Effectiveness of Valsalva Maneuver on Pain among Patients Undergoing Peripheral Intravenous Cannulation

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Abstract

Background: Peripheral intravenous cannulation is a frequent procedure nurses perform that causes pain and anxiety to patients. The valsalva maneuver performed during venous cannula insertion can effectively reduce the incidence and severity of venipuncture pain in adults. **Aim:** This study was designed to evaluate the effectiveness of valsalva maneuver in reducing pain among adult patients undergoing peripheral intravenous cannulation. **Method**: A quasi-experimental research design was adopted in this study, which was conducted at the surgical and medical departments of Mansoura University Hospital. A purposive sample of 60 patients who were randomly classified into two groups*:* The study group consisted of 30 patients who underwent peripheral intravenous cannulation during valsalva maneuver, and the control group comprised 30 patients who were punctured using the routine method. The patients' pain scores were evaluated 2 min after cannulation using the numerical rating scale for pain, and the Pain Anxiety Symptoms Scale-20 was used to assess the level of anxiety. **Results:** In the control group, 40% of the patients had severe pain, whereas, in the study group, 43.3% had mild pain. A statistically significant difference was observed between the control and study groups (p = 0.0023). Moreover, statistically significant differences in pain level and anxiety symptoms were observed between the control and study groups ($p < 0.05$). **Conclusion:** The valsalva maneuver is a simple cost-effective method for decreasing pain and level of anxiety during Peripheral intravenous cannulation. **Recommendation:** we recommend the use of the Valsalva maneuver before performing the Peripheral intravenous cannulation for reducing pain and related stress during venous cannulation in adults**.**

Keywords: Pain, Valsalva maneuver, peripheral, intravenous cannulation

Introduction:

Peripheral intravenous cannulation (PIVC) is the most widely used invasive procedure in hospitals, and approximately 70% of patients require PIVC during hospitalization **(Thomas, Cabilan, & Johnston, 2020)**. Although intravenous cannulation is a common clinical procedure, it has significant risks and can cause pain for patients. Pain remains the main obstacle to drug delivery for all people. It is related to the penetration of the needle through the skin and the mechanical and chemical effects of the drug during and after injection **(Ashkenazy & Ganz, 2019; Soliman, Ouda, & Mahmoud, 2019; Welyczko, 2020)**.

Expectations of painful venous cannulation are often underestimated. Past venous cannulation experiences may lead to the avoidance or delay of required medical care **(Vyas, Sharma, Goyal, & Kothari, 2021**). Fear of this process may trigger an autonomic nervous response, leading to vasoconstriction and further difficulties in venous access. A clinical study by an expert anesthesiologist has shown that the discomfort caused by intravenous cannulation was listed as the top five clinical results with low outcomes. For patients who fear needles or have bad experiences with needles, cannula insertion is often complicated **(Scarlett, 2019)**.

Relief of pain prescription is considered a basic human right; many pharmacological and non-pharmacological ways have been used to decrease pain and anxiety during PIVC. Interestingly, nurses can use the following alternative techniques to decrease PIVC-associated discomforts: parental presence, speech, local anesthesia, hypnosis, and ice compress **(Basak, Duman, & Demirtas, 2020)**. Studies on decreasing pain associated with PIVC have been conducted. **Bond et al. (2015)** has used local anesthetics to decrease pain, whereas have investigated the effectiveness of external cold and vibration in reducing pain during PIVC. Moreover, **Karaman (2016)** has investigated the effects of lavender

aromatherapy on PIVC-associated pain and anxiety.

Few clinical studies have shown that the Valsalva maneuver (VM) performed during PIVC can effectively decrease the frequency and level of venipuncture pain in adults. The VM is a non-pharmacological method that can be used to relieve pain during intravenous cannula insertion and is performed by exhalation against airway is closed to pain decrease. Applying the VM during PIVC decreases the severity and frequency of pain by increasing the pressure in the chest cavity, which causes the vagus nerve to respond. Vagus nerve stimulation has an analgesic effect, thus relieving pain **(Tapar et al., 2018)**. Therefore, this study designed to evaluate the effectiveness of the VM in reducing pain during PIVC.

Significance

Pain in PIVC is one of the main causes of medical negligence. It causes a vasovagal response, including a primary elevation in blood pressure, followed by a sharp decrease in blood pressure, which may possibly induce loss of consciousness and sometimes fits. The VM is a nonpharmacological technique that can be reduce this complication **(James, 2019)**.

Operational definitions

1. Effectiveness:

It means the use of the VM to decrease pain during PIVC as measured by the numerical rating scale.

2. Pain:

Pain is an unpleasant sensation induced by PIVC as evaluated in this study using the numerical rating scale.

3. Valsalva maneuver:

This is a breathing method. When your heartbeat is fast, it may slow down your heartbeat. To do this, you exhale forcefully through your mouth while closing your nose tightly **(Goldstein, & Cheshire, 2017)**. The VM eases the physical and psychological aspects of painful procedures. This maneuver relieves pain through the reflex arc and distraction of the middle aortic baroreceptor **(Kumar, et al. 2018).**

4. PIVC:

PIVC means inserting a 20-G venous cannula into a peripheral vein.

Aim of the study:

This study was designed to evaluate the effectiveness of the VM on pain among adult patients undergoing PIVC.

Research hypothesis:

The study group had significantly lower levels of pain and anxiety during PIVC than the control group.

Subjects and method:

A quasi-experimental research design was adopted in this study to determine the outcomes of the VM in decreasing pain during PIVC compared with the control group.

Setting:

This study was conducted in the Surgical and Medical Departments of Mansoura University Hospital, which consists of five floors serving all patients in the delta region. The Surgical Department consists of five wards, while the Medical Department consists of two wards.

Study period: The study was conducted between November 2020 and May 2021.

Subjects:

A purposive sample of 60 patients was enrolled in this study. The study population was calculated using MedCalc based on a previous study **(Agarwal et al., 2005)** at Type 1 error (α) 0.05 and Type II error (β) 0.20. The proportion of the intervention group was 72.0, while the proportion of the control group was 100.0; the ratio of sample size in the intervention group to that of the control group was 1:1. The sample size will be 30 for each group. Considering any dropouts, the study sample will be 33 for each group. They were randomly divided into the intervention and control groups. The inclusion criteria included patients of both sexes, those aged 20–60 years, those available during data gathering, and those who agreed to participate in this study. The exclusion criteria included adult patients with chronic pain, anxiety disorders, hearing

problems, long usage of analgesia, or neuropathy of peripheral nerves and those who are difficult to cannulate.

Data collection tools:

The following three tools were used in the study for collecting pertinent data:

Tool I: A self-administered interview questionnaire, developed by the researchers, consisting of questions regarding the patients' demographic data, such as age, gender, educational level, occupation, culture, and history of intravenous cannulation.

Tool II: Numerical rating scale for pain that was used to measure pain severity during PIVC. It is closed-ended survey question used to characterize feedback in a comparative form for particular individual. Rating scale is an alternative of the general multiple-choice question which is used to collect information about a particular subject matter. The patients were asked to circle the number between (0 & 10).

Scoring system: The pain scale has 10 points: 0 (no pain), 1–3 (mild pain), 4–6 (moderate pain), 7–9 (severe pain), and 10 (worst pain) **(Ibrahim, Akindele, Bello, & Kaka, 2020)**.

Tool III: The Pain Anxiety Symptoms Scale-20 (PASS-20), used to assess anxiety levels after PIVC. The PASS-20 assesses pain-specific anxiety symptoms and includes four item subscales, including fear thinking, avoidance, physiological anxiety response, and cognitive anxiety response. The cognitive subscale assesses cognitive anxiety symptoms, such as racing thoughts and impaired concentration due to pain; the fear subscale assesses fearful thoughts and anticipated negative consequences of pain; the escape/avoidance subscale assesses escape and avoidance of actions that may cause pain; and the physiological anxiety subscale assesses physiological arousal in response to pain **(López Martínez, et al 2021)**.

Scoring system: All items are rated on a frequency scale from 0 (never) to 5 (always) Total scores range from 0 representing no pain anxiety to 100 representing severe pain anxiety. **(Rogers, Gallagher, Garey, et al., 2020)**.

Method and phases of data collection:

Validity and reliability of the tools:

The content validity of the tools was reviewed by seven experts in medical surgical nursing, and necessary modifications were made accordingly. The reliability of the tools was assessed using Cronbach's alpha test (α = 88%) and was rated within the acceptable range.

Pilot study:

A pilot study was conducted involving 10% of the study sample for testing the feasibility and applicability of the developed tools. The patients included in the pilot study were excluded from the study sample, and necessary modifications were made accordingly.

Ethical considerations:

This study was approved by the Research Ethics Committee of the Faculty of Nursing, Mansoura University (**Ref. No P.206,** code of ethics). After clarifying the nature of the study, the researchers obtained informed consent from all participating patients. The researchers emphasized that participation is absolutely voluntary. Anonymity, privacy, safety, and confidentiality were assured throughout the study period. The participants were informed that they have the right to leave the study any time they wish.

Procedure:

The study was conducted from the start of November 2020 to the end of May 2021. Once the necessary approval to proceed with the proposed study was granted, patients who met the sampling criteria and accepted to participate in the study were randomly. The data collection technique was semi structured interview schedule to collect patient's demographic data & numerical rating pain scale was used to assess patient's pain were divided into four phases.

Phase I. Preparatory phase (assessment): The researcher introduced herself to each patient and provided them a brief idea

about the aim of the study. Then, oral and written consent was obtained from each participant. The interview sheets were distributed by the researchers to every participant separately; collection of data was started using tool I, which took approximately 5–10 min on average.

Phase II. Planning phase: The researchers assessed the VS maneuver conducted a literature review and Internet search for relevant information to construct the correct technique under the guidance of the supervisors, the researchers were divided the study sample into two equal groups: the control group was not given any intervention and received standard care, the study group were asked to perform VM during PIVC, the patients were informed that the VM will be conducted before PIVC.

Phase III. Implementation phase: The researchers were informed the patients that the VM will be conducted before PIVC. The patients were instructed to inhale deeply, then hold their breath, and then apply a tourniquet. PIVC was performed while the patient was still holding their breath. The VM lasted no longer than 20 s. After PIVC, the patients were instructed to resume breathing.

Phase IV. Evaluation phase: The evaluation phase focused on determining the effect of VS maneuver on Pain and anxiety levels were assessed by using tools II & III which took approximately 10–15 min on average.

Limitation of the study:

- The limitations of this study were the sample size, which was relatively small, and only one government hospital was used.
- Pain assessment depended on individuals communicating their pain experience with the researchers after accurately explaining the pain experience. Interpretation may vary from person to person.

Statistical analysis

After data were collected, they were revised, tabulated, and statistically analyzed using Statistical Package for the Social Sciences (version 20). The normality of data distribution was assessed before any calculations, which showed that the data were normally distributed. Continuous data were expressed as mean ± standard deviation, whereas categorical data are expressed as numbers and percentages. The t-test was used to compare variables with continuous data. The chi-square test was used to compare variables with categorical data.

The significance of the results was as follows:

- If $P < 0.05$, there were statistically significant differences.
- If $P > 0.05$, there were statistically insignificant differences.
- If $P < 0.001$, the statistically significant differences were high.

Results:

Table (1) showed that nearly half of the patients in the control group were in the age of 20–30 years (approximately 43.3%); however, in the study group, approximately 36.7% of the patients were in the age of 40–50 years. Regarding sex, 53.3% of the patients in the control group were females (53.3%), whereas, in the study group, 63.3% of the patients were males. Less than two third of patients in the control group (60%) were married, whereas, in the study group, 66.7% of the patients were divorced. The table also showed that 56.7% of the patients in the control group were living in urban areas and 76.7% of the patients in the study group were living in rural areas. Moreover, 36.7% and 40% of the patients in the control and study groups had middle education, respectively. Regarding occupation, more than half of patients in the control and study groups were unemployed (60% and 66.7%, respectively). Most patients in the control and study groups had no history of smoking (80% and 70%, respectively). Finally, 56.7% and 86.7% of the patients in the control and study groups, respectively, had previous intravenous cannulation experiences.

Table (2) showed the effectiveness of the VM in decreasing pain during PIVC in the study and control groups. More than one third of patients (40%) in the control group had severe pain, whereas, in the study group, 43.3% of the patients had mild pain. A statistically

significant difference was observed between the control and study groups (P = 0.0023*).

Table (3) presented that there was statistically significant difference in PASS-20 scores between the control and study groups (P = 0.0000*).

Table (4) stated that there was no statistically significant relationship between PASS-20 scores and sociodemographic characteristics in the control group. In the study group, a statistically significant variance was noticed in the mean difference between PASS-20 scores and sociodemographic characteristics, including age, gender, occupation, and smoking habit (P = 0.05).

Table 1: Distribution of the study and control groups regarding sociodemographic characteristics (n = 60 patients).

Items	Control group (n = 30)		Study group (n = 30)	
	No	%	No	%
Age				
▪ 20–30 y	13	43.3	7	23.3
▪ 30–40 y	9	30.0	7	23.3
▪ 40–50 y	1	3.3	11	36.7
▪ 50–60 y	7	23.3	5	16.7
Gender				
▪ Male	14	46.7	19	63.3
▪ Female	16	53.3	11	36.7
Marital status				
▪ Married	18	60.0	6	20.0
▪ Divorced	8	26.7	20	66.7
▪ Single	1	3.3	0	0.00
▪ Widow	3	10.0	4	13.3
Residence				
▪ Urban	17	56.7	7	23.3
▪ Rural	13	43.3	23	76.7
Educational level				
▪ Uneducated	5	16.7	3	10.0
▪ Read and write	4	13.3	4	13.3
▪ Middle education	11	36.7	12	40.0
▪ University education	10	33.3	11	36.7
Occupation				
▪ Not working	18	60.0	20	66.7
▪ Working	12	40.0	10	33.3
Smoking				
▪ Yes	6	20.0	9	30
▪ No	24	80.0	21	70
Previous cannulation				
▪ Yes	17	56.7	26	86.7
▪ No	13	43.3	4	13.3

Table 2: Percentage distribution and frequency of pain severity in the study and control groups (n = 60).

Pain severity	Control group		Study group		Significance test	
	No	%	No	%	*P*	X^2
▪ **No pain**	2	6.7	5	16.7		
▪ **Mild pain**	5	16.7	13	43.3		
▪ **Moderate pain**	10	33.3	9	30.0	0.023*	11.294
▪ **Severe pain**	12	40.0	3	10.0		
▪ **Worst pain**	1	3.3	0	0.00		

Table 3: The mean total score differences in anxiety levels in the control and study groups using the Pain Anxiety Symptoms Scale-20 (n = 60).

Anxiety score	Control group	Study group
Mean ± SD	62.73 ± 21.41	26.23 ± 13.66
Significance test	*p = 0.000** t=7.869*	

Table 4: The relation between Pain Anxiety Symptoms Scale-20 scores and sociodemographic characteristics (control and study groups) (n = 60).

Items	Control group Mean ± SD	Significance test	Study group Mean ± SD	Significance test
Age				
▪ 20:30 y	69.69 ± 16.48	*P* = 0.092	38.14 ± 17.03	*P* = 0.05*
▪ 30:40 y	50.66 ± 27.64	F = 2.391	20.28 ± 13.54	F = 2.883
▪ 40:50 y	37.00		23.36 ± 9.39	
▪ 50:60y	69.00 ± 13.22		24.20 ± 9.20	
Gender				
▪ Male	60.5 ± 24.74	*P* = 0.381	23.00 ± 9.00	*P* = 0.05 *
▪ Female	64.68 ± 18.64	T = −528	31.81 ± 18.47	T = −1.764
Marital status				
▪ Married	58.83 ± 23.31	*P* = 0.231	28.16 ± 13.37	*P* = 0.865
▪ Divorced	62.37 ± 13.34	F = 1.529	26.25 ± 14.75	F = 0.146
▪ Single	98.00		0.000	
▪ Widow	75.33± 20.25		23.25 ± 10.40	
Residence				
▪ Urban	59.52 ± 25.32	*P* = 0.195	26.42 ± 11.38	*P* = 0.728
▪ Rural	66.92 ± 14.84	T = −0.935	26.17 ± 14.51	T = 0.042s
Educational level				
▪ Not educated	70.40 ± 8.67		19.33 ± 16.86	*P* = 0.502
▪ Read and write	67.75 ± 24.95	*P* = 0.733	28.50 ± 11.84	F = 0.805
▪ Middle education	58.18 ± 29.70	F = 0.430	23.33 ± 9.30	
▪ University education	61.90 ± 13.67		30.45 ± 17.35	
Occupation				
▪ Not working	59.16 ± 22.64	*P* = 0.402	23.50 ± 9.42	*P* = 0.05*
▪ Working	68.08 ± 19.09	T = −1.122	31.70 ± 19.08	T = −1.590
Smoking				
▪ Yes	71.16 ± 22.21	*P* = 0.859	20.44 ± 7.05	*P* = 0.05*
▪ No	60.62 ± 21.16	T = 1.081	28.71 ± 15.14	t= −1.556
Previous cannulation				
▪ Yes	65.41± 15.12	*P* = 0.106	25.84 ± 13.03	*P* = 0.324
▪ No	59.23 ± 27.92	T = 0.778	28.75 ± 19.46	T = −0.390

Discussion:

Pain during PIVC is an important source of uneasiness for caring patients this pain increased by some factors like anxiety and previous cannulation. A lot of research tries to overcome this pain problem by variety of ways including pharmacological agent that usually expensive and have other health hazards. So non pharmacological intervention seems to be helpful .One of these methods nurses use to bring pain relief is the VM, which is inexpensive and easily perform **(Wang, Jiang, Han, & et al., 2020).**

In this study, the VM was effective in reducing pain perception. These findings conform to those of **Alan and Khorshid (2021),** who evaluated the efficacy of the VM during PIVC. Their study has revealed that compared with patients in the control group, patients in the intervention group had less pain during PIVC ($p < 0.001$).

These results conform to those of the following studies: **Sundaran, Jisha, Fareha, and et al., (2016)** and **Vijay, Meenakshi, Sukhpal, and etal., (2013),** who reported that pain level during intravenous cannulation decreases following the performance of the

VM. Moreover, **Kumar, Khuba, Agarwal, and etal., (2018)** have reported that the incidence of pain in the VM group was significantly lesser than that in the control group. According to our own point of view pain reported to be decreased due to distraction effect of VM in addition to sin aortic baroreceptor reflex arc and it's easily to be performed at any position which make it easily applied to patient and evaluated.

Regarding sex, the current study showed that 53.3% of the patients in the control group were females. These go in the same line with **Jagadamba A.K. Kutty et al (2010)** who stated (53.3%) were female conducted a study. This may due to desire both sex to participate in this procedure.

McGowan (2014) has shown that PIVC causes considerable anxiety and distress, and in that study, the VM was effective in reducing PIVC-associated anxiety. Furthermore, the study has reported no significant variance concerning the association between the selected variables: site and the number of previous cannulations. The findings of this study conform to those of **Gideon, Florence, Ida, and Serina (2019),** who assessed the effects of the VM on anxiety and the severity of pain in patients undergoing PIVC. According to our own point of view anxiety easily controlled by VM due to relaxion effect of deep breathing holding effect.

According to this study, there was a statistically significant difference between PASS-20 and sociodemographic characteristics, including age, gender, occupation, and smoking habit in the control group. The findings of **Kadyan (2017)** conform to the results of this study, which reported a significant association between posttest pain scores and sex.

In contrast, **Sundaran, Fareha, and Priyanka (2016)** have reported that an insignificant association between certain items, including age, the number of previous intubations, and insertion site. Additionally, **Anjana (2015)** has shown no correlation between pain level and demographic data and a history of PIVC.

Finally, based on the results of this study, the VM is an effective intervention for decreasing pain intensity associated with PIVC. The results of this study and other studies suggest that decreasing PIVC-associated pain improves the nurse–patient relationship, which will improve the quality of care delivered to patients, increase patient satisfaction, and decrease the burden of pain on patient and healthcare organization.

Conclusion

The conclusion drawn from the findings of the study are as follows, The VM is an effective nonpharmacological nursing intervention that can reduce pain and anxiety during PIVC in adult patients. VM can be used as a cost-effective non pharmacologic nursing intervention in reducing the pain during PIVC. There was no statistically significant relationship between PASS-20 scores and sociodemographic characteristics in the control group.

Recommendation

Considering the study findings, we recommend the use of the Valsalva maneuver before performing the Peripheral intravenous cannulation for reducing pain and related stress during venous cannulation in adults. Holding continuous periodic educational sessions, activities, and training for nurses who work in medical–surgical units to reduce patients' anxiety and pain levels associated with PIVC, and these will improve the quality of care delivered to patients. Further researches about Valsalva maneuver are highly recommended to reach the peak level of effectiveness during PIVC improve quality of care.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

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