of Fist Clenching on Vein Visibility and Palpability

An Observational Descriptive Study

Handan Eren, PhD, MSc, BSc, RN • Nurcan Calıskan, PhD, MSc, BSc, RN • Mahinur Durmus Iskender, PhD, MSc, BSc, RN

ABSTRACT

No information exists on the minimum number of times that fist clenching should be performed to increase vein visibility and palpability. In this study, the researchers aimed to determine the average number and duration of fist clenching to increase vein visibility and palpability before peripheral intravenous catheter insertion. This observational study included 207 healthy individuals. Participants meeting the inclusion criteria were asked to perform fist clenching. The number and duration of fist clenches performed to increase dorsal metacarpal vein and cephalic vein grade were determined. The participants carried out fist clenching 7.57 ± 4.26 times for the first increase and 22.16 ± 7.93 times for the second increase in dorsal metacarpal vein grade. Fist clenching was carried out 10.05 ± 7.30 times for the first increase and 21.30 ± 7.86 times for the second increase in cephalic vein visibility. A statistically significant, weak, but positive relationship was observed between the duration of fist clenching and the change in dorsal metacarpal vein grade and anxiety level ($r = 0.194$, $P < .005$). However, the relationship was negative between room temperature and the duration of fist clenching in dorsal metacarpal vein grade ($r = –0.207$, $P = .003$). This inexpensive and simple technique should be performed in specified numbers before catheter insertion.

Key words: fist clenching, vein assessment, vein grade, vein palpability, vein visibility

Author Affiliations: *Department of Nursing, Yalova University, Yalova, Turkey (Dr Eren); Department of Nursing, Gazi University, Ankara, Turkey (Dr Caliskan); Department of Midwifery, Kastamonu University, Kastamonu, Turkey (Dr Durmus Iskender).*

Handan Eren, PhD, MSc, BSc, RN, *is an assistant professor in the Yalova University Department of Nursing. She spent 4 years working as an intensive care nurse. She has been working as an academician for 10 years. She focuses on vein visibility and catheter insertion.* **Nurcan Caliskan, PhD, MSc, BSc, RN,** *is a professor in the Gazi University Department of Nursing. She spent 3 years working as a nurse in the surgical department. She has been working as an academic for 20 years. She has many national and international publications. Her works focuses on hot and cold applications, as well as psychomotor skills in nursing education.* **Mahinur Durmus Iskender, PhD, MSc, BSc, RN,** *is an assistant professor in the Kastamonu University Department of Midwifery. She has been working as an academician for 13 years. Her works focuses on complementary and supporting applications and nursing education.*

Disclosure: *The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.*

Funding: *The authors received no financial support for the research, authorship, and/or publication of this article.*

Corresponding Author: *Handan Eren, PhD, MSc, BSc, RN, Gokcedere District Nergis Street No: 23 Termal/Yalova, Turkey (erennhandan@gmail.com).*

DOI: 10.1097/NAN.0000000000000480

BACKGROUND

Peripheral intravenous catheter (PIVC) insertion is an invasive intervention, commonly performed by nurses, to replace fluid and electrolyte loss, to administer blood and blood products, and for administration of intravenous medications.[1,2] PIVC insertion is not always successful in a single attempt.[3] Multiple insertion attempts may be uncomfortable for the patient, threaten patient safety by introducing the risk of infections, and increase costs for health care institutions by prolonging the hospital stay. In addition, repetitive attempts can cause injury and further increase the risk of infection. Therefore, it is essential to place the catheter efficiently in the first attempt and use techniques that facilitate increased vein visibility and palpability.[3,4]

Vessel visibility and palpability during PIVC insertion assist the cannulation procedure, especially when vein visualization technologies are not being used, thereby increasing the success rate.[5,6] Therefore, techniques that improve the visibility and palpability of veins are indispensable for successful catheter insertion. Many methods are used to increase vein visibility, such as tourniquet application, holding the arm below the heart level, massaging in

the direction of venous flow, isometric arm exercise, fist clenching, local heat application to the site, and changing patient position.[6-9] Among these techniques, fist clenching makes the veins more prominent and helps ease catheter placement.[9]

In fist clenching, the power generated by the muscular contraction resulting from cyclic opening and closing of an individual's palm increases arterial blood flow, consequently providing venous return.[9] An increase in blood flow results in increased basilic and cephalic venous filling, as well as venous distension.[9,10] The literature reports that fist clenching can increase vein fullness.[9-11] This technique offers ease of applicability and is frequently used by nurses in clinics; however, the literature does not report information on the number or duration of fist clenching that would increase vein visibility. Bayram et al[11] conducted a study to determine the number of fist clenches that improved vein visibility in patients who received intravenous chemotherapy.

The practice of this technique before catheter insertion requires detailed information about the method. Defining the average number of fist clenches needed to improve vein visibility and palpability will help develop a standard procedure. In this study, the researchers aimed to determine the numerical values for using this technique. They did not examine clinical practice or nursing education curriculum costs.

METHODS

Participants

In this observational descriptive study, the participants were recruited from a university between January 2021 and May 2021 with the following inclusion criteria: age range of 18 to 74 years; a vein grade of 1, 2, 3, or 4; no recent history of blood drawn from the vein to be evaluated; no peripheral intravenous catheter inserted; no history of chronic disease; no record of any known cardiovascular disease; not having performed any exercise before the measurement; not having carried heavy weight; no history of mastectomy; absence of any acute trauma, inflammation, ecchymosis, hematoma, scar tissue, or edema; no metal prosthesis around the limb; no noticeable deformity in the arm; no history of anticoagulant treatment; absence of any musculoskeletal disease in the hands; no history of smoking; no communication problems; and a level of cognition suitable to participate in the study in addition to voluntary participation. Participants were excluded from the study in case of impairment of circulation after tourniquet application. If a patient was unable to continue the fist-clenching process, they were excluded from the study.

Sample Size and Randomization

The G Power package program (version 3.1.9.2, Heinrich Heine-Universitat, Dusseldorf, Germany) was used to determine the sample size. Because the literature does not report any similar study, the power analysis was performed assuming that the effect size of the relationship between the variables to be examined could be at a weak level ($r = 0.2$). The power was calculated as 90% at a 95% confidence interval when at least 207 people were included in the study. Data collection for the study continued until the specified number was reached.

Measurement Instruments

Data were collected through questionnaires (demographic data form and vein assessment form). The demographic data form included information on the participants' gender, age, skin color, body mass index (BMI), room temperature, body temperature, diastolic blood pressure, and anxiety level. A scale was used to measure participants' anxiety levels, the scores of which ranged from 0 (no anxiety) to 10 (total anxiety).

The vein assessment form included information on the vein grade before and after tourniquet application, and during the fist-clenching process, in addition to the number and duration of the fist clenching to be performed to increase the vein visibility of the dorsal metacarpal and cephalic vein. A 5-point vein assessment scale was used to assess the visibility and palpability of peripheral veins before and after applying the tourniquet and fist clenching.[12] This scale scoring was as follows: (1) vein is neither visible nor palpable, (2) vein is visible but not palpable, (3) vein is barely visible and palpable, (4) vein is visible or palpable, and (5) vein is visible and palpable (Table 1).

Intervention

Data were collected by researchers. Participants meeting the inclusion criteria were informed about the study and were invited to the researchers' office at an appropriate day and time. The height and weight of the participants were measured. Before the measurement of vital signs, participants were required to rest for 15 minutes. During this period, demographic information of the participants was enquired. The participants were informed about the instructions to be followed and explained by the illustration on how to clench and reopen the fist with the researchers' commands. During this time, the participants were asked to do the procedure at the same pace without pausing and to follow the process at the same speed without breaking. All of the procedures were carried out in the same examination

TABLE 1

Vein Assessment Scale

Grade	
1	Vein is neither visible nor palpable
2	Vein is visible but not palpable
3	Vein is barely visible and palpable
4	Vein is visible or palpable
5	Vein is visible and palpable

room at an ambient temperature determined by a digital thermometer. The process was completed on the same arm of every participant, first in the dorsal metacarpal vein and then in the cephalic vein.

Before the procedure, participants were asked to sit and bring their arm to heart level. The participants' vein grade was evaluated and recorded by the researchers on the vein assessment form. Because the literature mentions that tourniquet use and pressure affect vein visibility, a sphygmomanometer cuff was placed on the arm that the participant did not actively use. The cuff was inflated after vital signs were measured before altering the diastolic blood pressure level. As soon as the cuff reached the desired value, the participant was instructed to start, and the chronometer was activated. The participants' vein grade and the number and duration of fist clenching were evaluated by the researcher. The participants were allowed to rest for 15 minutes before cephalic vein measurements. The same procedures were performed for cephalic vein measurement. The process was continued until the vein grade was 5; however, because the literature reports that the maximum tourniquet application time should be 2 minutes, the fist clenching was limited to a maximum of 2 minutes.[12] The vein grade determined at the end of this period was accepted as the maximum.

Statistical Analysis

Demographic data were summarized as the means (standard deviations) for continuous variables and frequency counts (percentages) for categorical variables. The normality of the data was examined using a 1-sample Kolmogorov–Smirnov test. Nonconforming data were evaluated, with the Wilcoxon test being one of the nonparametric tests used to define comparisons between the increase in first and second vein grades. The Pearson correlation analysis was used to investigate the relationships between the variables. The level of statistical significance was accepted as $P < .05$.

Ethical Approval

The Kastamonu University Ethics Committee approved the study (institutional review board approval: 20210104), and all of the participants provided written informed consent before being interviewed.

RESULTS

The average age of the participants was 42.08 ± 14.03 years; 50.7% of the participants were women (Table 2).

For the dorsal metacarpal vein, the number of people with a vein grade of 1 was 25 before the tourniquet was applied; this number decreased to 13 after tourniquet application. For the cephalic vein, the number of people with a vein grade of 1 was 48 before tourniquet application; this number dropped to 28 after the tourniquet was applied (Table 3).

TABLE 2

Individual Identifying Features of the Participants (N = 207)

Variables	Data
Sex, n (%)	
Female	105 (50.7)
Male	102 (49.3)
Skin color, n (%)	
Light	60 (29.0)
Medium	75 (36.2)
Dark	72 (34.8)
Age (mean ± SD), y	42.08 ± 14.00
BMI (median [max, min]), kg/m^2	26.39 ± 4.64
Room temperature (mean ± SD), °C	27.44 ± 1.42
Diastolic blood pressure (mean ± SD), mm Hg	75.56 ± 7.60
Body temperature (mean ± SD), °C	36.29 ± 0.30
Anxiety level (mean ± SD)	2.13 ± 2.11

Abbreviations: BMI, body mass index; SD, standard deviation.

In the study, an increase in vessel grade with tourniquet and fist clenching was observed in all participants. Participants performed fist clenching 7.57 ± 4.26 times for the first increase and 22.16 ± 7.93 times for the second increase in dorsal metacarpal vein grade. Similarly, for cephalic vein grade, the procedure was repeated 10.05 ± 7.30 times for the first increase and 21.30 ± 7.86 times for the second increase. It was further determined that a significant relationship existed between the number and duration of fist clenching for the first and second increases in vein grade of the participants ($P < .05$; Table 4).

A statistically significant, weak, and negative correlation between room temperature and fist clenching duration was found with an alteration in the dorsal metacarpal vein grade ($r = –0.207$, $P = .003$). A statistically significant correlation between anxiety level and fist clenching duration was found, with a change in the dorsal metacarpal vein positive and at a weak level ($r = 0.194$, $P = .005$). Furthermore, a statistically significant, positive, and weak relationship was observed between BMI and duration ($r = 0.219$, $P = .002$) and the number of fist clenches required to change the cephalic vein grade ($r = 0.215$, $P = .002$; Table 5).

DISCUSSION

This study derived the numerical data for the fist-clenching technique used to increase vein visibility and palpability. Tourniquet application increased the success of PIVC insertion by increasing the visibility and palpability of the vein. Studies have shown that tourniquet application increases

TABLE 3

Vein Grade of Participants Before and Immediately After Tourniquet Application

		Before Tourniquet Application		Immediately After Tourniquet Was Applied		Maximum	
	Vein Degree	(n)	(%)	(n)	(%)	(n)	(%)
Dorsal metacarpal vein	1	25	12.1	13	6.3	-	-
	2	53	25.6	45	21.7	2	1.0
	3	69	33.3	23	11.1	4	1.9
	4	60	29.0	86	41.5	34	16.4
	5	-	-	40	19.3	167	80.7
Cephalic vein	1	48	23.2	28	13.5	-	-
	2	17	8.2	19	9.2	5	2.4
	3	115	55.6	77	37.2	11	5.3
	4	27	13.0	72	34.8	42	20.3
	5	-	-	11	5.3	149	72.0

the vein grade by preventing blood flow and ponding the veins.[10-14] This finding is similar with findings reported in the literature.

Because fist-clenching speed can vary among individuals, the fist clenching that should be performed to increase vein grade was measured in both duration and number of fist clenches. Participants performed fist clenching 7.57 ± 4.26 times, for 8.78 ± 5.49 seconds for the increase in the first vein grade in the dorsal metacarpal vein, and 10.05 ± 7.30 times, for 11.29 ± 8.38 seconds for the improvement in the first vein grade of the cephalic vein. The literature does not report any study similar to this research, except for the one conducted by Bayram et al,[11] who established that participants needed to perform fist clenching 10.13 ± 4.33 times for the first increase in vein grade. In their study, PIVCs were placed primarily in the basilic vein, and the study sample was composed of patients with impaired vascular structure who were receiving chemotherapy treatment. Therefore, the lower number of fist clenches required to increase vein grade in the present study may be related to the fact that the research was conducted on healthy individuals with an intact vein structure.

In the present study, the researchers found a significant difference between the first increase in vein grade and the second increase in duration and number averages. This may be due to fatigue in the participants who performed

TABLE 4

Average Number and Duration of Fist Clenches Performed by Participants to Increase Vein Grade After Tourniquet Application

Dorsal Metacarpal Vein (n = 167)		Mean ± SD	Med (min-max)	*P* Values
Total time (seconds)	First increase	8.78 ± 5.49	7.0 (3-31)	.0001 ($z = -9.157$)
	Second increase	26.10 ± 12.00	22.5 (11-61)	
Total number	First increase	7.57 ± 4.26	6 (3-25)	.0001 ($z = -9.565$)
	Second increase	22.16 ± 7.93	21 (11-52)	
Cephalic vein (n = 194)				
Total time (seconds)	First increase	11.29 ± 8.38	8 (2-53)	.0001 ($z = -8.874$)
	Second increase	24.02 ± 10.50	21 (10-60)	
Total number	First increase	10.05 ± 7.30	8 (2-43)	.0001 ($z = -9.187$)
	Second increase	21.30 ± 7.86	20 (11-52)	

Abbreviation: SD, standard deviation.

TABLE 5

Correlation Between Independent Variables and Number and Duration Averages of Fist Clenches (N = 207)

Fist Clenching		Dorsal Metacarpal Vein		Cephalic Vein	
		Time	Number	Time	Number
Age (y)	*r*	−.138	−.109	.023	.052
	P	**.047**	.118	.738	.457
BMI (kg/m^2)	*r*	.023	−.009	.219	.215
	P	.746	.895	**.002**	**.002**
Room temperature (°C)	*r*	−.157	−.207	.034	−.003
	P	**.023**	**.003**	.623	.969
Diastolic blood pressure (mm Hg)	*r*	.043	.013	.157	.131
	P	.538	.850	**.024**	.060
Body temperature (°C)	*r*	.053	.098	.012	.059
	P	.447	.162	.865	.396
Anxiety level (0-10)	*r*	.194	.135	.131	.085
	P	**.005**	.053	.059	.224

Abbreviation: BMI, body mass index.
Bold indicates significance.

fist clenching continually, supported by the fact that the fist-clenching period required for the second increase in the participants' vein grade is more than the number of fist clenches. In this case, it is expected that ponding in veins would decrease with the slowing of muscle movement.

Success for nurses in PIVC insertion increases when veins are visible and palpable.[11] One of the factors that increases vein visibility and palpability is the ambient temperature.[4-7] In this study, the researchers observed that as the room temperature increased, the number and duration of fist clenching to be performed for increased dorsal metacarpal vein grade decreased. Although this result was expected, it was observed that body temperature did not significantly affect this number and duration. This may be due to the small difference between the minimum and maximum values of the participants' body temperature.

The researchers further observed that, as BMI increased, the number and duration of fist clenches to be performed to improve the vein grade increased. This result may be related to the effect of the increased BMI on subcutaneous fat tissue, thus reducing vein visibility. In a meta-analysis examining the risk factors associated with difficult PIVC insertion, the authors stated that the increase in BMI made PIVC placement difficult.[15] In a study conducted by Brandt et al[16] involving individuals with morbid obesity (BMI >40 kg/m^2), evaluation of the veins on an ultrasound revealed that only 21.8% of the antecubital veins were visible.

In addition to room temperature and BMI, anxiety level can affect vein visibility and palpability.[17] As the anxiety level increases, the sympathetic nervous system is activated, the vasomotor center is stimulated, and the narrowing of the vessel diameters is seen.[18] In this case, the visibility of the veins may be reduced. In the current study, the researchers observed that, as the anxiety level increased, the number of fist clenches performed to improve the vein grade increased. Gerçeker et al[19] found a significant relationship between anxiety level and vein visibility ($P < .05$). In another study, the nurses stated that the increase in the patients' anxiety levels made the PIVC placement process difficult.[20] Therefore, interventions by nurses to reduce the anxiety levels of individuals before catheter placement would increase vein visibility and palpability.

Limitations

This study was conducted among healthy individuals, thus presenting a limitation. Another limitation was the evaluation of vein grade with only the vein assessment scale. More studies must be conducted with radiological images to investigate the effects of the fist-clenching technique on vein visibility and palpability. Furthermore, the length of time the vein remained dilated was not measured in the study. More studies are needed on how long fist clenching is effective before venipuncture.

CONCLUSION

Visibility and palpability of veins are essential for successful catheter placement when not using vein visualization technologies. Tourniquet application and fist clenching increase vein visibility and palpability. The use of the inexpensive

and simple fist clenching technique alone or in combination with other methods that increase visibility and palpability of the vein would shorten the catheter placement time, increasing its success and reducing anxiety and pain in patients. Because fist clenching increases vein size, venipuncture success rate may increase and the pain level of the patients may decrease.

ACKNOWLEDGEMENTS

The authors thank all those who participated in this study.

REFERENCES

1. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med*. 2017;13(2):83-89. doi:10.12788/jhm.2867
2. Lindstrom H, Kearney L, Massey D, Godsall G, Hogan E. How midwives manage rapid pre-loading of fluid in women prior to low dose epidurals: a retrospective chart review. *J Adv Nurs.* 2018;74(11):2588-2595. doi:10.1111/jan.13783
3. Rodriguez-Calero MA, Fernandez-Fernandez I, Molero-Ballester LJ, et al. Risk factors for difficult peripheral venous cannulation in hospitalised patients: protocol for a multicentre case–control study in 48 units of eight public hospitals in Spain. *Br Med J.* 2018;8(2):e020420. doi:10.1136/bmjopen-2017-020420
4. Tokizawa T, Tsujimoto T, Inoue T. Duration of venodilation for peripheral intravenous cannulation, as induced by a thermal stimulus on the forearm. *Biol Res Nurs.* 2017;19(2):206-212. doi:10.1177/1099800416651145
5. Angles E, Robin F, Moal B, et al. Pre-operative peripheral intravenous cannula insertion failure at the first attempt in adults: development of the VENSCORE predictive scale and identification of risk factors. *J Clin Anesth.* 2021;75:110435. doi:10.1016/j.jclinane.2021.110435
6. Yamagami Y, Inoue T. Patient position affects venodilation for peripheral intravenous cannulation. *Biol Res Nurs.* 2020;22(2):226-233. doi:10.1177/1099800419893027
7. Biyik Bayram S, Caliskan N. Effects of local heat application before intravenous catheter insertion in chemotherapy patients. *J Clin Nurs.* 2016;25:1740-1747. doi:10.1136/eb-2016-102451
8. Eren H, Turkmen AS, Aslan A. Effect of topical application of black pepper essential oil on peripheral intravenous catheter insertion: a randomized controlled study. *Explore (NY)*. 2022;18:457-462. doi:10.1016/j.explore.2021.06.001
9. Eren H. Difficult intravenous access and its management. In: Gaffar Z. *Outpatient Care*. IntechOpen; 2021:5.
10. Eren H, Caliskan N. Effect of a vein imaging device and of fist clenching on determination of an appropriate vein and on catheter placement time in patients receiving chemotherapy: a randomized controlled trial. *Cancer Nurs.* 2022;45(2):105-112. doi:10.1097/NCC.0000000000000931
11. Bayram SB, Eren H, Caliskan N. Vein visibility and venous fullness providing techniques in patients with chemotherapy. *Düzce Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi*. 2021;11(2):273-278. doi:10.33631/duzcesbed.732209
12. Yao J, Yan H, Zeng Z, et al. The effect of application of a distal tourniquet on ultrasound guided radial artery cannulation in adult patient. *Am J Emerg Med.* 2018;36(4):669-672. doi:10.1016/j.ajem.2017.12.034
13. Samra AS, Kumar CN. Effectiveness of moist heat therapy on visibility, palpability, pricks and pain experienced while undergoing peripheral intravenous cannulation of patients. *Int J Health Sci Res.* 2018;8:192-199.
14. Plohal A. A qualitative study of adult hospitalized patients with difficult venous access experiencing short peripheral catheter insertion in a hospital setting. *J Infus Nurs*. 2021;44(1):26-33. doi:10.1097/NAN.0000000000000408
15. Rodríguez-Calero MA, Blanco-Mavillard I, Morales-Asencio JM, et al. Defining risk factors associated with difficult peripheral venous cannulation: a systematic review and meta-analysis. *Heart Lung*. 2020;49(3):273-286. doi:10.1016/j.hrtlng.2020.01.009
16. Brandt HG, Jepsen CH, Hendriksen OM, Lindekær A, Skjønnemand M. The use of ultrasound to identify veins for peripheral venous access in morbidly obese patients. *Dan Med J.* 2016;63(2):A5191.
17. Parker SI, Benzies KM, Hayden KA, Lang ES. Effectiveness of interventions for adult peripheral intravenous catheterization: a systematic review and meta-analysis of randomized controlled trials. *Int Emerg Nurs*. 2017;31:15-21. doi:10.1016/j.ienj.2016.05.004
18. Faraci FM. Watching small vessel disease grow. *Circ Res*. 2018;122(6):810-812. doi:10.1161/CIRCRESAHA.118.312762
19. Gerçeker GÖ, Ayar D, Özdemir EZ, Bektaş M. The impact of the difficult vascular access, fear, and anxiety level in children on the success of first-time phlebotomy. *J Vasc Access.* 2018;19(6):620-625. doi:10.1177/1129729818765598
20. Piredda M, Fiorini J, Facchinetti G, et al. Risk factors for a difficult intravenous access: a multicentre study comparing nurses' beliefs to evidence. *J Clin Nurs*. 2019;28(19-20):3492-3504. doi:10.1111/jocn.14941