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Original Article

The Effect of Foot Reflexology on Pain Severity Associated with Mediastinal Chest Drain Removal in Patients Undergoing Open-Heart Surgery

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1.ABSTRACT

Background: Mediastinal chest drain removal (MCDR) has been described as one of the worst experiences for patients after cardiac surgery. However, patients report MCDR as an unpleasant and painful procedure that is poorly controlled. Untreated pain may lead to several negative effects, longer rehabilitation, limited mobility, and other complications. Therefore, introducing new modalities such as reflexology became an issue of concern for nursing. **Aim:** This study aimed to investigate the effect of foot reflexology on pain severity associated with mediastinal chest drain removal in patients undergoing open-heart surgery. **Method:** A quasi-experimental design was used to conduct this study in the cardiothoracic intensive care unit at the cardiothoracic and vascular surgery center of Mansoura University. A convenience sample of 80 patients was randomly assigned to foot reflexology group who received 45 minutes reflexology session for both feet before and throughout MCDR procedure and control group who received the routine intensive care unit care. Data were collected using numerical rating scale and critical care observation tool. **Results:** The findings showed statistical significant differences between the studied groups concerning all physiological indicators ($P < 0.05$). Moreover, a statistical significant decrease in pain level was observed in foot reflexology group compared to the control group ($P < 0.05$). **Conclusion:** Foot reflexology is a safe technique and can significantly be used to reduce pain associated with MCDR in patients undergoing open heart surgery. **Recommendations:** Nurses should incorporate foot reflexology into their nursing practices to reduce pain associated with MCDR, achieve better outcomes, and improve quality of care.

Keywords: *Foot reflexology, Pain, Mediastinal chest drain, Open heart surgery*

2.Introduction

Cardiovascular disease (CVD) is a general term that describes a disease of the heart and blood vessels such as coronary heart disease, stroke, peripheral arterial disease and aortic disease **(World Heart Federation, 2023)**. CVDs are considered the leading cause of death worldwide **(World Health Organization [WHO], 2021)**. CVDs are also highly prevalent and can lead to disability and premature mortality **(Bell, Richards, Zakrzewski-Fruer, Smith & Bailey, 2023)**. About 17.9 million people died of CVDs in 2019, accounting for 32% of all deaths worldwide **(WHO, 2021)**. It has been expected that this mortality rate would grow to more than 23.6 million by 2030 **(American Heart Association, 2017)**.

The **burden** of CVDs is sharply rising in low and middle income countries **(Farina et al., 2023)**. Antiplatelet and anticoagulant medications are some of the most frequently recommended drugs for treating CVDs **(Barnes, 2020)**. Heart surgery can be done to treat some cardiac conditions such as coronary artery diseases (CADs) and valve regurgitation or stenosis when other treatments can't be used **(Caglar, Yeşiltepe-Oskay, Arican, & Akyo, 2021)**. Some patients with heart disease may need a surgery depending on the type and degree of damage to the heart **(Bacmeister et al., 2019)**.

Heart surgery is one of the most efficient methods for treating CVDs **(Zadeh, Mohammadtaghizadeh, Bahadori, Saki, &**

Rezaeeyan, 2020). According to **Melly, Torregrossa, Lee, Jansens, and Puskas (2018)**, coronary artery bypass grafting (CABG) is the most commonly used form of cardiac surgery. CABG is a life-saving intervention **(Bakaeen, Blackstone, Pettersson, Gillinov, & Svensson, 2018)** which improves blood flow to the heart muscle by creating a new path for blood to flow around a blocked or partially blocked artery in the heart **(Doenst et al., 2019)**.

Patients require monitoring and are usually hospitalized in the cardiothoracic intensive care unit (CTICU) from 48 to 72 hours postoperatively **(Khoshkesht, Ghiyasvandian, Esmaeili, & Zakerimoghadam, 2021)**. As a standard postoperative practice after cardiac surgery, patients are connected to mediastinal chest drains to assist the clearance of blood and serous fluid to avoid postoperative complications **(Van- Linden et al., 2019)**.

Patients after open heart surgery (OHS) suffer from pain for various reasons such as surgical incision, sternotomy, or the chest drains **(Macaire et al., 2019)**. Sternal pain after OHS is predominant in the first two weeks and after discharge **(Micah, Barolia, Parpio, Kumar, & Sharif, 2019)**. It is influenced by many factors such as preoperative restlessness, anxiety, surgical site and its extent, degree of tissue damage, and perioperative analgesia management **(Zubrzycki et al., 2018)**.

However, patients report chest drain removal (CDR) as an unpleasant and painful procedure that is poorly controlled **(Aktaş & Karabulut, 2019)**. Additionally, CDR has been described as one of the worst experiences for patients after OHS **(Tareq, Morshed, Rahman, & Hoque, 2020)**. Untreated pain may lead to several negative effects including respiratory problems, anxiety, immune system impairment, mood disorders, delirium, and higher mortality rate **(Barzanji, Zareiyan, Nezamzadeh, & Mazhari, 2019; Bignami et al., 2018)**.Thus, ineffective pain management may lead to longer rehabilitation, limited mobility, and other complications **(Mori et al., 2021)**.

There is no doubt that poorly controlled pain results in considerable stress for many patients **(Aktaş & Karabulut, 2019)**. Opioids were primarily used to alleviate postoperative pain, but they have side effects that prevented achieving optimal results **(Kwanten, O'Brien, & Anwar, 2019)**. Therefore, non-pharmacological pain therapy has been used to reduce these side effects **(Amato-Nesbit et al., 2019; Barghamadi, Behboodi, & Singh, 2019)**.

New modalities such as reflexology is effective in decreasing pain and anxiety in patients who have undergone cardiac surgery **(Alameri et al., 2020; Chandrababu et al., 2020)**. Reflexology is a complementary therapy focusing mainly on the application of pressure on the feet, hands, and ears **(Whatley, Perkins, & Samuel, 2022**). Foot reflexology is focused on reflex zones **(Embong, Soh, Ming, & Wong, 2015)**. It is carried out by applying light pressure to certain areas of the feet that stimulate functional responses in the body **(Embong et al., 2015; Smith et al., 2018)**.

These zones shape a body chart in the feet **(Artioli, Tavares, & Bertolini, 2021)**. Thus, feet could be seen as the micro map **of** the whole body **(Mahdavipour, Sadat, Mirbagher-Ajorpaz, & Kafaei-Atrian, 2022)**. Contrary to the limits of pharmacological treatment, reflexology is a simple, practicable, and affordable technique with no major side effects **(Karamisefat, Cheraghi, Soltanian, & Hasan Tehrani, 2021)**. There are no standard procedures or guidelines to manage the pain associated with CDR **(Tareq et al., 2020)**.

From our empirical observations and clinical experience in cardiothoracic ICU, it has been found that pain is poorly assessed and managed during MCDR. To the best of our knowledge, research studies which evaluated the effect of foot reflexology on pain severity associated with MCDR in patients undergoing OHS are scarce, particularly in Egypt, despite the magnitude of the problem. Thus, this inspired us to investigate this area.

2.1Research Aim

This study aims to investigate the effect of foot reflexology on pain severity associated with mediastinal chest drain removal in patients undergoing open-heart.

2.2Research Hypothesis

Open-heart surgery patients who will receive foot reflexology will have less pain during mediastinal chest drain removal than those who would receive the routine ICU care.

3.Methods

3.1Research Design

A quasi-experimental research design was used in this study. Non-experimental variation is used in the main independent variable of interest,

essentially imitating experimental conditions in which some subjects are exposed to treatment and others are not on a random basis **(Gopalan, Rosinger & Ahn, 2020)**.

3.2Setting

This investigation was conducted in the CTICU at the Cardiothoracic and Vascular Surgery Center (CTVSC). It contains a single room with 13 beds. This ICU is adequately provided with advanced technology needed for caring of patients. Valvular Heart Surgeries (VHS) and CABG are the most common operations performed in this unit.

3.3Sample

A convenience sample of 80 patients who were admitted to the CTICU after OHS were included in the study. Patients were enrolled in the current study based on the following criteria: Adult conscious patients ≥ 18 years old after OHS, who have a mediastinal chest drain. Sedated patients were excluded, patients with any problem in the foot as a wound, allergy, injury, pain, callus, corn, fungal skin infection, or previous scars, and patients use analgesics for ٦ hours before the intervention were also excluded.

3.4Sample size calculation

Based on data from literature **Babajani et al. (2014)**, considering the level of significance of 5%, and power of study of 80%, the sample size can be calculated using the following formula: n = [(Zα/2 + Zβ)2 × {2(SD)2}]/ (mean the difference between the two groups)2, where, SD = standard deviation obtained from the previous study; Zα/2, for 5% this is 1.96; and Zβ, for 80% this is 0.84. Therefore, n= [(1.96 + 0.84)2 × {2(2.07)2}]/ (1.26)2= 40.1 Based on the above formula, the total sample size required was 80 (40 per group).

3.5Data Collection Tool

Data were collected using the pain severity assessment tool.

Pain Severity Assessment Tool

This tool consisted of four parts: part I and II were developed by the researcher based upon relevant literature **(Abbaszadeh et al., 2018; Hashemzadeh et al., 2019; Rejeh et al., 2020)**. While, part III included the NRS adopted from **Freyd (1923)** and part IV included the CPOT adopted from **Gélinas, Fillion, Puntillo, Viens, and Fortier (2006)**.

Part I: Patients' Socio-Demographic Data

The personal data of the patients were addressed in this part which contained the patient's age, gender, marital status, level of education, and occupation.

Part II: Patients' Health-Relevant Data

This part focused on the patient's health history as the date of admission, diagnosis, length of stay in ICU, previous ICU admission, type of operation, co-morbidities and past surgical history, smoking status, and physiological parameters as heart rate (HR), respiratory rate (RR), oxygen saturation (SpO_2), and invasive systolic, diastolic and mean arterial blood pressure (SBP, DBP, and MAP). The six measurement time points included monitoring the physiological parameters at 45 minutes before drain removal, immediately before drain removal, during drain removal, 15 minutes, 30 minutes, and 60 minutes after drain removal by using an electronic monitor.

Part III: Numerical Rating Scale (NRS)

This scale was adopted from **Freyd (1923)**. The numeric rating scale (NRS) is mostly utilized to assess patients' levels of pain. Using a scale from 0 to 10, where zero represents no pain and ten expressing the worst pain **(Farrar, Troxel, Stott, Duncombe, & Jensen, 2008)**. The information collected through NRS is simple to document, easy to understand, and complies with regulatory criteria for pain evaluation and documentation. The scoring system is interpreted as 0 = no pain, 1–3 = mild pain, 4–6 = moderate pain, 7–10 = severe pain **(Karcioglua, Topacoglub, Dikmea, & Dikmea, 2018)**.

Part IV: "Critical Care Pain Observation Tool (CPOT)"

This scale was adopted from **Gélinas et al. (2006)**. It is one of the few pain scales that assesses objective behavioral indicators of pain. Each of the four portions is given a score of 0, 1, or 2, for a total score that ranges from 0 (no pain) to 8 overall (maximum pain). The reliability and validity of CPOT were acceptable. Inter-rater reliability was supported by moderate to high weighted kappa coefficients **(Dale, Prendergast, Gélinas, & Rose, 2018; Gélinas et al., 2006)**.

This pain assessment tool evaluates four clinical components: facial expressions, body movements, muscle tension, and compliance with the ventilator for mechanically ventilated patients or vocalization for the non-intubated patients. CPOT score ranges from 2 to 8 and a

score of more than 2 required pain management. The scoring system is interpreted as ≤2 = no pain, 3-6 = moderate pain, >6 = severe pain **(Rawal, Kumar & Yadav, 2019)**.

3.6Validity and Reliability

The validity and clarity of the developed parts (part I and II) were assessed by a jury of five experts from the Critical Care and Emergency Nursing field, Faculty of Nursing, Mansoura University. Necessary modifications were done accordingly such as determining number of drains, taking complete smoking history such as type and rate of smoking. The Cronbach's alpha value (internal consistency) of the NRS was 0.896, and of the CPOT was 0.889

3.7Pilot Study

A pilot study was conducted on 10% of the sample (8 patients) from CTICU at the Cardiothoracic and Vascular Surgery Center to assess the feasibility and applicability of the tool. Those patients were excluded from the study.

3.8Ethical Considerations

An ethical approval was obtained from the Research Ethical Committee of the Faculty of Nursing – Mansoura University for this study (No. P.0235). Before MCDR procedure, written informed consent was requested from study participants after they had been informed of the study's purpose, method, benefits, and hazards. The study's participants had been informed that their involvement was completely optional and that they had the option of participating or not. Also, participants were informed that they might leave the research at any time and without consequence. They also received assurances on the privacy of their personal information.

3.9Procedure

The current study was carried out in three phases including the preparation, implementation, and evaluation phases.

I. Preparation Phase

Data collection tool was constructed in this phase. Before initiating the study, the researcher had received a training course in massage and reflexology from two professors' experts in reflexology at The Egyptian Academy of Complementary Medicine. An official permission to conduct the study was obtained from administrative authorities of Cardiothoracic and Vascular Surgery Center after explaining the aim of the study. The researcher interviewed patients who met the inclusion criteria before MCDR procedure to explain to them the nature of the research and to invite them to participate in the study. Patients who accepted to take part in this research were enrolled in this investigation

II. Implementation Phase

Patients were assigned into two groups: foot reflexology group and control group 40 patients for each group. Patients' socio-demographic and health-relevant data were collected using part I and part II of the tool. **For both groups:** Pain was assessed at 45 minutes before drain removal, immediately before drain removal, during drain removal, 15 minutes, 30 minutes, and 60 minutes after drain removal using part III and IV of the tool. **For the Control Group:** Patients received only the routine ICU care before and throughout MCDR procedure. **For the foot reflexology group:** Foot reflexology was performed for 45 minutes before and throughout the MCDR procedure for both feet. It was performed on the right foot for 20 minutes, then on the left foot in the same manner beside the routine ICU care. **This phase was consisted of four parts:** Preparation for foot reflexology session, warm-up phase, mini-reflexology session and finishing phase.

1- Preparation for foot reflexology session:

Fingernails were cut at an appropriate length because too long nails will make contact with the patient's foot and decrease relaxation **(B. Kunz & Kunz, 2008)**. The researcher sat in a quiet comfortable and relaxed position in front of the patient's leg. After that, a small amount of non-therapeutic baby lotion was applied on hands to facilitate massaging and minimize skin friction **(Ghaljaei & Jalalodini, 2021)**

2- Warm-Up Phase:

Relaxation techniques were performed for two minutes for each foot **(Fazlollah et al., 2021)**. Prior to reflexology, foot massage and general foot squeeze were performed before working on the different reflex areas to create relaxation **(Taman, Shehata, Sallam, & Mady, 2018)**.

3- **Mini-reflexology session:** The following significant foot reflex regions received extra focus during the specific reflexology **(Abbaszadeh et al., 2018; Embong et al., 2015; Rooney, 2019; Sheikh et al., 2018)**

a. **Diaphragm and solar plexus reflex areas**: As the chest region is situated between the

shoulder line and the diaphragm line, the diaphragm line is below the ball of the foot.

b. **The heart and lung reflex areas**: These areas are located below the chest of the feet which circulates blood throughout the body.
c. **Pituitary gland reflex area:** Working with the pituitary gland, which is situated in the middle of the big toe, helps improve bodily functions such as metabolism.

4- Finishing Phase:

Scrubbing and rubbing motions are used from the ankle to the toes to end the session **(Zengin & Aylaz, 2019)**.

- **For the Control Group:** Patients received only the routine ICU care before, during, and after MCDR procedure.

III. Evaluation Phase

This phase aimed to investigate the effect of foot reflexology on pain severity associated with MCDR procedure in patients undergoing OHS. Patients' subjective and objective pain scores and their all physiological parameters as HR, RR, SpO_2, SBP, DBP, MAP were monitored and recorded at 45 minutes before MCDR, after immediately before drain removal, during drain removal, 15 minutes, 30 minutes, and 60 minutes after drain removal by using two pain scales (NRS and CPOT) and an electronic monitor.

3.10Data Analysis

The gathered data were arranged, tabulated and statistically analyzed using SPSS for windows version 20.0 (SPSS, Chicago, IL). Continuous data were normally distributed and expressed in mean ± standard deviation (SD). Categorical data were expressed in number and percentage. One-way analysis of variance (ANOVA) test was used for comparison among more than two for variables with continuous data. Chi-square test (or fisher's exact test when applicable) was used for comparison of variables with categorical data. Correlation co-efficient test was used to test for correlations between two variables with continuous data. The reliability (internal consistency) test for the questionnaires used in the study was calculate. Statistical significance was set at $p<0.05$. Regression analysis test was used to test for factors predicting the NRS and the CPOT.

4.Results

Table1presents the demographic characteristics of the studied sample. The results showed that most of the reflexology and control groups were males (75% & 67.5%, respectively) in the age group between 51 and 60 years old. More than two thirds of the foot reflexology group (77.5%) and more than half of the control group (62.5%) were married. Nearly half of the studied groups (45% & 47.5%) had achieved a basic level of education. Additionally, the most of both groups were employed. No statistically significant differences were detected between both groups regards the demographic characteristics indicating the similarity of the studied groups before the intervention ($P > 0.05$).

Table 2 illustrates the health relevant data of the studied sample. The results exhibited that ischemic heart disease (55% & 52.5%, respectively) was the most common medical diagnosis among the foot reflexology and control groups followed by valvular heart disease (40% & 40%, respectively). Chest pain was the most common chief complain described by the patients in both groups (50% & 45%, respectively) followed by difficulty in breathing (40% & 40%, respectively). The majority of both groups had no previous ICU admission (80% & 77.5%).

Regarding the type of operation, CABG was the most common surgery performed in the studied groups (55% & 50%, respectively) followed by valvular surgery (40% & 42.5%, respectively). Additionally, the majority of both groups had two chest drains (90% & 92.5%). In relation to co-morbidities, the findings showed that the majority of the studied groups had a hypertension (80% & 81.8%, respectively) followed by diabetes mellitus (44% & 36.4%). Concerning the past surgical history, 72.7% of the reflexology group and 69.2% of the control group had underwent open heart surgery. No statistically significant differences were noted between the studied groups regarding their health relevant data ($P > 0.05$).

Table 3 describes the smoking history of the studied groups. A half of the foot reflexology group (50%) and more than one third of the control group (37.5%) were smokers. Cigarettes was the most common type of smoking among the studied groups (90% & 93.3%, respectively). The predominant smoking rate in both groups was light (70% & 53.3%, respectively). There were no statistically significant differences detected between the foot refleology and control groups regarding smoking history ($P > 0.05$).

Table 4 compares the physiological parameters of the studied groups. The results exhibited statistical significant differences within the reflexology group compared to the control

group in relation to the mean of HR, SBD, and DBP which significantly declined toward the normal values. The findings reveal a significant improvement in the mean of physiological parameters after the reflexology session as HR changed (from 92.7±15.4 to 69.9±7.0, *P*<0.001), SBP changed (from 133.5±19.6 to122.1±12.0, *P*=0.021), and DBP changed (from 72.1±14.7 to 67.1±11.0, *P*=0.007), then the mean maintained within normal range during drain removal. Conversely, the mean of physiological parameters in the control group increased during drain removal.

Table 5 compares the NRS score before and during drain removal between the studied groups. The results showed a highly statistical significant difference within the reflexology group compared to the control group. The mean of NRS scores was lower in the reflexology group. The findings revealed a significant decline in pain score after reflexology session which decreased (from 4.2 ±1.9 to 2.7 ±1.1, *p*<0.001) and remained during drain removal within range (2.6 ±1.3, *p*<0.001), compared to the control group in which NRS score was between (4.2 ±2.1 & 4.5 ±1.6, respectively).

Additionally, a significant decrease in pain was found during drain removal after performing reflexology (2.6 ±1.3) compared to control group (6.0±1.7). Furthermore, more than one third (37.5%) had no pain, more than half of the reflexology group (52.5%) had mild pain, 10% had modetrate pain, and no one experienced severe pain during drain removal in relation to NRS score. While in the control group, 75% had moderate pain and 25% had severe pain during the procedure.

Table 6 compares the CPOT before and during drain removal between the studied groups regarding facial expressions, body movements, muscle tension, and vocalization. The results showed a statistical significant difference within the reflexology group compared to the control group. After foot reflexology session, more than half of the reflexology group (77.5%) had relaxed facial expression, the most of them (95%) had absence of body movement, 92.5% of them had relaxed muscle and all of them were talking in normal tone. Conversely, in the control group no one showed relaxed facial expression, the majority of them (82.5%) showed tense expression, 90% of them showed protection of the drain, 85% of them showed tense and rigid muscle and more than half (55%) used sighing and moaning immediately before drain removal. While, during drain removal in the reflexology group near to one quarter (20%) showed relaxed expression, more than half (55%) showed tense expression, , the majority of them (85%) had absence of body movement, 97.5% of them had relaxed muscle, 80% of them were talking in normal tone and near to quarter (20%) were sighing. On the contrary, in the control group no one showed relaxed facial expression, the majority of them (95%) showed grimacing expression, 55% of them showed protection of the drain, 50% of them showed tense and rigid muscle and near to half (47.5%) used sighing and moaning during drain removal.

Table 1 *Demographic Characteristics of the Studied Groups*

Variables	Reflexology Group n=40 N (%)		Control Group n=40 N (%)		Significance Test FET/ X^2	*P*-value
Age (Years)						
< 41	7	17.5	4	10.0		
41 < 50	3	7.5	12	30.0	6.885	0.076
50 – 60	20	50.0	16	40.0		
> 60	10	25.0	8	20.0	0.319	0.751
Mean ±SD	53.1 ±12.1		53.9 ±11.0			
Gender						
Male	30	75.0	27	67.5	0.549	0.459
Female	10	25.0	13	32.5		
Marital Status						
Single	9	22.5	15	37.5	2.143	0.143
Married	31	77.5	25	62.5		
Education						
Basic	18	45.0	19	47.5		
Secondary	11	27.5	9	22.5	0.271	0.873
University	11	27.5	12	30.0		
Occupation						
Employed	28	70.0	25	62.5		
Unemployed	4	10.0	7	17.5	0.988	0.610
Retired	8	20.0	8	20.0		

Data are expressed as numbers (N) and frequency (%). χ2: Chi-square test, FET: Fisher's exact test , P is significant if ≤ 0.05.

Table 2 *Health Relevant Data of the Studied Groups*

Variables	Reflexology Group n=40 N (%)		Control Group n=40 N (%)		Significance Test FET/ X^2	P-value
Diagnosis						
Congenital Heart Disease	2	5.0	3	7.5	0.223	0.894
Ischemic Heart Disease	22	55.0	21	52.5		
Valvular Heart Disease	16	40.0	16	40.0		
Chief Complain						
Chest pain	20	50.0	18	45.0	0.468	0.792
Difficulty in breathing	16	40.0	16	40.0		
Palpitation	4	10.0	6	15.0		
Length of ICU stay (Days)	3.6 ±0.6		3.8 ±0.6		1.567*	0.121
Previous ICU admission						
Yes	8	20.0	9	22.5	0.075	0.785
No	32	80.0	31	77.5		
Type of operation						
CABG	22	55.0	20	50.0	0.326	0.850
Valvular surgery	16	40.0	17	42.5		
Surgical congenital repair	2	5.0	3	7.5		
Number of drains						
1 Drain	4	10.0	3	7.5	0.156	0.692
2 Drains	36	90.0	37	92.5		
Co-morbidities						
Present	25	62.5	22	55.0		
Absent	15	37.5	18	45.0	0.464	0.496
#If yes, what is it?	**(n=25)**		**(n=22)**			
Hypertension	22	88.0	18	81.8	0.353	0.553
Diabetes mellitus	11	44.0	8	36.4	0.283	0.496
Respiratory disease	0	0.0	2	9.1	2.374	0.123
Past surgical history						
Present	11	27.5	13	32.5	0.238	0.626
Absent	29	72.5	27	67.5		
Past surgical history	**(n=11)**		**(n=13)**			
Abdominal Surgery	3	27.3	4	30.8	FET=0.035	0.851
Open Heart Surgery	8	72.7	9	69.2		

Data are expressed as numbers (N) and frequency (%). $\chi 2$: Chi-square test, FET: Fisher's exact test, # More than one answer,

- Student's t– test, *P* is significant if ≤ 0.05.

Table 3 *Smoking History of the Studied Groups*

Variables	Reflexology Group n=40 N (%)		Control Group n=40 N (%)		Significance Test FET/ X^2	P-value
Smoking history						
Yes	20	50.0	15	37.5		
No	20	50.0	25	62.5	1.270	0.260
#Type of smoking	**(n=20)**		**(n=15)**			
Cigarettes	18	90.0	14	93.3	0.122	0.727
Shisha	6	30.0	4	26.7	0.047	0.829
Duration of smoking (Days)	16.0 ±7.9		12.0 ±5.8		0.107*	1.652
Rate of smoking	**(n=20)**		**(n=15)**			
Light	14	70.0	8	53.3		
Heavy	6	30.0	7	46.7	1.020	0.313

Data are expressed as numbers (N) and frequency (%). $\chi 2$: Chi-square test, FET: Fisher's exact test, # More than one answer, * Student's t – test, P is significant if ≤ 0.05

Table 4 *Comparing the Studied Groups' Physiological Parameters Before and During Drain Removal*

Physiological Parameters	Reflexology Group Mean ±SD	Control Group Mean ±SD	*P*-value
45 Minutes before drain removal			
Heart rate	92.7 ±15.4	89.5 ±11.8	0.301
Systolic blood pressure (IBP)	133.5 ±19.6	128.1 ±12.2	0.143
Diastolic blood pressure (IBP)	72.1 ±14.7	71.5 ±8.8	0.833
Immediately before drain removal			
Heart rate	69.9 ±7.0	92.1 ±10.8	<0.001
Systolic blood pressure (IBP)	122.1 ±12.0	128.6 ±12.7	0.021
Diastolic blood pressure (IBP)	67.1 ±11.0	73.0 ±8.0	0.007
During drain removal			
Heart rate	73.4 ±8.0	106.7 ±14.7	<0.001
Systolic blood pressure (IBP)	122.5 ±16.2	129.2 ±10.2	0.029
Diastolic blood pressure (IBP)	66.9 ±9.7	77.5 ±8.6	<0.001

Data are expressed as mean and standard deviation (SD). MAP: Mean arterial pressure, IBP: Invasive blood pressure, T: Student's t – test, *P* is significant if ≤ 0.05.

Table 5 *Comparing the Numerical Rating Scale Score Between the Studied Groups Before and During Drain Removal*

Numerical Rating Scale	Reflexology Group		Control Group		*P*-value
	N	%	N	%	
45 Minutes before drain removal					
Mild Pain	11	27.5	13	32.5	
Moderate Pain	27	67.5	25	62.5	
Severe Pain	2	5.0	2	5.0	0.885
Mean ±SD	4.2 ±1.9		4.2 ±2.1		0.956
Immediately before drain removal					
No Pain	5	12.5	0	0.0	
Mild Pain	30	75.0	13	32.5	
Moderate Pain	5	12.5	25	65.5	
Severe Pain	0	0.0	2	5.0	0.070
Mean ±SD	2.7 ±1.1		4.5 ±1.6		<0.001
During drain removal					
No Pain	15	37.5	0	0.0	
Mild Pain	21	52.5	0	0.0	
Moderate Pain	4	10.0	30	75.0	
Severe Pain	0	0.0	10	25.0	<0.001
Mean ±SD	2.6 ±1.3		6.0 ±1.7		<0.001

Data are expressed as numbers (N) and frequency (%).mean and standard deviation (SD). $\chi 2$: Chi-square test, FET:

Fisher's exact test, *P* is significant if ≤ 0.05, 0 = No pain, (1–3) Mild pain, (4–6) Moderate pain, (7–10) severe pain

Table 6*Comparing the Critical Care Pain Observation Tool Between the Studied Groups Before and During Drain Removal*

Critical Care Pain Observation Tool	Reflexology Group		Control Group		Significance Test	
	N	%	N	%	FET/ X^2	*P*-value
45 Minutes before drain removal						
Facial expression						
Relaxed, neutral	0	0.0	1	2.5	4.769	0.092
Tense	25	62.5	32	80.0		
Grimacing	15	37.5	7	17.5		
Body movement						
Absence of movement	1	2.5	2	5.0	7.465	0.024
Protection	30	75.0	37	92.5		
Restlessness	9	22.5	1	2.5		
Muscle tension						
Relaxed	2	5.0	3	7.5	1.545	0.462
Tense, rigid	33	82.5	35	87.5		
Very tense or rigid	5	12.5	2	5.0		
Vocalization						
Talking in normal tone or no sound	18	45.0	18	45.0	4.400	0.111
Sighing, moaning	18	45.0	22	55.0		
Crying out, sobbing	4	10.0	0	0.0		
Immediately before drain removal						
Facial expression						
Relaxed, neutral	31	77.5	0	0.0	42.696	<0.001
Tense	9	22.5	33	82.5		
Grimacing	0	0.0	7	17.5		
Body movement						
Absence of movement	38	95.0	3	7.5	61.299	<0.001
Protection	2	5.0	36	90.0		
Restlessness	0	0.0	1	2.5		
Muscle tension						
Relaxed	37	92.5	4	10.0	54.534	<0.001
Tense, rigid	3	7.5	34	85.0		
Very tense or rigid	0	0.0	2	5.0		
Vocalization						
Talking in normal tone or no sound	40	100.0	16	40.0	34.286	<0.001
Sighing, moaning	0	0.0	22	55.0		
Crying out, sobbing	0	0.0	2	5.0		

Table 6 (continued)

Critical Care Pain Observation Tool	Reflexology Group		Control Group		Significance Test	
	N	%	N	%	FET/ X^2	*P*-value
During drain removal						
Facial expression						
Relaxed, neutral	8	20.0	0	0.0	11.250	<0.001
Tense	22	55.0	2	5.0		
Grimacing	10	25.0	38	95.0		
Body movement						
Absence of movement	34	85.0	2	5.0	53.587	<0.001
Protection	6	15.0	22	55.0		

Restlessness	0	0.0	16	40.0		
Muscle tension						
Relaxed	39	97.5	6	15.0	55.390	<0.001
Tense, rigid	1	2.5	20	50.0		
Very tense or rigid	0	0.0	14	35.0		
Vocalization						
Talking in normal tone or no sound	32	80.0	3	7.5	46.875	<0.001
Sighing, moaning	8	20.0	19	47.5		
Crying out, sobbing	0	0.0	18	45.0		

5.Discussion

Postoperative pain and discomfort are extremely severe following sternotomy and mediastinal tube placement **(Ata, Yılmaz, & Yılmaz, 2023)**. Up to 75% of patients reported moderate to severe pain within the first four days **(Viana et al., 2023)**. Pain following cardiac surgery can result in alterations in the heart, lungs, digestive system, respiratory system, metabolism, and immunological system that can impair the healing of incision, increase the risk of thromboembolism, reduce muscle strength, and suppress the immune system **(de Andrade et al., 2022)**. According to **Hamed, Abdelhady, Hassan, and Boules (2022)**, patients find it difficult to manage post-sternotomy pain, which may also be followed by delirium, hypertension, tachycardia, arrhythmias, and respiratory issues after OHS.

Therefore, this study focused on investigating the effect of foot reflexology on pain severity associated with MCDR in patients undergoing OHS. The results of the current study revealed that the most of the reflexology and the control groups were males in the age group between 51 and 60 years old. A clinical trial conducted by **Abbaszadeh et al., (2018)** found that the mean of participants' age was 56.50 ± 7.99 and all participants were males. A study conducted by **Tunç, Şahutoğlu, Karaca, Kocabaş, and Aşkar (2018)** also declared that the mean age of the patients was 61.5±10 years, and 69% of studied sample were males. The current study also showed that the majority of both reflexology and control groups were employed.

These results are aligned with **Shehata et al., 2021** who evaluated the effect of therapeutic foot reflexology massage on anxiety and sleep quality among hospitalized cardiac patients at Menoufia University Hospital and revealed that 75% and 77.5% of study and control groups were worked. However, this result is disagreed with other studies which found that the highest percentage of the studied sample were housewives **(Amer, Khalil, & Seloma, 2022; Khaledifar et al., 2017; Rahmani et al., 2017)**.

In relation to medical diagnosis, the results of current study showed that IHD was the predominant medical diagnosis among both reflexology and control group followed by VHD. A previous study conducted by **Al-Qalah, Shereif Salam, and Hassanein. (2015)** reported that the majority of the study and control groups had rheumatic and ischemic heart disease. Our findings also coincides with a study conducted in Turkey by **Şahin and Çilingir (2022)** who found that CAD was the most common diagnosis in the studied sample (88.6% & 80%, respectively).

Regarding the chief complain, the current study showed that chest pain and difficulty in breathing (40% & 40%) were the patients complains in the current study. On the contrary, **Tefera, Abegaz, Abebe, and Mekuria (2017)** reported that headache was the leading chief complaint among the patients. This can be due to hypertension which accounted for the majority (62.3%) of CVDs followed by heart failure (23.9%) in the studied sample.

Concerning length of stay in ICU, our results indicated that the mean of days patients spent in ICU was 3.6±0.6 in the reflexology group and 3.8 ±0.6 in the control group. This finding is matched with a study conducted by **Ertürk and Ünlü (2018)** who declared that the predominant duration of stay in ICU following OHS was 3-4 days and **Bucerius et al. (2004)** who showed that the mean duration of ICU stay was 3.8±6.9 days. According to **Tunç, Şahutoğlu, Karaca, Kocabaş, and Aşkar (2018)**, the duration of stay in hospital was 8.7±2.9 and 11.2±7.0 in the studied groups.

Regarding previous ICU admission, the current study showed that less than half of the studied groups had previous ICU admission (20% & 22.5%). This view is matched with **Çakalağaoğlu, Selçuk, Erdem, Elibol, and Köksal (2020)** who declared that emergency CABG showed a strong association with ICU readmissions. The ICU readmission rate was 3.5%

due to respiratory (29%) and cardiac (23.4%) complications.

In relation to the type of operation, the results showed that the most common surgery performed in the foot reflexology and control groups was CABG (55% & 50%) followed by valvular surgery (40% & 42.5%). This finding is consistent with the results of **Tunç et al. (2018)** and **Ertürk and Ünlü (2018)**. They declared that CABG was the predominant operation in the studied groups followed by valve replacement operation.

Similar to our findings, **Rezaei-Nodehi et al. (2018)** declared that the majority of the studied sample performed CABG surgery. Contrary to our findings, **Al-Qalah, Shereif Salam, and Hassanein (2015)** found that more than half of both study and control group underwent valve replacement surgeries. In relation to number of drains, the findings revealed that the majority of reflexology and control groups had two drains and few percent had a single drain. The surgeons in our unit prefer insertion of two mediastinal drains for fear of blockage of a single mediastinal drain with subsequent occurrence of CT.

This goes with **Richards et al. (2018)** who reported that after cardiac surgery two or three chest tubes are placed in the mediastinal space to continuously monitor postoperative blood loss and to prevent undesirable blood collection, especially in the pericardial space. It can be suggested that the higher the number of drains the patient has, the greater the pain the patient experiences. This view is disagreed by other studies which reported that there were no statistically significant differences between the studied sample regarding using single or double tubes (**Zhang, Lv, Li, Sun, & Liu, 2016)**.

Concerning co-morbidities, the present study revealed that more than half of the reflexology and control groups suffered from co-morbidities. The more prevalent type of co-morbidity in the studied sample was HTN followed by DM. This is aligned with **Shehata et al. (2021)** who showed that the most common type of co-morbidity was HTN (45.7% & 42.9%) followed by DM (48.5% & 45.5%) in the studied groups. This can be attributed to high prevalence of HTN and type 2 DM in Egypt **(Hussein, Mahmoud, Awad, & Mahmoud, 2020)**.

Concerning surgical history, the present study revealed that more than half of the studied groups didn't have any past surgical history but less than half of the reflexology group (27.5%) and the control group (32.5%) had a previous cardiac surgery. This finding is also matched with **Cook et al., (2017)** who declared that one third of participants had previous valvular surgery and only 13.5% of them had previous CABG surgery. On the contrary, **Ertürk and Ünlü (2018)** evaluated the effects of pre-operative individualized education on anxiety and pain severity in patients following open-heart surgery. They found that nearly two third of the studied sample (63.3%) had a positive surgical history.

Regarding smoking, the current study noted that a half of the reflexology group (50%) compared to 37.5% of the control group were smokers. This can be attributed to the fact that smoking harms and constricts arteries and exacerbate the risk to develop CVDs. This is supported by **Hopley et al. (2019)** who declared that smoking raises blood pressure because tobacco leaves contain nicotine which accelerates the HR and elevate BP. Additionally, long term smoking can result in complete narrowing of the arteries **(Volpe, Gallo, & Tocci, 2018)** as blood pressure deteriorates as the inner layer of blood vessels gradually became thick **(Burnier, 2015)**.

Contrary to our findings, **Al-Qalah et al. (2015)** found that the highest percentage of the studied groups were non smokers (66% & 76%). A randomized controlled clinical trial conducted by **Rejeh et al. (2020)** also disagreed with our findings. They found that the predominant percentages were among non smokers (26.7% & 27.8%) and few percent of studied sample were tobacco smokers (8.9% & 7.8%). Our findings revealed a significant improvement in all studied physiological parameters within the foot reflexology group and continued for one hour after drain removal. This improvement can be due to the impact of reflexology on stimulating specific reflex zones in the foot which in turn relieves anxiety, provides comfort, and decreases pain.

This finding is matched with **Abbaszadeh et al., (2018)** who revealed that a statistically significant difference was found between the studied groups in terms of all physiological parameters including SpO_2, RR, SBP, DBP, and MAP, except for the HR. This is also consisted with the results of **(Mohamed, Thabet, Sayed, & Mohamed, 2021)** who noticed that foot reflexology declined SBP and DBP after the intervention and significantly reduced HR at all measured times after the intervention.

Additionally, **Tian, Li, and Yan (2021)** observed that reflexology intervention decreased pain and HR postoperatively. Supporting our findings, **Sheikh, Yaghoubinia, and Navidian (2017)** reported a significant improvement in some of the vital parameters including SBP, DBP, HR, and RR in the reflexology group, except for HR.

The present study revealed a statistically significant difference between the reflexology group and control group in relation to pain severity associated with removal of mediastinal drian. There was no significant difference between groups before intervention. The immediate improvement in pain scores after performing reflexology was noticed as the mean pain score of NRS in the foot reflexology decreased compared to the control group which remained without reflexology. The current findings are supported by **Sayari et al. (2021)** a double blinded randomized clinical trial that evaluated the effect of foot reflexology on chest pain and anxiety in patients with MI. They found less chest pain in reflexology group than the control group with maximal effect in 20 minutes after intervention.

Similarly, **Hashemzadeh et al. (2019)** revealed that reflexology significantly reduced the pain severity postoperatively in the intervention group among patients undergoing CABG. This is matched with the results of **Kapıkıran et al. (2022)** who investigated the effect of reflexology on patient satisfaction, pain and vital signs after abdominal surgery. They found the pain intensity of the intervention group was lower compared to the control group.

Moreover, a study conducted in Egypt by **Sliman, Mahmoud, and Ali (2020)** to investigate the effect of foot massage on pain severity, hemodynamic parameters, and the length of mechanical ventilation weaning time among patients in critical care settings. They revealed a statistically significant decrease in the intervention group in relation to pain score. The current findings are supported by the other studies which reported that foot reflexology is effective in reducing pain after surgery **(Abdullayev, 2021; Rejeh et al., 2020)**.

Furthermore, another study evaluated the effect of foot massage on the intensive care patients' pain and reported that foot massage showed a significant reduction (**Momeni et al., 2020)**. This finding is also aligned with the results of **Şahin and Çilingir (2022)** who observed a statistically significant decrease in the mean scores of the visual analogue scale in study group compared to the mean score of control group.

6.Conclusion and Recommendations

Foot reflexology is a safe technique and can significantly reduce pain associated with MCDR in patients undergoing OHS. Thus, it can be used as an adjunct to the routine care.

7.Limitations

The generalization of this study finding was limited due to the small sample size (80 patients) which was collected from one Egyptian hospital. Moreover, several sessions of reflexology and using of hand reflexology adjunct to foot in the perioperative period was not studied this sample.

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9. Declaration of competing interests

There are no potential conflicts of interest.

10.References

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