Effect of Physical Counter Pressure Maneuvers during Femoral Sheath Removal on Adverse Events Post Cardiac Catheterization

Nayera A. Yassen [1], Abeer F. El-Far [2], Magdy M. Elmasry[3], Sheren Mohammed Diab [4]

[1]Demonstrator of Critical Care Nursing, Faculty of Nursing, Tanta University, Egypt.

[2]Lecturer of Critical Care Nursing, Faculty of nursing, Tanta University, Egypt.

[3] Professor of Cardiology, Faculty of Medicine, Tanta University, Egypt.

[4]Assistant Professor of Critical Care Nursing, Faculty of Nursing, Tanta University, Egypt.

Corresponding author: **Nayera Abd Elafatah Yassen**

Email:Naira.Abdelfatah@nursing.tanta.edu.eg

Abstract

Background: Femoral sheath removal post- cardiac catheterization may cause adverse events such as vasovagal reactions, local pain, bleeding and hematoma. Physical counter pressure maneuvers are safe, effective to reduce these risks. **Aim:** This study evaluated the effect of Physical counter pressure maneuvers during femoral sheath removal on adverse events for post- cardiac catheterization Patients. **Design & Setting: A** Quasi-experimental study was conducted in the Cardiac Care Units at both Tanta University Teaching Hospital and Tanta New Surgical Hospital Affiliated to the Ministry of Higher Education and Scientific Research. **Subjects:** A purposive sample of 100 patients post cardiac catheterization was divided into two groups, (50) patients in each group. Control group received standard routine care, whereas study group received physical counter pressure maneuvers with routine care. **Tools:** Data were collected using, **Tool I,** Cardiac Catheterization Patient's Assessment Tool and **Tool II,** Femoral Sheath Removal Adverse Events Assessment Sheet **Results:** The findings showed that none of patients in the study group experienced blurred vision, diaphoresis, or dizziness in contrast to (30%, 36% and 20%) in the control group respectively within 30 min after sheath removal where P=0.000*. Also A highly significant difference was observed between two groups in relation to pain severity, bleeding and hematoma within 30 min after sheath hematoma where P=0.000*.**Conclusions &Recommendations:** Physical counter pressure maneuvers (PCMs) effectively reduce adverse events associated with femoral sheath removal and should be integrated into routine care. Replication of the study on a large probability sampling

***Key Words*:** Adverse Events, Physical Counter Pressure Maneuvers, Post Cardiac Catheterization

Introduction

Cardiovascular diseases are among the top causes of death worldwide, with developing nations experiencing a notable increase in cases. This rising trend has led to the widespread use of non-pharmacological treatment strategies for many patients to restore blood flow such as coronary stent, angioplasty, coronary artery bypass grafting (CABG) **(Jankowski, Floege, Fliser, Böhm, Marx &N. 2021).** Globally, over 46 million interventional cardiology procedures were performed in 2022, with CC procedures comprising the majority **(Bangalore et al., 2022).** In Egypt, an estimated about 250,000 patients undergo CC procedures each year, **(Barbato et al., 2021)**.

Although cardiac catheterization significantly reduces the morbidity and mortality associated with cardiovascular disease, it is invasive nature means that it still carries a risk of complications **(Ibrahem et al., 2024).** The femoral artery is a widely utilized access site for percutaneous coronary interventions (PCI). However, this approach can lead to certain complications, including vasovagal reactions, which are relatively common during interventional coronary procedures with a reported incidence of 9.8% to 10% according to statistical developed by American society of peri anesthesia Nursing (**Cho, Lee, Hyun, Kim, & Park, 2020)** and contribute to different forms of patient discomfort during sheath removal **(Alizadeh & Takasi, 2024).** Many studies have reported that vascular access site complications (VASCs) occur in about 0.1% to 61% of CC procedures, leading to increased morbidity, mortality, length of stay, and cost. Therefore, it is crucial to prevent and treat these complications by using non-pharmacological approaches **(Hetrodt et al., 2021).** Consequently, the physical counter maneuvers therapy (PCM) has demonstrated its effectiveness in stabilizing blood pressure among patients with autonomic failure. This therapy involves techniques such as tensing the arms with clenched fists, leg pumping, and leg crossing. Given its safety, effectiveness, and low cost, PCM is recommended as a first line treatment for vasovagal reactions, especially when used in combination with pharmacological therapy during femoral sheath removal after cardiac catheterization **(Williams, Khan & Claydon, 2022).**

Significance of study:

Generally, arterial sheath removal is associated with adverse events include vasovagal reaction, local pain, bleeding and groin hematoma. Vasovagal reactions frequently occur following sheath removal, typically presenting with low blood pressure and sinus bradycardia, and in rare instances, progressing to sinus arrest (**Cho et al., 2020)**. The removal of the sheath,

along with the firm pressure applied to control bleeding, can result in discomfort. Bleeding is associated with femoral artery access that extending into the retro peritoneum or deep thigh causing large hematomas that can be difficult to detect, this vascular complications including bleeding and hematoma were found in 24.6% according to statistical developed by Open Journal of Nursing **(Hayat et al., 2017)** Moreover, numerous studies have confirmed that physical counter pressure maneuvers (PCM) effectively stabilize blood pressure in patient with autonomic failure. **(Dockx et al., 2019)**

The aim of the study was to determine the effect of physical counter pressure maneuvers during femoral sheath removal on adverse events for post cardiac catheterization patients.

Research hypothesis:

Patients who were exposed to the physical counter pressure maneuvers are expected to decrease risk of adverse events related femoral sheath removal post cardiac catheterization compared to control group who wasn't exposed.

Subjects and Method:

Design: A quasi-experimental research design was employed in this study.

Setting: The study was carried out in Cardiac Care Unit at both Tanta University Teaching and Tanta New Surgical Hospital.

Subjects: A convenience sample of 100 adult patients who fulfilled the inclusion and exclusion criteria was selected based on the Epi-Info software statistical program according to the total population admitted per year to the cardiac care unit and underwent cardiac catheterization (1000) patients.

Inclusion criteria:

Adult patients 21 years and above of both sexes, undergoing cardiac catheterization through femoral artery route.

Exclusion Criteria:

- Hemodynamic instability as (systolic blood pressure less than 90 mmHg and heart rate less than 50 beat/min)
- Inability to perform a physical counter pressure maneuver

-Inguinal or umbilical hernia

The sample size was calculated as the following: Z= confidence level 95%, d= Error proportion (0.05), P= population (60%). The subjects were divided into two equal groups: **Control group**: It consisted of 50 patients who received routine Cardiac Care Unit during femoral sheath removal. **Intervention group:** It consisted of 50 patients who received the Physical Counter Pressure Maneuvers which implemented by the researcher with routine Cardiac Care Unit.

Tools of the study: Two tools were employed in this study

Tool (I): Cardiac Catheterization Patient's Assessment Tool:

This tool was designed by the researcher based on a thorough review of relevant literature **(Afrassa, Kassa,**

& Legesse, 2022; Das, et al., 2022). It comprises two main sections:

Part (a) Socio-Demographic Data: This section includes socio-demographic information such as code, age, sex, marital status, educational level and occupation.

Part (b) Clinical Data:

This section covers the patient's current diagnosis, medical history (past and present), surgical history.

Tool II: Femoral Sheath Removal Adverse Events Assessment Sheet: It was designed by the researcher to incidence of adverse events following femoral sheath removal, including vasovagal reaction, local pain, external bleeding at the sheath insertion site and hematoma formation. The tool comprises four main sections:

Part (a) Indices of Vasovagal Reaction:-This section developed by the researcher after reviewing relevant literature (**Pawlowski, et al., 2023; Ghods, Roshani, Mirmohammadkhani, & Soleimani, 2022),** assesses various indicators of vasovagal reactions, including:

- Physiological parameters as (heart rate, blood pressure and oxygen saturation) and indices as (blurred vision, diaphoresis, dizziness)
- Nausea Numerical Rating Scale:

This scale originally developed by **(Meek et al., 2009),** and later adopted by the researcher, is used to measure nausea severity. Patients rate their nausea on a 100-mm visual analogue scale (VAS) (0=least severe nausea, 100=most severe nausea). The Nausea Numerical Rating Scale illustrated high degree of consistency, with a Pearson Correlation Coefficient of 0.92, indicating excellent Test-Retest Reliability **(Jones, & Smith, 2023).**

Scorning system: The NRS scores will categorized into four groups (0 = no nausea, 10–30 = mild, 40–60= moderate, 70–100 = severe)

Part (b) Numerical Pain Rating Scale, This scale originally developed by **McCaffery et al. (1989),** is used to assess pain severity. It allows patients to rate their pain along a continuum ranging from no pain to extreme pain. The scale is typically represented as a 10 cm horizontal line, where patients indicate their perceived pain level by marking a point on the line. The pain score is determined by measuring the distance in centimeters from the left end of the scale to the patient's mark. The Numerical Pain Rating Scale (NRS) demonstrated good internal consistency, (Test- Retest Reliability) with a Cronbach's alpha value of 0.82 **(Wiederien, Wang, & Frey-Law, 2024)**

Scoring system: was as following (0) no pain, from (1-3) mild pain, from (4-6) moderate pain, from (7-10) severe pain**.**

Part (c) Bleeding Assessment Scale: originally developed by **Black et al. (2008**) and later adopted by the

researcher. This scale evaluates blood leakage from the puncture site. Bleeding classified based on the surface area of the blood-soaked dressing as follows: No bleeding (dry dressing), mild bleeding (< 2cm^2 of blood soaked dressing), moderate bleeding (2≤ 5cm^2 of blood soaked dressing) and severe bleeding (5≤ 10 cm^2 of blood soaked dressing). The Bleeding assessment Scale showed a high degree of reliability, (Inter rater Reliability) with Intra class Correlation Coefficients 0.88 **(Smith, & Lee, 2022).**

Part (d) Hematoma Formation Scale: This scale developed by **Al Sadi et al. (2010**) and adopted by the researcher to measures hematoma size based on surface area. Hematoma is categorized as follows: No hematoma (<2cm^{2}in diameter), small hematoma (2≤ 5cm^2 in diameter), medium hematoma (5≤ 10 cm^2 in diameter) and large hematoma (≥ 10 cm^2 in diameter). The Hematoma Formation Assessment Scale demonstrated a high degree of reliability, (Inter rater Reliability) with Intra class Correlation Coefficients 0.85 **(Brown, & Green, 2023).**

Method

Official Permissions: Approval to conduct the study was obtained from relevant hospital authorities through official letters issued by the Faculty of Nursing, outlining the study's purpose.

Ethical considerations:

-Approval was granted by the Scientific Nursing Research Ethical Committee of the Faculty of Nursing was obtained with the assigned code number (254/12/23).

-Informed consent was obtained from each patient after explanation study's aim.

-Patient privacy and data confidentiality were ensured by using code number instead of names.

-The study was designed to ensure no harm to the participants.

-It was also assured that the study posed no risk or pain to the participants and any unexpected risks that arose during the course of the research were clearly communicated to the participants

-Patients had the right to withdrawal from the study at any time.

Tool development:-

Tool I was developed by the researcher based on comprehensive review of relevant literature. Regarding to nausea numerical rating scale was developed by **(Meek et al., 2009)**, Considering tool II part (b) developed by (**McCaffery et al., 1989)** and adopted by **(Gorrall et al., 2016)** while part (c) developed by **(Black et al., 2008)** and finally part (d) developed by **(Al Sadi et al., 2010).**

- Tool validity:-

The study tools were reviewed by a panel of seven experts in critical nursing to ensure the applicability, feasibility and validity of the tools and accordingly the needed modifications

were done.

- Tool reliability:-

The reliability was measured on the study tools using Cronbach`s Alpha test. It was 0.95 for tool I and 0.88 for tool II.

- Pilot study:-

A pilot study was conducted on 10% of the study sample before the main study to assess the clarity, feasibility; relevance and applicability of the tools. This also helped identify any potential challenges in data collection.

- Data collection:

Data collection took place from the end of March 2024 to the end of September 2024.

- Patient Grouping:

Patients meeting the inclusion criteria were assessed upon admission and randomly assigned divided into two equal groups with 50 patients in each. The researcher initially worked with the control group before proceeding with the intervention group.

-The study was conducted in four phases: Assessment, Planning, Implementation and Evaluation.

I. Assessment phase:

Both the study and control groups were assessed immediately after catheterization and before application of physical counter pressure maneuvers. This assessment aimed to collect baseline data and identify patients meting the inclusion criteria using Tool I.

II. Planning phase:

This phase was developed based on finding from the assessment phase, goals and expected outcome criteria were considered to ensure an effective plan for patient care that includes:-

- Minimize risk of vasovagal reaction
- Decrease severity of pain
- Reduce risk of bleeding and hematoma

During this phase, the researcher prepared the equipment as a rubber ball that was used to perform the Physical counter pressure maneuvers for the study group.

III. Implementation phase:

Control group: was received the routine cardiac care unit nursing care as applying manual pressure after sheath removal, ECG monitoring, intravenous access for potential emergency medication and monitoring vital signs.

Study group: was received physical counter pressure maneuver combined with routine care that was implemented by the researcher, as following:

Patient preparation before physical counter pressure maneuver technique:-

- Explain all maneuvers to the patient and advise the patient to follow the instructions.
- Prepare necessary equipment (rubber ball).
- Attach the patient to cardiac monitoring.
- The patient is placed in a supine position.

Physical counter pressure maneuver technique:-

-The Physical counter pressure maneuvers have been standardized to support cardiovascular stability and elevate blood pressure by activating the skeletal muscle pump, often leading to increase sympathetic nervous system activity.

-Standardized verbal instructions was used to help patients to achieve target pressure

-Immediately during sheath removal, patients perform the physical counter pressure maneuvers by squeezing the muscles in legs, abdomen and buttocks.

-Arm tensing can be performed by gripping one hand with the other while simultaneously pulling both arms outward or by squeezing a rubber ball with the dominant hand.

-Positioning patient in trendelenburg position and this according to cardiac care unit policy.

-The technique was continued during sheath removal and after sheath removal for about five minutes or until symptoms subside as indicated by heart beat between 60-90 beats/ min, systolic blood pressure more than 100 mm Hg ,decrease severity of pain and nausea and finally minimal bleeding and hematoma size.

Post physical counter pressure maneuver technique:-

-If physical counter pressure maneuver resulted in absence of any adverse events, patients were placed again in a comfortable position.

- Continuously monitoring the patient's for any signs of adverse events.

IV. Evaluation phase:

-Evaluation of both groups were done three times as follow before sheath removal, during removal of sheath and 30 minutes after removal of sheath to assess adverse events occur during femoral sheath removal using tool II, part (a) to assess indices of vasovagal reaction, part (b) to measure severity of pain, part (c) to assess blood leakage from the puncture site, and categorize bleeding based on the extent of the blood- soaked surface area and the affected region. (d) to measure hematoma size.

-A comparison was conducted between two groups to evaluate the impact of applying physical counter pressure maneuvers during femoral sheath removal on adverse events in patients after cardiac catheterization.

Results

Table (1): presents the socio-demographic characteristics of both studied groups. The data indicate that nearly half (42%, 46%) of both control and study group respectively were aged between (50-60) years with a mean age of 51.88±8.258 for control group and 52.26±7.917 for study group. Regarding gender, more than half (54%) of control group were female whereas approximately two third (60%) of were male in the study group Concerning marital status and educational level, the result presented

that the majority (88% and 92%) of both control and study groups were married respectively. Moreover, nearly two third (60%) and most (70%) of the control and study groups respectively were educated. Also, more than half (66%, 58%) of both patients in control and study groups were occupied respectively. Additionally, there was no statistically significant difference between both groups in relation to their demographic characteristics.

Table (2): Shows patients' clinical data of the studied groups. It was observed that a higher percentage (36%, 28%) in both control and study group were diagnosed with unstable angina respectively. Additionally, about one quarter (24%, 20%) of patients in both control and study groups had NSTEMI respectively. **Moreover**, the lower percentage (10%) of patients in both groups had Heart block.

Table (3): Demonstrates the percent distribution of the studied patients post cardiac catheterization regarding their physiological indices throughout periods of the study, The findings revealed that none of the patients in the study group experienced blurred vision, diaphoresis, or dizziness, In contrast to (30%, 36% and 20%) in the control group experienced blurred vision, diaphoresis and dizziness respectively within 30 min after sheath removal.

Additionally, there was highly statistically significant difference among two groups in relation to physiological indices of vasovagal reactions 30 minutes after sheath removal where P 0.000,0.000 and 0.001 respectively.

Table (4): illustrates the severity of nausea of the studied patients. It was indicated that after 30 min of sheath removal in the control group, (32%) of patient had moderate level of nausea severity compared to (78%) of patient in the study group had no nausea. Also, there were statistically significant difference was observed among the control and the study group throughout the period of the study where P=0.000*. **Additionally**, a highly statistically significant difference was observed between the two groups 30 minutes after sheath removal (P= 0.000*).

Table (5): presents the mean scores of physiological parameters among the studied patients after cardiac catheterization across different study periods. The finding indicated that the mean heart rate in the study group improved and was significantly higher compared to the control group during and 30 minutes afterward (66.10±18.34, 71.44±19.84) and (53.72±14.32, 59.40±8.89) respectively, also there were statistically significant difference between the two groups 30 min after sheath removal where P=0.047*. Concerning systolic blood pressure, the mean values in the study group showed significant improvement and were

notably higher than those in the control group during and 30 minutes after sheath removal **(**113.20±18.57, 126.40±8.27) (103.00±22.70, 105.60±27.16) with highly statistically significant was observed within each group where P= (0.001, 0.000) respectively, also there were statistically significant difference between the two groups 30 min after sheath removal where P=0.002*.

Regarding diastolic blood pressure, the results indicated a statistical significant improvement in the two groups 30 minutes after sheath removal. The mean ± SD values were (70.42±14.78, 83.00±6.47) in control and study group respectively and P=0.000*. Similarly, O_2 saturation levels illustrated a statistical significant increase in the two groups 30 minutes after sheath removal. The mean ± SD values were (94.04±4.31, 97.66±1.02) in control and study group respectively and P value 0.006*.

Table (6): shows severity of pain mean scores of the studied groups. It was revealed that approximately one-third (30%) of patients in the control group experienced severe pain compared to (60%) of the patient in the study group had no pain 30 minutes after sheath removal with highly statistically significant in both group as P= 0.000*. **More ever**, a highly statistically significant difference was observed between the two groups 30 minutes after sheath removal as P= 0.000*.

Table (7): demonstrates percent distribution regarding to bleeding assessment among studied groups. The findings revealed that the majority (78%, 80%) of both control and study group did not experience bleeding before sheath removal respectively compared to the majority (72%, &70%) of both control and study group exhibited moderate bleeding during sheath removal respectively. Notably, half (50%) of study group whereas (10%) of control group showed no bleeding 30 min after sheath removal with highly statistically significant in both group as P= 0.000*. Also, there was highly statistically significant difference between both control and study group 30 minutes after sheath removal as P= 0.000*.

Table (8): illustrates percent distribution regarding to hematoma assessment among studied groups. The results indicated that the majority (80%, 70%) of control and study group did not develop hematoma before sheath removal respectively compared to (24%, 34%) of both control and study group had small hematoma during sheath removal respectively. Notably, about two- third (60%) of the control group whereas only (20%) of the study group continued to experience hematoma 30 min after sheath removal with highly statistically significant in both group with P-values (0.001*, 0.002*) respectively.

Table (9): Shows the relationship between clinical data of the studied patients and bleeding assessment score, It was illustrated that there was no significant relationship between mean bleeding assessment score and current diagnosis, surgical history in both control and study group, whereas there was a significant relationship between mean bleeding assessment score and past medical history in the study group during sheath removal where P= (0,049*), where the highest mean (2.04±0.51) was among the patient with hypertension.

Table (10): Clarifies the relationship between clinical data of the studied patients and their hematoma assessment score, It was showed that there was no significant relation between hematoma assessment score and current diagnosis in both control and study group whereas there was a significant relationship between mean hematoma assessment score and past medical history in the study group 30 min after sheath removal where P= (0,003*), where the highest mean (2.04±0.51) among the patient with hypertension during sheath removal. Also there was a significant relationship between mean hematoma assessment score and past surgical history in the control group before, during sheath removal and 30 min after sheath removal where P= (0.001*, 0.003*, 0.046*) respectively.

Table (1): socio- demographic characteristics in both studied groups post cardiac catheterization

Characteristics	The studied patients (n=100)				χ^2 P
	Control group (n=50)		Study group (n=50)		
	N	%	N	%	
Age (in years)					
(30-<40)	5	10.0	3	6.0	
(40-<50)	13	26.0	14	28.0	0.681
(50-<60)	21	42.0	23	46.0	0.878
(≥60)	11	22.0	10	20.0	
Range	(35-66)		(35-67)		t=0.235
Mean ± SD	51.88±8.258		52.26±7.917		P=0.815
Gender					
Male	23	46.0	30	60.0	FE
Female	27	54.0	20	40.0	0.229
Marital status					
Single	1	2.0	1	2.0	
Married	44	88.0	46	92.0	0.550
Widow	5	10.0	3	6.0	0.760
Level of education					
Educated	30	60.0	35	70.0	FE
Non-educated	20	40.0	15	30.0	0.402
Occupation					
Occupied	33	66.0	29	58.0	FE
Not occupied	17	34.0	21	42.0	0.537

FE: Fisher' Exact test

Table (2): Patients' clinical data of the studied groups post cardiac catheterization

Clinical data	The studied patients (n=100)				χ^2 P
	Control group (n=50)		Study group (n=50)		
	N	%	N	%	
Current diagnosis					
Unstable angina	18	36.0	14	28.0	
Stable angina	9	18.0	9	18.0	
NSTEMI	12	24.0	10	20.0	1.055
STEMI	6	12.0	12	24.0	0.944
Heart block	5	10.0	5	10.0	
# **Past medical history**					
None	14	28.0	10	20.0	
DM	32	64.0	24	48.0	
Hypertension	28	56.0	24	48.0	3.084
CVS disorder	1	2.0	5	10.0	0.160
Hepatic disorder	4	8.0	1	2.0	
GIT disorder	2	4.0	1	2.0	
# **Surgical history**					
None	33	66.0	28	56.0	
Vascular surgery	7	14.0	10	20.0	2.156
Abdominal surgeries	11	22.0	15	30.0	0,879

More than one answer was chose

Table (3): Percent distribution of the studied patients post cardiac catheterization regarding their physiological indices of vasovagal reactions throughout periods of study

Physiological Indices	The studied patients (n=100)													
	Control group (n=50)						χ^2 P	Study group (n=50)						χ^2 P
	Before sheath removal		During sheath removal		30 mins after sheath removal			Before sheath removal		During sheath removal		30 min after sheath removal		
	N	%	N	%	N	%		N	%	N	%	N	%	
Blurred vision														
Absent	36	72.0	28	56.0	35	70.0	3.336	35	70.0	27	54.0	50	100.0	39.71
Present	14	28.0	22	44.0	15	30.0	0.189	15	30.0	23	46.0	0	0.0	0.000*
Control Vs Study χ^2 , P	FE , 1.00		FE , 1.00		FE , 0.000*									
Diaphoresis														
Absent	40	80.0	27	54.0	32	64.0	7.934	38	76.0	24	48.0	50	100.0	45.45
Present	10	20.0	23	46.0	18	36.0	0.019*	12	24.0	26	52.0	0	0.0	0.000*
Control Vs Study χ^2 , P	FE , 0.810		FE , 0.689		FE , 0.000*									
Dizziness														
Absent	46	92.0	35	70.0	40	80.0	8.303	46	92.0	33	66.0	50	100.0	29.51
Present	4	8.0	15	30.0	10	20.0	0.016*	4	8.0	17	34.0	0	0.0	0.000*
Control Vs Study χ^2 , P	FE , 1.00		FE , 0.830		FE , 0.001*									

* Statistically significant at level P<0.05

Table (4): Percent distribution of the studied patients regarding their severity of nausea throughout periods of implementation

Severity of nausea	The studied patients (n=100)													
	Control group (n=50)						χ^2 P	Study group (n=50)						χ^2 P
	Before sheath removal		During sheath removal		30 min after sheath removal			Before sheath removal		During sheath removal		30 min after sheath removal		
	N	%	N	%	N	%		N	%	N	%	N	%	
None	50	100.0	31	62.0	32	64.0	**38.85 0.000***	50	100.0	30	60.0	39	78.0	**73.18 0.000***
Mild	0	0.0	0	0.0	2	4.0		0	0.0	0	0.0	11	22.0	
Moderate	0	0.0	19	38.0	16	32.0		0	0.0	20	40.0	0	0.0	
Range Mean ± SD	(0-0) 0.00±0.00		(0-60) 20.20±6.22		(0-60) 17.60±3.69		**F=14.51 P=0.000***	(0-0) 0.00±0.00		(0-50) 19.00±23.67		(0-10) 2.20±1.18		**F=28.05 P=0.000***
Control Vs Study t , P	-		0.240 , 0.811		4.526 , 0.000*									

* Statistically significant at level P<0.05

Table (5): Mean scores of physiological parameters of vasovagal reactions for both studied patients post cardiac catheterization throughout periods of study

Physiological Parameters	The studied patients (n=100) Range Mean ± SD							
	Control group (n=50)				Study group (n=50)			
	Before sheath removal	During sheath removal	30 min after sheath removal	F P	Before sheath removal	During sheath removal	30 min after sheath removal	
HR	(49-88) 66.42±8.92	**(40-88) 53.72±14.32**	(50-88) 59.40±8.89	1.436 0.241	(48-92) 63.78±12.48	(38-95) 66.10±18.34	(45-130) 71.44±19.84	6.15 0.003*
Control Vs Study t , P	1.639 0.104	**3.393, 0.055**	2.1011, 0.047*					
Blood pressure								
Systolic	(110-140) 127.40±9.44	**(80-140) 103.00±22.70**	(80-180) 105.60±27.16	7.417 0.001*	(110-140) 128.00±9.48	(80-140) 113.20±18.57	(110-140) 126.40±8.27	19.68 0.000*
Control Vs Study t , P	0.317 , 0.752	**0.048 , 0.962**	3.188 , 0.002*					
Diastolic	(60-90) 81.00±6.47	**(40-90) 68.60±14.62**	(40-97) 70.42±14.78	7.866 0.001*	(70-90) 72.20±6.53	(50-90) 80.40±11.74	(70-90) 83.00±6.47	25.86 0.000*
Control Vs Study t , P	1.693 , 0.094	**0.302 0.763**	4.199, 0.000*					
O_2 saturation	(95-99) 97.46±1.11	**(0-99) 88.48±22.92**	(87-99) 94.04±4.31	5.654 0.004*	(96-99) 97.72±1.03	(88-99) 94.38±4.08	(96-99) 97.66±1.02	29.21 0.000*
Control Vs Study t , P	1.213 , 0.228	**0.405 , 0.686**	2.830 , 0.006*					

* Statistically significant at level P<0.05.

Table (6): Percent distribution of the studied patients regarding their severity of pain throughout periods of intervention

Severity of pain	The studied patients (n=100)													
	Control group (n=50)						χ^2 P	Study group (n=50)						χ^2 P
	Before sheath removal		During sheath removal		30 min after sheath removal			Before sheath removal		During sheath removal		30 min after sheath removal		
	N	%	N	%	N	%		N	%	N	%	N	%	
None	4	8.0	0	0.0	0	0.0		4	8.0	0	0.0	30	60.0	
Mild	36	72.0	0	0.0	2	4.0	**118.37 0.000***	39	78.0	0	0.0	15	30.0	**172.04 0.000***
Moderate	10	20.0	35	70.0	33	66.0		7	14.0	34	68.0	5	10.0	
Severe	0	0.0	15	30.0	15	30.0		0	0.0	16	32.0	0	0.0	
Range Mean ± SD	**(0-6) 3.08±1.61**		**(4-10) 6.34±2.05**		**(3-10) 6.12±2.09**		**F=44.51 P=0.000***	**(0-6) 2.78±1.48**		**(5-10) 6.76±1.78**		**(0-5) 1.14±1.55**		**F=161.67 P=0.000***
Control Vs Study t , P	**0.97 , 0.334**		**1.09 , 0.276**		**13.52 , 0.000***									

*** Statistically significant at level P<0.05**

Table (7): Percent distribution of the studied patients regarding their bleeding assessment throughout periods of study

Bleeding Assessment	The studied patients (n=100)													
	Control group (n=50)						χ^2 P	Study group (n=50)						χ^2 P
	Before sheath removal		During sheath removal		30 min after sheath removal			Before sheath removal		During sheath removal		30 min after sheath removal		
	N	%	N	%	N	%		N	%	N	%	N	%	
No bleeding	39	78.0	0	0.0	5	10.0		40	80.0	0	0.0	25	50.0	
Mild	10	20.0	7	14.0	15	30.0	**122.05**	10	20.0	8	16.0	17	34.0	**156.67**
Moderate	1	2.0	36	72.0	25	50.0	**0.000***	0	0.0	35	70.0	8	16.0	**0.000***
Severe	0	0.0	7	14.0	5	10.0		0	0.0	7	14.0	0	0.0	
Control Vs Study $\chi2$, P	1.39 , 0.497		0.08 , 0.960		62.12 , 0.000*									

*** Statistically significant at level P<0.05**

Table (8): Percent distribution of the studied patients regarding their hematoma assessment throughout periods of study

Hematoma assessment	The studied patients (n=100)													
	Control group (n=50)						χ^2 P	Study group (n=50)						χ^2 P
	Before sheath removal		During sheath removal		30 min after sheath removal			Before sheath removal		During sheath removal		30 min after sheath removal		
	N	%	N	%	N	%		N	%	N	%	N	%	
No hematoma	40	80.0	25	50.0	20	40.0		35	70.0	25	50.0	40	80.0	
Small	5	10.0	12	24.0	20	40.0	**22.62**	7	14.0	17	34.0	10	20.0	**21.13**
Medium	3	6.0	7	14.0	8	16.0	**0.001***	5	10.0	5	10.0	0	0.0	**0.002***
Large	2	4.0	6	12.0	2	4.0		3	6.0	3	6.0	0	0.0	
Control Vs Study χ^2 , P	1.38 , 0.711		2.22 , 0.528		24.06 , 0.000*									

*** Statistically significant at level P<0.05**

Table (9): The relationship between Clinical data of the studied patients and their bleeding assessment score

Clinical data	The studied patients (n=100) Mean ± SD Bleeding score					
	Control group (n=50)			Study group (n=50)		
	Before sheath removal	During sheath removal	30 min after sheath removal	Before sheath removal	During sheath removal	30 min after sheath removal
Current diagnosis						
Unstable angina	0.28±0.58	2.00±0.69	1.67±1.09	0.28±0.46	2.00±0.59	0.33±0.49
Stable angina	0.22±0.44	2.22±0.44	1.67±0.71	0.00±0.00	1.89±0.33	0.56±0.53
NSTEMI	0.17±0.39	1.92±0.29	1.33±0.65	0.08±0.29	1.75±0.45	0.58±0.52
STEMI	0.33±0.52	2.00±0.63	1.83±0.41	0.17±0.41	2.17±0.41	0.17±0.41
Heart block	0.20±0.45	1.80±0.45	1.60±0.55	0.60±0.55	2.40±0.89	0.20±0.45
F , P	0.16 , 0.96	0.62 , 0.65	0.48 , 0.75	2.47 , 0.06	1.54 , 0.21	1.28 , 0.29
Past medical history						
None	0.21±0.58	2.00±0.56	1.43±0.85	0.21±0.43	2.00±0.56	0.43±0.51
DM	0.25±0.44	1.97±0.54	1.63±0.79	0.22±0.42	1.97±0.60	0.38±0.49
Hypertension	0.25±0.44	2.00±0.54	1.75±0.80	0.21±0.42	2.04±0.51	0.39±0.50
CVS disorder	0.00±0.00	2.00±0.00	1.00±0.00	0.00±0.00	2.00±0.00	1.00±0.00
Hepatic disorder	0.25±0.50	2.00±0.00	1.75±0.50	0.50±0.58	2.01±0.58	0.50±0.58
GIT disorder	0.50±0.71	1.50±0.71	1.50±0.71	0.00±0.00	2.00±0.00	0.00±0.00
F , P	0.002 , 0.966	0.00 , 1.00	0.147 , 0.703	2.469 , 0.123	4.088 , 0.049*	1.516 , 0.224
Surgical History						
None	0.24±0.50	2.06±0.50	1.73±0.72	0.24±0.44	2.00±0.56	0.42±0.50
Vascular surgery	0.29±0.49	2.00±0.58	1.43±0.79	0.00±0.00	1.86±0.38	0.43±0.54
Abdominal surgeries	0.18±0.41	1.82±0.60	1.27±1.01	0.18±0.41	2.00±0.63	0.36±0.51
F , P	0.616 , 0.437	1.855 , 0.180	0.031 , 0.860	2.036 , 0.160	0.125 , 0.726	0.229 , 0.634

*** Significant at level P<0.05**

Table (10): The relationship between Clinical data of the studied patients and their hematoma assessment score

Clinical data	The studied patients (n=100) Mean ± SD Hematoma score					
	Control group (n=50)			Study group (n=50)		
	Before sheath removal	During sheath removal	30 min after sheath removal	Before sheath removal	During sheath removal	30 min after sheath removal
Current diagnosis						
Unstable angina	0.44±0.86	1.06±1.06	0.94±0.87	0.67±0.84	0.72±0.83	0.11±0.32
Stable angina	0.56±0.88	1.11±1.27	0.89±0.93	0.67±1.00	1.00±0.87	0.44±0.53
NSTEMI	0.00±0.00	0.33±0.65	0.58±0.52	0.17±0.58	0.42±0.67	0.08±0.29
STEMI	0.17±0.41	1.17±1.17	1.00±0.89	0.50±1.23	0.67±1.21	0.33±0.52
Heart block	0.60±1.34	0.80±1.30	0.80±1.30	0.60±1.34	1.00±1.23	0.20±0.45
F , P	1.06 , 0.39	1.16 , 0.34	0.39 , 0.81	0.62 , 0.65	0.70 , 0.60	1.52 , 0.21
Past medical history						
None	0.21±0.43	0.79±0.89	0.71±0.73	0.64±1.01	0.93±0.92	0.21±0.43
DM	0.44±0.91	1.03±1.15	0.94±0.91	0.50±0.92	0.69±0.90	0.22±0.42
Hypertension	0.36±0.87	0.89±1.10	0.89±0.92	0.50±0.92	1.50±0.71	1.00±0.00
CVS disorder	0.00±0.00	1.00±0.00	1.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Hepatic disorder	0.00±0.00	0.00±0.00	0.25±0.50	0.75±1.50	0.75±1.50	0.25±0.50
GIT disorder	2.00±0.00	3.00±0.00	2.00±0.00	1.00±1.41	0.61±0.92	0.18±0.39
F , P	0.007 , 0.933	0.071 , 0.790	0.203 , 0.655	0.351 , 0.557	1.090 , 0.302	9.601 , 0.003*
Surgical History						
None	0.33±0.74	0.91±1.07	0.88±0.82	0.48±0.91	0.67±0.89	0.18±0.39
Vascular surgery	0.43±1.13	1.00±1.16	0.86±1.07	0.57±0.98	0.86±0.90	0.29±0.49
Abdominal surgeries	0.27±0.65	0.73±1.01	0.73±0.79	0.55±0.93	0.73±0.91	0.18±0.41
F , P	11.736 , 0.001*	9.788 , 0.003*	4.216 , 0.046*	0.143 , 0.707	0.351 , 0.557	0.193 , 0.662

* Significant at level P<0.05

Discussion

Percutaneous coronary intervention is a crucial procedure for evaluating and accessing the coronary vasculature, playing an increasingly essential role in the managing coronary artery disease. Although the femoral artery remains a commonly used access route, it is linked to a higher risk of complications, as vasovagal reflex (VVR), localized pain, bleeding, and hematoma formation, all of which can impact patient recovery and outcomes **(Valikhani, Mahdizadeh, Eshraghi, Mazloum, & Dehghani, 2021).** Hence, the study aimed to assess the impact of physical counter pressure maneuvers (PCM) on adverse events occurring during femoral arterial sheath removal in patients underwent cardiac catheterization. **Part I: Socio-demographic characteristics and clinical data of studied groups.** The total sample in this study consisted of (100) patients divided equally divided between control and study groups. **Regarding age** distribution among patients who underwent Cardiac Catheterization (CC), the findings indicated that the nearly half of both control and study groups were between 50 and 60 years old with mean **± SD** (**51.88±8.258, 52.26±7.917) respectively**. **On observation of sex,** it was noticed that more than half of control group were female whereas nearly two third were male in study group. This might be explained by the fact that Pre-menopausal women tend to have higher levels of estrogen, a hormone that has protective effects on cardiovascular health by improving lipid profiles and maintaining the flexibility of blood vessels. **(Meyer & Lee 2024)** The results are aligned with similar study about "The Effect of Different Positions on Clinical Outcomes of Post Coronary Catheterization patients" which reported that about two third (64%) were male in the study group reported by **(MA Alaa Eldin, AR Khamis,& Mohamed Abdelhamed,2021). In Relation to current diagnosis**, it was observed that a higher percent in control and study group were diagnosed with unstable angina respectively. Additionally, about one quarter of patients in both control and study groups had NSTEMI respectively, which are more likely to prompt individuals to seek immediate hospital care because they cause severe chest pain and other debilitating symptoms. Unstable angina presents as sudden, unpredictable chest pain that occurs even at rest or with minimal exertion, signaling that the heart is not receiving enough oxygen. **(Smith, Miller, & Davis. 2024) Also,** the result is in the line with **(Ranka et al., 2021)** that carried out study about "Right heart catheterization in cardiogenic shock is associated with improved outcomes" and also reported That NSTEMI count about one quarter of patients in the study group. **Regarding past medical history**, it is found that the most patients in both the study and control groups had diabetes mellitus (DM) and hypertension (HTN) respectively. This result was in agreement with **(Baqal & Mahmood., 2022)** who stated that most of patients in the study group had DM & HTN. This might be explained by the fact that hypertension and diabetes

are key risk factors for coronary artery disease (CAD) as they directly impact the cardiovascular system. In hypertension, sustained high blood pressure increases the force against the artery walls, causing endothelial injury. This damage promotes the development of atherosclerosis **(Williams, Zhang, & Roberts. 2024). Part II:** Adverse events assessment for studied patients during femoral sheath removal post cardiac catheterization. Concerning physiological indices for Vaso-Vagal Reactions (VVRs) of the studied patients post cardiac catheterization throughout periods of intervention, the present study indicated a significant improvement in physiological indices of VVRs include reduction in (blurred vision, diaphoresis, dizziness, nausea) and increasing in (heart rate, systolic and diastolic blood pressure and oxygen saturation) was observed among study group patients throughout periods of intervention compared with control group. Physical counter-pressure maneuvers, such as crossing the legs, tensing the muscles, neck flexion help to prevent or alleviate a vasovagal reaction by increasing venous return and stabilizing blood pressure. These maneuvers activate the body's sympathetic nervous system and increase peripheral vascular resistance, which helps counteract the parasympathetic over activity responsible for the vasovagal response **(Taylor, Green, & Jacobs. 2024).** This result is supported by **Alharbi, et al (2024)** who conducted study about "The efficacy of non-pharmacological and non-pacing therapies in preventing vasovagal syncope" and found that the physical counter pressure maneuvers had higher success rates to decrease and prevent VVR. **In relation to the severity of pain throughout periods of intervention**, the current study clarified that approximately one-third of patients in the control group experienced severe pain compared to about two-third of the patient in the study group had no pain 30 minutes after sheath removal. This finding was consistent with **(Heidaranlu, Goyaghaj, Moradi, & Ebadi, 2021)** who reported that effectiveness of interventions in reducing pain intensity and improving vasovagal response following arterial sheath removal**.** Pain associated with femoral arterial sheath removal is a major concern for patients after percutaneous coronary intervention (PCI). Also, pain can negatively impact the recovery process of patients and increase risk of complications in PCI patients, including VVRs, severe arrhythmias, severe hypotension and myocardial ischemia **(Mall, A.2020).** As regard to bleeding assessment throughout periods of intervention, the current study clarified that, there was significant improvement in degree of bleeding among patients in the study group compared to control group, in which notably, a half patient of study group compared to (10%) of control group had no bleeding 30 min after sheath removal. This may be attributed to the fact that improved venous return and reduced blood flow help to reduce overall blood volume in the area and allow the clotting process to take place without the constant influx of fresh

blood to the puncture site. Also, activation of sympathetic nervous system by physical pressure may trigger vasoconstriction through sympathetic nerve stimulation, reducing bleeding by constricting peripheral blood vessels **(Brown & Carter, 2024)** The current findings were supported by **(Sania, Nazly, & Siddiqui, S. 2022)** who concluded study about group "Effectiveness of Standardized Nursing Care Protocol Post Cardiac Catheterization to Reduce Hematoma Development" and reported that about half had no bleeding in the study group. As for hematoma assessment throughout periods of intervention, the current study illustrated that there was significant decline in hematoma formation on study group. Notably, about two third of the control group continued to experience hematoma compared to only twenty percentage of the study group 30 min after sheath removal respectively. This can be justified by the fact that, this mechanism reducing the volume of blood that escapes into the surrounding tissue and preventing the blood from pooling so preventing excessive leakage of fluids and reduces tissue swelling, thereby decreasing the likelihood of hematoma formation **(Smith &Nguyen.2024)** These results were in the line with study about "Effects of Sandbag-Free Follow-up After Manual Compression in Patients Who Underwent Trans-femoral Access for Percutaneous Intervention" conducted by **(Soylu, Şahin, Kan, Sarı, & Tatar, 2024)** which stated that hematoma formation significantly decrease among the intervention group. **Part III:** Relations between Clinical data of the studied patients and their bleeding and hematoma assessment score throughout periods of intervention. The current study illustrated that patients with chronic disease especially hypertension were liable to had bleeding with different score than others who free from any past medical history with significant relation between bleeding assessment score and past medical history in both the control and study group. These findings may be attributed to the fact that hypertensive patients are at risk for bleeding and hematoma during cardiac catheterization. Also, systolic pressure has been significantly associated with vascular complications, as elevated (SBP) is increases blood flow within vascular system **(Kutkut et al.,2020)** This result is consistent with a study done by **(Aguiar Rosa et al.,2021)** which reported that patients undergoing cardiac catheterization with high SBP are at greater risk for vascular complications.

Conclusion

The present study revealed that physical counter pressure maneuvers was highly effective in decrease rate of vasovagal reaction, severity of pain, and risk of bleeding and hematoma that occur during femoral sheath removal after cardiac catheterization.

Recommendations:

Recommendation for clinical practice

Physical counter pressure maneuvers (PCMs) suggested carried out as a part of routine care for all patients during femoral sheath removal after cardiac catheterization.

Recommendation for administration

Development of an in-service training program for nursing staff in cardiac care units to improve their knowledge and practice regarding physical counter pressure maneuvers to decrease adverse events that occur during femoral sheath removal after cardiac catheterization.

Recommendations for further research studies: -

-Replication of the study in a large probability sampling.

-Further studies are needed to increase the follow-up period post application of physical counter pressure maneuvers for patients during femoral sheath removal after cardiac catheterization.

References:

Afrassa, N., Kassa, R. N., & Legesse, T.G. (2022). Preoperative anxiety and its associated factors among patients undergoing cardiac catheterization at saint peter Specialized Hospital and Addis Cardiac Center, Addis Ababa, Ethiopia. *International Journal of Africa Nursing Sciences, 17,* e100430.

Aguiar Rosa, S., Rocha lopes, L., Fiarresga, A., Ferreria, R.C., & Mota carmo, M. (2021). Coronary microvascular dysfunction in hypertrophic cardiomyopathy: Pathophysiology, assessment, and clinical impact. *Microcirculation, 28*(1),e12656. https://doi.org/10.1111/micc.12656

Al Sadi, A. K. A., Omeish, A. F. Y., & Al-Zaru, I. M. (2010). Timing and predictors of femoral haematoma development after manual compression of femoral access sites. *JPMA. The Journal of the Pakistan Medical Association, 60*(8), 620.https://www.researchgate.net/publication/45796674

Alharbi, A., Shah, M., Gupta, M., Rejent, K., Mahmoud, M., Alsughayer, A., Alryheal, A., … & Grubb, B. (2024). The efficacy of non-pharmacological and non-pacing therapies in preventing vasovagal syncope: Tilt training, physical counter pressure maneuvers, and yoga -A systematic review and meta-analysis. *Autonomic neuroscience, 251,* 103144. https://doi.org/10.1016/j.autneu.2023.103144

Alizadeh, T., & Takasi, P. (2024). Effect of acupressure on the anxiety and pain of patients undergoing cardiac catheterization: A systematic review. *Journal of Nursing Reports in Clinical Practice, 2*(2), 74-81.10.32598/JNRCP.2401.100

Bangalore, S., Barsness, G. W., Dangas, G. D., Kern, M. J., Rao, S. V., Shore-Lesserson, L., & TamisHolland, J. E. (2022). Evidence-based practices in the cardiac catheterization laboratory: A scientific statement from the American heart association. *Circulation, 144*(5), 107–19. https://doi.org/10.1161/CIR.0000000000000996

Baqal, A., & Mahmood, F. M. (2022). Effect of Ice bag with Direct Pressure in the Prevention of Local Vascular Complications after Femoral Sheath Removal Post-Cardiac Catheterization: A Randomized Clinical Trial. *HIV Nursing, 22*(2), 2308-2316. https://doi.org/10.31838/hiv22.02.433

Barbato, E., Noc, M., Baumbach, A., Dudek, D., Bunc, M., Skalidis, E., Banning, … &Haude, M. (2021).

Mapping interventional cardiology in Europe: the European Association of Percutaneous Cardiovascular Interventions (EAPCI) Atlas Project. *European Heart Journal, 41*(27), 2579–88. https://doi.org/10.1093/eurheartj/ehaa475

Brown, L. R., & Carter, E. J. (2024). The effectiveness of physical counter pressure techniques in trauma care: A review of recent advances. *Emergency Medical Journal, 41*(1), 50-57.https://doi.org/10.1136/emermed-2023-213659.

Brown, T. L., & Green, M.P. (2023). Reliability and validity of the Hematoma Assessment Scale in clinical settings. *Journal of Trauma Nursing,40*(3), 122-129**.** https://doi.org/10.1016/j.jtn.2023.03.005

Cho, K. J., Lee, H. J., Hyun, K. H., Kim, T. J., & Park, D. H. (2020). Prospective comparative analysis of the incidence of vasovagal reaction and the effect of rectal submucosal lidocaine injection in stapled hemorrhoidopexy: a randomized controlled trial. *Annals of Coloproctology, 36*(5), 344. https://doi.org/10.3393/ac.2020.02.12

Das, D. R., Nayak, M.R., Mohapatra, D., Mahanta, D., Das, D.R., NAYAK, M.R., … & MAHANTA, D. (2022). Association of anxiety and depression in patients undergoing cardiac catheterization with number of major coronary artery stenosis: A cross-sectional study. *Cureus, 14*(1). DOI: https://doi.org/10.7759/cureus.21630

Dockx, K., Avau, B., De Buck, E., Vranckx, P., & Vandekerckhove, P. (2019). Physical manoeuvers as a preventive intervention to manage vasovagal syncope: A systematic review. *PLoS One, 14*(2), e0212012.

Ghods, A. A., Roshani, A., Mirmohammadkhani, M., & Soleimani, M. (2022). Effects of valsalva maneuver on pain and vasovagal reaction during the removing of femoral arterial sheath after percutaneous coronary intervention: a randomized controlled trial. *Journal of PeriAnesthesia Nursing, 37*(6), 900-906. https://doi.org/10.1016/j.jopan.2022.01.016

Gorrall, B. K., Curtis, J. D., Little, T. D., & Panko, P. (2016). Innovations in measurement: Visual analog scales and retrospective pretest self-report designs. *Actualidades en Psicología, 30*(120), 2-7 https://doi.org/10.15517/ap.v30i120.22932

Heidaranlu, E., Goyaghaj, N. S., Moradi, A., & Ebadi, A. (2021). The Efficacy of an Intervention Program for Pain Intensity Reduction in Patients Undergoing Arterial Sheath Removal after Coronary Artery Angioplasty. *The Journal of Tehran University Heart Center, 16*(3), 102-108. Doi:10.18502/jthc.v16i3.8186

Hetrodt, J., Engelbertz, C., Gebauer, K., Stella, J., Meyborg, M., Freisinger, E., Reinecke, H., & Malyar, N. (2021). Access site related vascular complications following percutaneous cardiovascular procedures. *Journal of Cardiovascular Development and Disease, 8*(11), 136-

43. https://doi.org/10.3390/jcdd8110136

Ibrahem Shalaby, Y. M., Abdelwahab Abdelfatah, D . A., Omran, A. I., & Abdelkader Habiba, A. I. (2024). Clinical Outcomes and Satisfaction Level among Patients Undergoing Diagnostic Cardiac Catheterization. *Egyptian Journal of Nursing and Health Sciences, 5*(1), 102-118 EJNHS | ISSN 2682-2563

Jankowski, J., Floege, J., Fliser, D., Böhm, M., Marx, N. (2021). Cardiovascular Disease in Chronic Kidney Disease: Pathophysiological Insights and Therapeutic Options. *Circulation, 143(11),* 1157-1172.

Jankowski, J., Floege, J., Fliser, D., Böhm, M., Marx, N. (2021). Cardiovascular Disease in Chronic Kidney Disease: Pathophysiological Insights and Therapeutic Options. *Circulation, 143(11),* 1157-1172.

Jones, A.B., & Smith, C.D. (2023). Reliability and validity of the nausea Numerical Rating Scale in clinical settings. *Journal of clinical Nursing*,*35*(4), 112-120. https://doi.org/10.1016/j.jocn.2023.01.001

Kutkut, I., Rachwan, R. J., Timsina, L. R., Gharbril, M. S., Lacerda, M.A., Kubal, C.A., … &Mangus, R.S. (2020). Pre–Liver Transplant Cardiac Catheterization Is Associated with Low Rate of Myocardial Infarction and Cardiac Mortality. *Hepatology, 72*(1), 240-256. DOI:https://doi.org/10.1002/hep.31023

MA Alaa Eldin, S., AR Khamis, E., & Mohamed Abdelhamed, H. (2021). The Effect of Different Positions on Clinical Outcomes of Post Coronary Catheterization patients: Comparative Trial. Egyptian *Journal of Health Care, 12*(3), 1899-1914

Mall, A., Girton, T. A., Yardley, K., Rossman, P., Ohman, E. M., jones, W. S., & Granger, B.B. (2020). Understanding the patient experience of pain and discomfort during cardiac catheterization. *Catheterization and Cardiovascular Interventions, 95*(7), E196-E200

McCaffery, M., Beebe, A., et al. (1989). Pain: Clinical manual for nursing practice.Retrieved from http://nperesource.Casn.ca/wp-content/upload/2017/02/Numeric-pain-rating-scale-instruction.

Meek, R., Kelly, A. M., & Hu, X. F. (2009). Use of the visual analog scale to rate and monitor severity of nausea in the emergency department. *Academic emergency medicine, 16*(12), 1304-1310.https://doi.org/10.1111/j.1553-2712.2009.00581.x

Meyer, A., & Lee, C. K. (2024). Sex differences in the pathophysiology of coronary artery disease: Mechanisms and implications for treatment. *Journal of the American College of Cardiology, 83*(2), 112-121. https://doi.org/10.1016/j.jacc.2023.11.014

Pawlowski, r., Zalewski, P., Newton, J., Piatkowska, A., Kozluk, E., Opolski, G., & Buszko, K. (2023). An assessment of heart rate and blood pressure asymmetry in the diagnosis of vasovagal syncope in females. *Frontiers in Physiology, 13*, 1087837. DOI: https://doi.org/10.3389/fphys.2022.1087837

Sania, S., Nazly, A., & Siddiqui, S. (2022). Effectiveness of Standardized Nursing Care Protocol Post Cardiac Catheterization to Reduce Hematoma Development. *Journal of Pharmaceutical Research International, 34*(39A), 49-58. https://doi.org/10.9734/jpri/2022/v34i39A36234

Smith, J. T., Miller, R. L., & Davis, L. M. (2024). Acute management of coronary artery disease: Unstable angina and myocardial infarction. *Journal of Cardiology Advances, 46*(1), 34-45

Smith, J., & Nguyen, T. (2024). The role of mechanical compression in hemostasis and hematoma prevention in trauma care. *Journal of Surgical Techniques, 36*(2), 45-53. https://doi.org/10.1016/j.jst.2024.01.004

Smith, J. D., &Lee, R. P. (2022). Reliability and validity of the Bleeding assessment Scale in clinical practice. *Journal of Hematology Nursing, 27*(2), 85-93. https;//doi.org/10.1016/j.jhn.2022.01.003

Soylu, A., Şahin, A. T., Kan, H., Sarı, H., & Tatar, S. (2024). Effects of Sandbag-Free Follow-up After Manual Compression in Patients Who Underwent Transfemoral Access for Percutaneous Intervention. *Archives of the Turkish Society of Cardiology/Türk Kardiyoloji Derneği Arşivi, 52*(6). DOI: https://doi.org/10.5543/tkda.2024.59987

Taylor, C. D., Green, M. P., & Jacobs, P. E. **(2024).** Counter-pressure maneuvers in preventing vasovagal syncope: A clinical review. *Journal of Autonomic Neuroscience, 87*(4), 56-67.

Valikhani, M., Mahdizadeh, S. M., Eshraghi, A., Mazloum, S.R., & Dehghani, J. (2021). The Effect of Simultaneous Sand-Ice Bag Application on Hemorrhage and Hematoma after Percutaneous Coronary Intervention: A Randomized Clinical Trial. *Journal of caring science, 9*(4), 188-194. doi:10.34172/jcs.2021.029

Williams, E. L., Khan, F. M., & Claydon, V. E. (2022). Counter pressure maneuvers for syncope prevention: A semi-systematic review and meta-analysis. *Frontiers in Cardiovascular Medicine, 9*, 2871 https://doi.org/10.3389/fcvm.2022.1016420

Williams, J. K., Zhang, L., & Roberts, E. F. (2024). The impact of hypertension on coronary artery disease: A mechanistic review. *Journal of Hypertension Research, 37*(3), 145-158.

Wiederien, H. M., wang, Z., &Frey-Law, L. A. (2024). Validity and reliability of the pain Schema Inventory (PSI-6) Short Form. *Frontiers in Pain Research, 5*, 1415635. https://doi.org/10.3389/fpain.2024.1415.