

The Effect of Diaphragmatic Breathing Technique on Pain Intensity for Adult Patients Post Orthopedic Surgeries

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Abstract

Background: Post orthopedic surgery patients experiencing numerous symptoms such as pain, which is the most frequently reported symptom that is linked to decreased quality of life and impaired overall function. Diaphragmatic breathing technique is an effective complementary and non-pharmacological technique used to reduce pain with beneficial effects on physical and mental health in patients post orthopedic surgeries. **Aim of the study:** To evaluate the effect of diaphragmatic breathing technique on pain intensity for adult patients post orthopedic surgeries. **Design:** A quasi-experimental design was utilized to conduct the current study. **Setting:** The study was conducted in orthopedic department affiliated to Benha University Hospital, Qalyubia Governorate, Egypt. **Subjects:** A purposive sample of sixty-five adult patients post orthopedic surgeries within six months were enrolled in this study. **Tools:** Four tools were used to collect data; (I) Structured interview questionnaire for patients which consisted of patients' personal and health data, (II) Patient's knowledge questionnaire, (III) Patient's practice observational checklist, (IV) The Brief Pain Inventory. **Results:** There was significant statistical improvement in total knowledge and practice scores of studied patients after three months of implementing the technique as compared to pre implementation, all mean total scores of pain scale for post orthopedic surgery patients decreased significantly after applying diaphragmatic breathing technique. Finally, the independent variables contributing to variance in pain score were knowledge and practice scores, as well as respiratory rate, accounting for 51.8% of the variance of pain intensity. **Conclusion:** Diaphragmatic breathing technique had a positive effect in decreasing pain intensity for post orthopedic surgery patients. **Recommendations:** Importance of presenting posters to remind patients about diaphragmatic breathing technique and to improve patients' knowledge and practices. Also, hospitals are recommended to use the diaphragmatic breathing technique alongside other treatments to decrease pain intensity in patients post orthopedic surgeries.

Keywords: Diaphragmatic breathing technique, Pain, Patients post orthopedic surgeries

Introduction

Orthopedic surgery is a surgical procedure associated with the correction of musculoskeletal system deformities and orthopedic problems that aim to improve function by restoring movement and stability as well as reducing pain and disabilities (Chengwu & Ginting, 2022). Broken bones can cause soft tissue edema, bleeding in muscles and joints, rupture tendons, nerve tissue damage and vascular damage, surgeries are ways that are carried out to restore the

motion function, the effect that occur due to these actions is pain (Sasongko et al., 2019).

After surgery, the patient enters the postoperative recovery phase, which defined as a complex, and multidimensional process that involves multiple domains, including physical, psychological, social, and economic aspects (Fiore et al., 2022). The amount of discomfort following orthopedic surgery depends on many factors, including the type of performed surgery. Typical discomfort may

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include, pain, nausea and vomiting from general anesthesia, sore throat caused by the tube placed in the windpipe for breathing during surgery, and swelling around the incision site, restlessness and sleeplessness (Elsaid et al., 2021).

Orthopedic patients experience severe pain following surgical interventions. Pain management is a vital component of post-orthopedic nursing care (Mahedy et al., 2021). Postoperative pain may increase the risk of complications. Untreated surgical pain may result in a decrease in alveolar ventilation and vital capacity and even pneumonic consolidation. Also it can cause hypertension, tachycardia, myocardial infarction, insomnia and poor wound healing and also delay rehabilitation (Li & Xiao, 2019).

Pharmacological management of pain, including opioids, non-steroidal anti-inflammatory drugs (NSAIDs), local anesthetic infiltration and nerve blocks, for managing the analgesic requirements after orthopedic surgeries, may produce other health side effects, including nausea, vomiting, constipation, damage to the liver, kidneys, and gastrointestinal tract (Datta et al., 2021).

There is a need for effective nonpharmacological interventions for managing pain. Relaxation techniques include a number of practices like progressive relaxation, biofeedback, guided imagery, meditation, self-hypnosis, acupuncture, yoga, psychotherapy and diaphragmatic breathing exercises; can help reducing pain of postorthopedic surgery (Sandvik et al., 2020).

Diaphragmatic breathing technique (DBT) plays an important role in pain signaling and autonomic nervous system (ANS) activation, anti-inflammatory processes, emotion regulation and acid/base balance. Recent studies suggested that (DBE) relieves pain and

sleep disruption from pain and improves mood (Pawa, 2020).

Diaphragmatic breathing or abdominal breathing is the natural breathing that inhaled air is drawn deep into the lungs and exhaled as the diaphragm contracts and expands (Thomas & Malawade, 2022). Diaphragmatic breathing technique has been proposed as an effective and beneficial intervention for postorthopedic surgery pain relief. It reduces pain and improves function, quality of life, mood, and confidence to manage health (Larsen et al., 2019).

Orthopedic specialist nurse plays an important role in caring of orthopedic patients because nurse is responsible for observing and monitoring of the patient (Hoang, 2022). Orthopedic nursing was caring for musculoskeletal disorders. There were basic duties for orthopedic nurses as monitor vital signs, report about abnormalities after surgery, assessment of patient from head to toes, collect needed samples, provide dressing on the operation sites, monitor signs and symptoms of infection, change position of patient with safety precaution, administer medication as prescribed in correct manner and provide extensive education for patients and their families regarding therapy services (Reid, 2019)

Therefore, post orthopedic surgery nurses should aware of pharmacological management, its side effect and its management, and understand the nonpharmacological benefits of diaphragmatic breathing technique, she helps patient for implementation of (DBT) by teaching patient the correct steps of it, evaluating knowledge and practice for patient and making time table for practice as a part of nursing care plan (Miri et al., 2022).

Significance of the study

Orthopedic surgeries increased globally (**Howard et al., 2020**). In 2017, the number of orthopedic surgery procedures performed worldwide totaled approximately 22.3 million. The number of procedures per year is forecast to grow at a 4.9% compound annual rate over the 2017-2022 intervals, approaching 28.3 million by 2022 and making this one of the most rapidly growing surgical procedure categories (**Collins, 2021**). According to the annual census of Benha University Hospital the number of orthopedic surgery procedures performed at 2019 was about 2307 while at 2020 was 114 (it is the year of corona pandemic) and at 2021 was 1719 (**Statistics office at Benha University Hospital, 2019 2020, 2021**).

Complications are displayed in 45% of patients in the postoperative period. Severe postoperative pain may increase the risk of complications and also delay rehabilitation (**Wang & Thyagarajan, 2022**). Post-operative pain may also overall healthcare costs due to a prolonged hospital stay and elevated rates of hospital readmission. The relationship between pain and non-pharmacological interventions was supported by previous studies. The definitive evidence about the impact of diaphragmatic breathing exercise on pain intensity as a supportive intervention for patients post orthopedic surgeries is still lacking, therefore there is an urgent need to examine its effectiveness to improve patients' post-orthopedic surgery pain (**Miri et al., 2022**). So, the current study was designed to evaluate the effect of diaphragmatic breathing exercise on pain intensity for adult patients post orthopedic surgeries.

Aim of the study

The present study was conducted with the aim to evaluate the effect of diaphragmatic breathing technique on pain intensity for adult patients post orthopedic surgeries.

Research Hypothesis:

H1: The mean scores of patients' level of knowledge post implementing diaphragmatic breathing technique could be higher than their scores before implementation.

H2: The mean scores of patients' level of practices post implementing diaphragmatic breathing technique could be higher than their scores before implementation.

H3: Patients' level of pain could be significantly decreased after implementation of the diaphragmatic breathing technique than before.

Subjects and method

Research design:

Quasi-experimental pre and post intervention comparison study design was implemented to achieve the aim of the present study.

Setting:

This study was conducted in orthopedic department affiliated to Benha University Hospital, Qalyubia Governorate, Egypt.

Subject:

A purposive sampling technique was used for selecting the sample size from patients post orthopedic surgery in the previously mentioned setting. The sample size was calculated based on the previous year census report of admission in the orthopedic department of Benha University Hospital for census 2021.

Tools of Data Collection:

Four tools were used to collect data for this study as follows:

Tool I: Structured interview questionnaire:

This questionnaire was designed by the investigator in simple Arabic structure items after reviewing recent relevant literatures and

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scientific references (Boateng, 2018). It aims to assess patient personal and medical data about pain and it involved three parts it consisted of 15 questions in the form of multiple-choice questions as following:

Part (1): It contains (6 questions).

Concerning patient's personal data: It was including data related to age, gender, marital status, level of education, occupation and residence.

Part (2): It includes (6 questions).

Regarding patient's medical and surgical data as diagnosis, patient present and past history, patient complaint.

Part (3): It was concerned with physical assessment of patients such as vital signs and pain assessment (site of pain, the nature of pain and the place of pain radiation) pre, post one month and after three months of implementation the diaphragmatic breathing technique, it included the table of vital signs and 3 multiple choice questions.

Tool II: Patient's knowledge questionnaire: (4 questions)

It was designed by the researcher after reviewing recent relevant literatures and scientific references (Fink, 2019). to assess patient's knowledge regarding the diaphragmatic breathing technique pre, post one month and after three months implementation of the technique and it was include a set of questions as regard definition of diaphragmatic breathing technique, the positions in which the diaphragmatic breathing exercise was practiced, the duration of the diaphragmatic breathing exercise at one time and the number of times per day, benefits of diaphragmatic breathing exercise.

Patients' knowledge scoring system:

Each correct answer was scored (1) and the wrong answer was scored (zero). The total score for knowledge was (4 marks), The Total patients' knowledge score was summed-up and converted into a percent then categorized

into two levels as follows: If the score 75% or more of total score (3 scores or more), it was considered satisfactory level of knowledge, while if it was less than 75% (less than 3 scores) it was considered unsatisfactory level of knowledge.

Tool III: Patient's practice observational checklist: It aimed to assess the patients' practice pre, post one month and three months follow up post implementation of diaphragmatic breathing technique, this tool was adapted from (Ibrahim et al., 2020). This tool consisted of 5 steps related to diaphragmatic breathing technique instructions that should be followed during the application of the technique.

Patient's practice scoring system:

One grade was given for each step that done correctly, zero for the step that done incorrectly or not done. The total level of patients' practice score was computed out of 5 marks; total practice scores was converted into a percent and categorized as follows: The score 75% or more of total score 3.75 marks or more, it was considered an adequate level of practice, while if it was less than 75% (less than 3.75) it was considered as an inadequate level of practice.

Tool IV: The Brief Pain Inventory:

The Brief Pain Inventory (BPI) rapidly assesses the severity of pain and its impact on function pre, post one month and after three months implementation of the diaphragmatic breathing technique. The (BPI) is available in two formats: The BPI short form and the (BPI) long form, the investigator used the short form of the BPI, and it was adopted from (Shahid et al., 2011). The BPI is a 15-minute questionnaire that can be self-administered. It includes several questions about the characteristics of the pain, including its origin, effects of prior treatments, Severity of pain that score it at its best, worst, and on average, and includes the perceived level of

interference with normal functions as general activity, mood, walking ability, relation with other people, sleep, enjoyment of life.

Brief pain inventory scoring system:

1- Pain severity score:

This is calculated by adding the scores for questions 3, 4, 5 and 6 and then dividing by 4. This gives a severity score out of 10 (**Shimoji & Aida, 2021**).

- 0 will be considered "no pain".
- 1-3 will be considered "mild pain".
- 4-6 will be considered "moderate pain".
- 7-9 will be considered "severe pain".
- 10 will be considered "worst possible pain"

2- Pain Interference Score:

This is calculated by adding the scores for questions 9a, b, c, d, e, f, and g and then dividing by 7. This gives an interference score out of 10. (**Shimoji & Aida, 2021**).

Validity and Reliability:

Tools validity: The face and content validity of the tools were checked by five experts in the field of Medical Surgical Nursing from the Faculty of Nursing, Benha University, to check the relevancy, clarity, comprehensiveness, and applicability of the questions. The consensus among experts regarding the tools was between 90% to 100% for most items, then all required modifications were done consequently, and the final form of the tools was used for data collection.

Reliability of tools: All tools of the study were tested statistically for its reliability, and it was evaluated using test-retest method by the Cronbach's alpha test which is used to measure the internal consistency. The reliability scores of the tools were r coefficient for patients physical characteristics tool I (part III) was ($r= 0.802$), patients' knowledge questionnaire tool II was ($r= 0.739$), for patients' practice questionnaire tool III was ($r= 0.788$), and structured tool (brief pain inventory) was ($r= 0.91$), which denotes the high internal consistency of the used tools.

Ethical Considerations:

An official permission for data collection was obtained from hospital director and head managers of the orthopedic department at Benha University Hospital by the submission of a formal letter from the dean of Faculty of Nursing at Benha University.

- The study approval was obtained from the ethical committee of Faculty of Nursing before initiating the study work after explanation of its purpose.
- Explaining the study's aim and benefits, as well as the procedure of data collection to all participants (patients) clearly.
- The participants were informed that their participation was optionally, and that they had the right to withdraw at any time without any consequences.
- Verbal and written consent was obtained from each patient enrolled into the study.
- The researcher assured that all collected data would be absolutely confidential and only used for the study' aim.

Pilot Study:

A pilot study was conducted on 10% of all patients that were included in the study (7 patients) from the total number of patients (72) in order to test the clarity and applicability of the tools. There was a slight modification in the tool. So the patients involved in the pilot study were excluded from the main study sample. The pilot study was done two weeks before starting the study (1/April, 2022).The time needed to fill in the tool was about 30-45 minutes.

The study was conducted through four phases:

Assessment phase:

The investigator initiated data collection by interviewing each participant of all groups separately for assessing patient's personal data , medical , surgical data and physical assessment by using tool I, then assess patients' knowledge by tool II, assess their

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practice by tool III, patients' pain by tool IV. This assessment was given more insight about the pre-implemented patients' level of knowledge, practice and pain after surgery.

Implementation phase:

- All available patients in orthopedic department at Benha University Hospital during the time of data collection, that was met the inclusion criteria and was agree to participate in this study.
- The investigator divided the studied patients into 6 groups each group contain 11 patients.
- The technique of implementation was carried out for each group through the conduction of three sessions during their hospital stay, and each session lasted about 35 minutes.
- Different teaching and learning methods were used during the sessions which included; videos, group discussions, demonstration and redemonstration, to learn patients about diaphragmatic breathing technique.
- Each group attended the sessions as the following:
 - The first session covered the definition, benefits of diaphragmatic breathing technique, its effect on pain, and performance instructions.
 - The second session focused on application of diaphragmatic breathing technique, by the researcher and asked care giver to observe and guide patients to practice correctly.
 - The third session included performing of diaphragmatic breathing technique, by the patient and in front of the researcher to ensure that the patient done it correctly.
 - The investigator carried out revision and reinforcement according to participants' needs. Also the researcher corrected the wrong performance of technique and answered questions.
 - The investigator gave the instructions for the practice of diaphragmatic breathing technique (DBT) and demonstration was provided by the researcher to the patients

followed by a practice session of DBT and clarification of any doubts regarding the procedure before the application of the diaphragmatic breathing technique period was began.

- The intervention was started by DBT for 15 minutes in the morning on an empty stomach then repeat it three times per day for four consecutive weeks.
- The instruction of the diaphragmatic breathing technique included the following steps:
 - Lie on back on a flat surface (or in bed) with knees bent. Can use a pillow under his/ her head and knees for support, if that's more comfortable.
 - Can also practice this technique by sitting in a chair, with the knees bent and the shoulders, head, and neck relaxed.
 - Place one hand on the upper chest and the other on the belly, just below the rib cage and stay focused and attentive on the relaxing words, images, feelings and turn out any other thoughts or sounds.
 - Breathe in slowly through the nose, letting the air in deeply, towards the lower belly. The hand on the chest should remain still, while the one on the belly should rise.
 - Tighten the abdominal muscles and let them fall inward as exhale through pursed lips. The hand on the belly should move down to its original position, these steps constitute one round of diaphragmatic breathing technique. Do this for 15 minutes 3 times per day for four consecutive weeks if possible, preferred on an empty stomach.

Evaluation phase:

The posttest was done by using the same study tools of the pretest for patients post 1 month and 3 months to determine the effect of using diaphragmatic breathing technique on pain among post orthopedic surgery patients.

Statistical analysis:

Data were analyzed using the statistical package for social science (SPSS), version 25. Numerical data were expressed as mean, standard deviation (SD) and range. Qualitative data were expressed as frequency and percentage. Chi-square test was used to examine the relation between qualitative variables, for comparing the mean scores between two different periods within the same group were used to the paired t-tests. Correlation between different numerical variables was tested using Pearson product-moment correlation coefficient. Linear regression was used for multivariate analyses on pain intensity as dependent factor A p-value < 0.05 was considered significant, and <0.001 was considered highly significant.

Results

Table (1) shows that 47.7% of the studied patients aged from 40 to less than 50 years old with Mean \pm SD was 39.49 ± 0.98 years, also (76.9, 83.1% & 49.2 %, respectively) of the studied patients were males, married as well as read and write. Whereas 83.1% were working, and 72.2% of them were performing manual work, moreover 78.5% were resident in rural area.

Table (2) displays reduction in patients' total mean score of pain severity pre and post diaphragmatic breathing technique implementation. Where, there was a highly significant statistical difference between pre breathing technique with post one month and three months post diaphragmatic breathing technique implementation.

Table (3) displays reduction in patients' total mean score of pain interference pre and post diaphragmatic breathing technique implementation. Where, there was a highly significant statistical difference between pre breathing technique with post one month and three months post diaphragmatic breathing technique implementation.

Figure (1) illustrates that there was a significant statistical reduction in pain intensity level throughout breathing technique phases. Where, (67.7% & 32.3%, respectively) of the studied patients had a moderate and severe pain level pre-breathing technique implementation, to be reduced only to a moderate level among (63.1% & 3.1%, respectively) during post period (post 1 month) and three months post breathing technique implementation.

Table (4) shows that there was a significant statistical relation during pre-breathing technique between total knowledge of the studied patients and their education level with p value = 0.038*. While after breathing technique, there was statistically significant relation with age, marital status and education level with p value = (0.010*, 0.046*, & 0.008*, respectively) during post implementation (post 1 month) and p value = (<0.001**, <0.001**, & 0.007*, respectively) during three months period post breathing technique implementation.

Table (5) shows that there was no significant statistical relation between total knowledge of the studied patients and their health-related data throughout breathing technique periods.

Table (6) shows that there was a highly significant statistical relation during pre-breathing technique between total practice of the studied patients and their education level with p value = <0.001**. While post breathing technique, there was statistically significant relation with age, and education level with p value = (0.018* & 0.009*, respectively) during post period (post 1 month) and with age, marital status and education level at p value = (0.003*, 0.001**, & <0.001**, respectively) during three months period post breathing technique implementation

Table (7) shows that there was no significant statistical relation between total

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practice of the studied patients and their health-related data throughout breathing technique periods.

Table (8) shows that there was no significant correlation between total knowledge and practice for the studied patients during pre-breathing technique with p-value 0.875, while a positive and highly significant correlation was found during post period (post

1 month) and three months post breathing technique implementation with p value <0.001**.

Table (9) presents that pain intensity in the studied patients was best predicted by knowledge, practice and respiration rate (p= 0.047, 0.028, and 0.015*, respectively), accounting for 51.8% of the variance of pain intensity.

Table (1): Frequency and percentage distribution of the studied patients according to their personal data (n = 65).

Patients' personal data		No.	%
Age (in year)	20-<30	15	23.1
	30-<40	11	16.9
	40-<50	31	47.7
	50- 60	8	12.3
	Mean ± SD 39.49± 0.98		
Sex	Male	50	76.9
	Female	15	23.1
Marital status	Married	54	83.1
	Not married	11	16.9
Education level	Illiterate	11	16.9
	Read and write	32	49.2
	Secondary education	22	33.9
Working status	Working	54	83.1
	Not working	11	16.9
Nature of work (n=54)	Official	15	27.8
	Manual work	39	72.2
Residence	Urban	14	21.5
	Rural	51	78.5

Table (2): Difference between total mean scores of pain severity among studied patients throughout the different study phases (n=65).

Pain severity	Pain (pre breathing technique) (n= 65)	Pain (1 month post breathing technique) (n= 65)	Pain (3 months post breathing technique) (n= 65)	t-test P value (1)	t-test P value (2)
	Mean ± SD	Mean ± SD	Mean ± SD		
Pain at its worst in the past 24 hours	9.49 ± 0.77	6.45 ± 2.46	4.06 ± 1.49	-9.508 <0.001* *	-26.102 <0.001**
Pain at its least in the past 24 hours	3.83 ± 1.23	2.51 ± 1.01	1.88 ± 1.03	-6.687 <0.001* *	-9.799 <0.001**
Pain on average	6.75 ± 0.83	4.14 ± 1.48	2.97±1.08	-12.401 <0.001* *	-22.374 <0.001**
Pain right now	5.95±1.83	3.32 ± 1.34	1.94±1.08	-9.348 <0.001* *	-15.215 <0.001**
Total	6.50 ±0.67	4.10 ± 0.63	2.71±0.66	-21.039 <0.001* *	32.490 <0.001**

****Highly significant at p <0.001.**

(1) Difference between pain severity score Pre breathing technique and 1 month post breathing technique

(2) Difference between pain severity score Pre breathing technique and 3 months post breathing technique

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Table (3): Difference between total mean scores of pain interference among the studied patients throughout the different study phases (n=65).

Pain interference	Pain (pre breathing technique) (n= 65)	Pain (1 month post breathing technique) (n= 65)	Pain (3 months post breathing technique) (n= 65)	t-test P value (1)	t-test P value (2)
	Mean ± SD	Mean ± SD	Mean ± SD		
In past 24 hours, how much relief have pain treatment provided	73.23 ± 7.80	78.46 ± 17.17	84.77 ± 16.21	2.236 0.027*	5.172 <0.001**
Pain interference with					
General activity	8.95 ± 1.45	4.12 ± 2.06	2.46±1.18	-15.458 <0.001* *	-19.364 <0.001**
Mood	6.00±3.15	4.08 ± 2.70	2.97±1.08	-3.731 <0.001* *	-7.336 <0.001**
Walking ability	6.62±4.15	5.02 ± 1.47	4.03±1.17	-2.930 0.004*	-4.843 <0.001**
Normal work (includes both work outside the home and house work)	7.42±3.80	6.31 ± 1.81	6.18±1.27	-2.126 0.035*	-2.495 0.013*
Relations with other people	7.88±1.36	3.98 ± 1.55	2.05±1.26	-15.248 <0.001* *	-25.353 <0.001**
Sleep	7.37±2.34	3.97 ± 1.21	2.29±1.07	-10.406 <0.001* *	-15.918 <0.001**
Enjoyment of life	6.77±2.17	3.66 ± 0.97	2.08±1.36	-10.549 <0.001* *	-14.765 <0.001**
Total	7.28 ± 1.40	5.80 ± 4.00	3.15±0.45	-2.816 0.005*	- 22.643 <0.001**

****Highly significant at p <0.001**

(1) Difference between pain interference score Pre breathing technique and 1 month post breathing technique

(2) Difference between pain interference score Pre breathing technique and 3 months post breathing technique

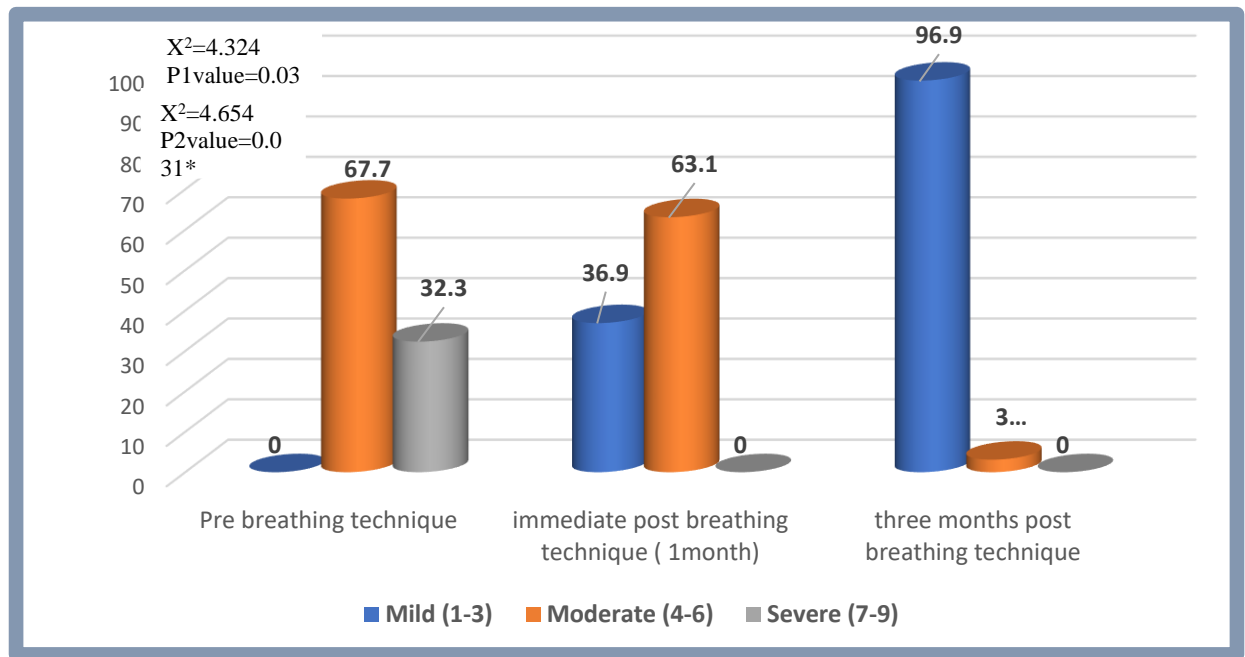


Figure (1). Difference between total pain intensity level of the studied patients throughout the different study phases (n=65)

(*) Significant statistical difference at $p \leq 0.05$

(1) Difference between total pain intensity pre breathing technique and 1 month post breathing technique

(2) Difference between total pain intensity pre breathing technique and three months post breathing technique

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Table (4): Relationship between patients' total knowledge level and their personal data throughout the different study phases (n=65)

Personal data	Total Knowledge (pre breathing technique) (n= 65)		χ^2 P value	Total Knowledge (1 month post breathing technique) (n= 65)		χ^2 P value	Total Knowledge (3 months post breathing technique)(n= 65)		χ^2 P value
	Satisfactory (n=11)	Unsatisfactory (n=54)		Satisfactory (n=50)	Unsatisfactory (n=15)		Satisfactory (n=48)	Unsatisfactory (n=17)	
	No (%)	No (%)		No (%)	No (%)		No (%)	No (%)	
Age (in year)									
20-<30	2(27.3)	12(22.2)	3.347 0.341 n.s	14(28.0)	1(6.7)	11.245 0.010*	2(4.2)	13(76.5)	39.786 <0.001**
30-<40	1(9.1)	10(18.5)		9(18.0)	2(13.3)		9(18.8)	2(11.8)	
40-<50	4(36.4)	27(50.0)		20(40.0)	11(73.3)		31(64.6)	0(0.0)	
50- 60	3(27.3)	5(9.3)		7(14.0)	1(6.7)		6(12.5)	2(11.8)	
Sex									
Male	7(63.6)	43(79.6)	1.317 0.251 n.s	37(74.0)	13(86.7)	1.043 0.307 n.s	36(75.0)	14(82.4)	0.382 0.536 n.s
Female	4(36.4)	11(20.4)		13(26.0)	2(13.3)		12(25.0)	3(17.6)	
Marital status									
Married	9(81.8)	45(83.3)	0.015 0.903 n.s	39(78.0)	15(100.0)	3.972 0.046*	45(93.8)	9(52.9)	14.870 <0.001**
Not married	2(18.2)	9(16.7)		11(22.0)	0(0.0)		3(6.3)	8(47.1)	
Education level									
Illiterate	0(0.0)	11(20.4)	4.639 0.038*	5(10.0)	6(40.0)	9.739 0.008*	10(20.8)	1(5.9)	9.972 0.007*
Read and write	6(54.5)	26(48.1)		29(58.0)	3(20.0)		27(56.3)	5(29.4)	
Secondary education	5(45.5)	17(31.0)		16(32.0)	6(40.0)		11(22.9)	11(64.7)	
Working status									
Working	9(81.8)	45(83.3)	0.015 0.903 n.s	41(82.0)	13(86.7)	0.179 0.672 n.s	38(79.2)	16(94.1)	1.996 0.158 n.s
Not working	2(18.2)	9(16.7)		9(18.0)	2(13.3)		10(20.8)	1(5.9)	
Residence									
Urban	3(27.3)	11(20.4)	0.258 0.612 n.s	12(24.0)	2(13.3)	0.777 0.378 n.s	13(27.1)	1(5.9)	3.339 0.068 n.s
Rural	8(72.7)	43(79.6)		38(76.0)	13(86.7)		35(72.9)	16(94.1)	

n.s Not significant at p > 0.05.

*Significant at p ≤0.05

** Highly Significant at p ≤0.001

Table (5): Relationship between patients' total knowledge level and their health-related data throughout the different study phases (n=65)

Health related data	Total Knowledge (pre breathing technique) (n= 65)		χ^2 P value	Total Knowledge (1 month post breathing technique) (n= 65)		χ^2 P value	Total Knowledge (3 months post breathing technique) (n= 65)		χ^2 P value
	Satisfactor y (n=11)	Unsatisfact ory (n=54)		Satisfacto ry (n=50)	Unsatisfact ory (n=15)		Satisfactor y (n=48)	Unsatisfactor y (n=17)	
	No (%)	No (%)		No (%)	No (%)		No (%)	No (%)	
Type of surgery									
Minor	1(9.1)	9(16.7)	0.403	8(16.0)	2(13.3)	0.063	9(18.8)	1(9.5)	1.597
Major	10(90.9)	45(83.3)	0.526 n.s	42(84.0)	13(86.7)	0.802 n.s	39(81.3)	16(94.1)	0.206 n.s
Presence of comorbid disease									
No	8(72.7)	48(88.9)	2.001	43(86.0)	13(86.7)	0.004	39(81.3)	17(100.0)	3.700
Yes	3(27.3)	6(11.1)	0.157 n.s	7(14.0)	2(13.3)	0.948 n.s	9(18.8)	0(0.0)	0.054 n.s
previous surgery									
No	7(63.6)	36(66.7)	0.037	30(60.0)	13(86.7)	3.665	31(64.6)	12(70.6)	0.202
Yes	4(36.4)	18(33.3)	0.846 n.s	20(40.0)	2(13.3)	0.056 n.s	17(35.4)	5(29.4)	0.653 n.s

n.s Not significant at p > 0.05.

*Significant at p ≤0.05

** Highly Significant at p ≤0.001

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Table (6): Relationship between patients' total practice level and their personal data throughout the different study phases (n=65)

Personal data	Total practice (pre breathing technique) (n= 65)		χ^2 P value	Total practice (1 month post breathing technique) (n= 65)		χ^2 P value	Total practice (3 months post breathing technique) (n= 65)		χ^2 P value
	Adequate (n=3)	Inadequate (n=62)		Adequate (n=60)	Inadequate (n=5)		Adequate (n=56)	Inadequate (n=9)	
	No (%)	No (%)		No (%)	No (%)		No (%)	No (%)	
Age (in year)									
20-<30	0 (0.0)	15(24.2)	3.450 0.327 n.s	12(20.0)	3(60.0)	10.075 0.018*	9(16.1)	6(66.7)	13.769 0.003*
30-<40	0 (0.0)	11(17.7)		11(18.3)	0(0.0)		9(16.1)	2(22.2)	
40-<50	3(100.0)	28(45.2)		31(51.7)	0(0.0)		31(55.4)	0(0.0)	
50- 60	0 (0.0)	8(12.9)		6(10.0)	2(40.0)		7(12.5)	1(11.1)	
Sex									
Male	3(100.0)	47(75.8)	0.944 0.331 n.s	46(76.7)	4(80.0)	0.029 0.865 n.s	44(78.6)	6(66.7)	0.619 0.431 n.s
Female	0(0.0)	15(24.2)		14(23.3)	1(20.0)		12(21.4)	3(33.3)	
Marital status									
Married	0(0.0)	51(82.3)	0.641 0.423 n.s	50(83.3)	4(80.0)	0.036 0.849 n.s	48(85.7)	6(66.7)	12.109 0.001**
Not married	3(100.0)	11(17.7)		10(16.7)	1(20.0)		8(14.3)	3(33.3)	
Education level									
Illiterate	3(100.0)	8(12.9)	15.440 <0.001**	10(16.7)	1(20.0)	9.374 0.009 *	11(19.6)	0(0.0)	20.418 <0.001**
Read and write	0(0.0)	32(51.6)		30(50.0)	2(40.0)		32(57.1)	0(0.0)	
Secondary education	0(0.0)	22(35.5)		20(33.3)	2(40.0)		13(23.2)	9(100.0)	
Working status									
Working	3(100.0)	51(82.3)	0.641 0.423 n.s	49(81.7)	5(100.0)	1.103 0.294 n.s	45(80.4)	9(100.0)	2.128 0.145 n.s
Not working	0(0.0)	11(17.7)		11(18.3)	0(0.0)		11(19.6)	0(0.0)	
Residence									
Urban	0(0.0)	14(22.6)	0.863 0.353 n.s	14(23.3)	0(0.0)	1.487 0.223 n.s	13(23.2)	1(11.1)	0.672 0.412 n.s
Rural	3(100.0)	48(77.4)		46(76.7)	5(100.0)		43(67.8)	8(88.9)	

n.s Not significant at p > 0.05.

*Significant at p ≤0.05

** Highly Significant at p ≤0.001

Table (7): Relationship between patients' total practice level and their health-related data throughout the different study phases (n=65)

Health related data	Total practice (pre breathing technique) (n= 65)		χ^2 P value	Total practice (1 month post breathing technique) (n= 65)		χ^2 P value	Total practice (3 months post breathing technique) (n= 65)		χ^2 P value
	Adequate (n=3)	Inadequate (n=62)		Adequate (n=60)	Inadequate (n=5)		Adequate (n=56)	Inadequate (n=9)	
	No (%)	No (%)		No (%)	No (%)		No (%)	No (%)	
Type of surgery									
Minor	0(0.0)	10(16.1)	0.572	10(16.7)	0(0.0)	0.985	10(17.9)	0(0.0)	1.899
Major	3(100.0)	52(83.9)	0.450 n.s	50(83.3)	5(100.0)	0.321 n.s	46(82.1)	9(100.0)	0.168 n.s
Presence of comorbid disease									
No	3(100.0)	53(85.5)	0.505	52(86.7)	4(80.0)	0.172	47(83.9)	9(100.0)	1.679
Yes	0(0.0)	9(14.5)	0.477 n.s	8(13.3)	1(20.0)	0.678 n.s	9(16.1)	0(0.0)	0.195 n.s
previous surgery									
No	3(100.0)	40(64.5)	1.609	39(65.0)	4(80.0)	0.464	34(60.7)	9(100.0)	3.734
Yes	0(0.0)	22(35.5)	0.205 n.s	21(35.0)	1(20.0)	0.496 n.s	22(39.3)	0(0.0)	0.053 n.s

n.s Not significant at $p > 0.05$.

*Significant at $p \leq 0.05$

** Highly Significant at $p \leq 0.001$

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Table (8): Correlation coefficient between studied patients' total knowledge and total practice throughout the different study phases (n=65).

Variables	Total Knowledge score pre breathing technique		Total Knowledge score post 1 month of breathing technique)		Total Knowledge score post 3 months of breathing technique)	
	r	P value	r	P value	r	P value
Total practice	0.020	0.875 ^{n.s}	0.437	<0.001 ^{**}	0.471	<0.001 ^{**}

****A Highly Statistical significant $p \leq 0.001$**

Table (9): Multiple Linear Regression Analysis for Predictor Variables of pain intensity of the studied patients post three months of diaphragmatic breathing technique implementation (n=

Predictor Variable of pain intensity	Standardized Coefficients		Unstandardized Coefficients		t	Sig.
	Beta		B	Std. Error		
(Constant)			-.643	8.967	-.072	.943
Age	-.130		-.087	.095	-.922	.360
sex	-.150		-.233	.272	-.857	.395
Type of surgery	-.079		-.144	.386	-.372	.711
Presence of comorbidities	.142		.270	.239	1.129	.264
Knowledge	.342		.040	.020	-2.033	.047
Practice	-.309		-.131	.058	-2.253	.028
Pulse	.302		.035	.019	1.858	.068
Respiration	-.379		-.107	.043	-2.518	.015
Systolic blood pressure	.004		.000	.006	.028	.977
Diastolic blood pressure	-.024		-.001	.009	-.168	.867

Adjusted R² = 0.518

P = 0.032*

(B) Beta Co-Efficient

(SEB) Standard Error

Discussion

Orthopedic surgeries are known to be one of the most painful operations. Poorly controlled acute post orthopedic surgery pain is associated with increased morbidity, impaired functional and quality-of-life, delayed recovery time, prolonged duration of opioid use, and higher health-care costs. In addition, the presence and intensity of acute pain post orthopedic surgery is predictive of the development of chronic pain. So; postoperative pain management should be given a high priority in emergency orthopedic surgeries. Appropriate pain management strategy should be implemented to decrease postoperative pain suffering as diaphragmatic breathing technique (**Pirie et al., 2022**).

Diaphragmatic breathing technique (DBT) is an effective complementary and non-pharmacological technique used to reduce and prevent the build-up of toxins in the lungs by encouraging the clearing of alveoli, increasing lung volume, clearing secretions, improve gas exchange, controlling breathlessness, increasing exercise capacity, reducing blood pressure, relaxation response for stress reduction and controlling pain. Current literature and best nursing practice recommended applying DBT have likely to reduce pain and enhance the healing process, thus achieving cost savings (**Hany et al., 2019**).

The present study aimed to evaluate the effect of diaphragmatic breathing technique on pain intensity for adult patients post orthopedic surgeries. The discussion of reported findings of the current study compared with the recent literatures and other related studies. It also explains to what extent the results of the current study supported or contradicted with the results of others.

The discussion of the findings is presented in the following parts:

Regarding age, the findings of the current study revealed that approximately half of the studied patients' age ranged from forty to less than fifty years old with a mean age of 39.49 ± 0.98 years. From the researcher point of view, this result might be due to the criteria of the selection of sample or increase the probability of accidents usually occur the former age groups. This finding at the same line with a study carried out by **Mohamed et al., (2021)** about "Effect of implementing nursing educational protocol on reducing deep venous thrombosis among orthopedic surgery patients" revealed that more than half of the studied patients aged 41-50 years old.

On the other hand, this result disagrees with **Arefayne et al., (2020)** who stated in his study entitled "Incidence and associated factors of post-operative pain after emergency Orthopedic surgery" showed that more than two fifth of the studied sample was aged between 30 to <59 years old. From the researcher point of view, this result might be due to the site of this study as it conducted in emergency department.

In addition, this result is inconsistent with another study done by **Ibrahim et al., (2020)** about " Effect of diaphragmatic breathing exercise on postoperative nausea, vomiting, and retching among orthopedic surgery patients" revealed that, the majority of sample was aged between 20 to <40 years old, with mean age was 35.2 ± 13 years.

In relation to gender, the result of the current study showed that more than three quarters of the studied patients were males. From a scientific standpoint, this might be explained by the well-documented fact that Egyptian males are more workers than female which making them more prone to accidents. This finding is in agreement with study done by **Arefayne et al., (2020)** revealed that slightly less than three fifth of the studied patients were males.

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This finding disagreed with **De Boer et al., (2019)** who studied "Risk factors for postoperative pain in the first three weeks after arthroscopic or open shoulder surgery" revealed that more than half of the studied patients were female.

Concerning the marital status, the result of the present study demonstrated that the vast majority of studied patients were married. From the researcher point of view, this result might be due to the inclusion criteria of the selection of sample that aged from 20 to 60 years old; more persons at this age were married. This finding is in agreement with study conducted by **El-sead et al., (2022)** in a study entitled "Effect of Implementing a Protocol of Nursing Care on Clinical Outcomes for Patients Undergoing Lumbar Spine Disc Prolapse Surgeries" who reported that three quarters of the studied patients were married.

Also, these findings were in the same line with study conducted by **Rahmani et al., (2020)** who stated in his study entitled "The Effect of Family-Oriented Educational Intervention on Postoperative Pain after Orthopedic Surgery" revealed that two thirds of the studied sample were married.

As for educational level, the current study revealed that about half of studied patients read and write. From the researcher point of view, this may be due to that the study was conducted in governmental hospital wish accommodate many numbers of patient with low socioeconomical level and low educational level. This result was agreed with **Ibrahim et al., (2020)** who emphasized that more than half of patients can read and write. On the contrary with **Kathirvel et al., (2021)** who studied "Impact of structured educational interventions on the prevention of pressure ulcers in immobile orthopedic patients in India" they mentioned that more than half of

the participants had an educational level of high school.

In relation to working status, the present study illustrated that the majority of the studied patients were worked and three quarters of them occupied with manual work and need physical effort in work. From the researcher point of view, this may be due to that the study was conducted on low level educated patients that decrease their chance in official work.

This finding is in congruent with **Sayed et al., (2019)** who studied "Effect of nursing management on pin site infection among incidence patients with external fixators" who found that three quarters of the studied patients were manual workers. On the other hand, this result disagrees with **Rahmani et al., (2020)** who showed that approximately more than half of the studied sample was unemployed.

Regarding residence, the result of the current study showed that more than three quarter of the studied patients lived in rural area and this might be resulted from taking the study subjects from Benha University Hospital which serve the surrounding areas and the majority of them are rural areas. This finding was in consistent with **El-sead et al., (2022)** Who mentioned that slightly less than three fifth of the studied patients were from rural area.

But this result was contradicted by **Wang et al., (2021)** who studied "Clinical attitudes towards pain treatment post-orthopedic surgery" revealed that more than two fifth of studied patients were lived in urban area. On the other hand this result wasn't in the same line with **Ibrahim et al., (2020)** showed that more than half of the studied patients were from urban areas.

This result displays reduction in patients' total mean score of pain severity throughout the different study phases of breathing technique implementation. Where, there was a highly significant statistical difference

between pre breathing technique with post one month period and three months post diaphragmatic breathing technique implementation. From researcher point of view, and from reading literature review this result may be due to the good effect of diaphragmatic breathing on body relaxation state as it increases relaxation which lead to decrease pain.

This finding was agreed with **Sasongko et al., (2019)** showed that Deep breathing exercise was effective in reducing pain in post orthopedic surgery patients with severe pain scale, and proved that the reduction in pain level in the intervention group who received relaxation therapy was greater than the control group who not received it.

These findings are confirmed by **Abo El Ata et al., (2021)** in a study entitled "Effect of Breathing exercise on reducing pain associated with breathing among hospitalized burned patients" who revealed the benefit of relaxation breathing technique for hospitalized burned patients during wound dressing and found that there was a highly statistically significant difference in pain level pre and post-measurement, it was clarified that the majority of patients reported a significant decrease in their pain intensity level.

This finding is in contrast with **Erol & Catakli, (2020)** in a study entitled "The effect of diaphragmatic breathing exercise on pain, anxiety, and depression in patients undergoing total knee replacement" showed that diaphragmatic breathing technique did not significantly affect patients' pain scores and show that DBT alone is enough to decrease anxiety after surgery and not adequate for pain management.

In relation to pain interference level throughout the different study phases of diaphragmatic breathing technique. this result showed the difference in patients' total mean score of pain interference pre and post

diaphragmatic breathing technique implementation. Where, there was a significant statistical difference between pre breathing technique with post one month period and three months post diaphragmatic breathing technique implementation period. From the researcher point of view, this will occur successively when the pain level decreased because of the Positive relationship between pain intensity level and pain interference level.

This result comes in agree with **Sasongko et al., (2019)** showed that the level of patient's performance in the study group improved after the relaxation technique intervention. Also, these findings are confirmed by **Jackson, (2019)** who studied "Pain Psychology" who revealed the high positive effect of (DBT) on decreasing pain interference level on sleep, mood and enjoyment of live and its moderate effect on general activity and walking ability.

Concerning relation between patients' total knowledge level and their personal data throughout the different study phases of diaphragmatic breathing technique implementation, the present study revealed that there was a significant statistical relation during pre breathing technique implementation between total knowledge of the studied patients and their education level. While after breathing technique, there was statistically significant relation with age, marital status and education level during post one month period and three months period post breathing technique implementation.

From the researcher point of view, these results may be due to that nearly majority of the studied patients wear educated read and write that help them to read and understand the booklet.

These findings are consistent with **Hany et al., (2019)** in a study entitled "Effect of Deep Breathing Technique on the severity of Pain among Postoperative Coronary Artery Bypass Graft patients" who found that there was a

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significant statistical relation between patients' total knowledge level and educational level pre and post diaphragmatic breathing technique implementation.

But, the current study was contrasted with **Ünver et al., (2018)** who showed that there was no significant statistical Relationship between patients' total knowledge level and their personal data regarding diaphragmatic breathing technique implementation.

Concerning relation between patients' total knowledge level and their health related data throughout the different study phases of diaphragmatic breathing technique implementation, the result of current study illustrated that there was no significant statistical relation between total knowledge of the studied patients and their health related data throughout breathing technique periods. From the researcher point of view this result due to that the total knowledge of the studied patients depend on level of education not on health state.

This result disagreed with **Grinberg et al., (2020)** in a study entitled "Effect of diaphragmatic breathing on procedural anxiety during transrectal prostate biopsy" showed that there was a significant statistical relation between total knowledge of the studied patients and their health related data regarding breathing technique implementation and showed that patients without chronic diseases have the ability to understand and perform the technique.

With regards to relation between patients' total practice level and their personal data throughout the different study phases of diaphragmatic breathing technique implementation, this table shows that there was a highly significant statistical relation during pre-breathing technique between total practice of the studied patients and their education level. While post breathing technique, there was statistically significant relation with age

and education level during post one month period and with age, marital status and education level three months post breathing technique implementation.

From the researcher point of view, this results may be due to that about half of studied patients read and write that help them to read and understand the booklet. Although the current study was performed on patients with age from 20 to 60 years, the person becomes mature enough to understand the technique and perform it correctly.

These results are in the same line with **Hamasaki H. (2020)** in a study entitled "Effects of Diaphragmatic Breathing on Health" Shaw that there was a statistical relation between total practice and educational level of the studied patients. But this result disagreed with **Ghorbani, et al., (2019)** which entitled "The effects of deep-breathing exercises on postoperative sleep duration and quality in patients undergoing coronary artery bypass graft" showed that demographic metrics were not significantly different between the two groups.

Regarding relation between patients' total practice level and their health related data throughout periods of diaphragmatic breathing technique implementation, the current study clarified that there was no significant statistical relation between total practice of the studied patients and their health related data throughout breathing technique periods.

This is congruent with a previous study done by **Mosallaiezhadeh et al., (2023)** about "Effects of Combining Diaphragmatic Exercise with Physiotherapy on Chronic Neck Pain" documented that there was no significant statistical relation between total practice of the studied patients and their health related data throughout breathing technique periods of implementation.

The result of current study revealed that there was no significant correlation between total

knowledge and practice for the studied patients pre-breathing technique, while a positive and highly significant correlation during post one month period and three months post breathing technique implementation.

From researcher's points of view, this highly significant correlation during post one month period and three months post breathing technique implementation, was significantly associated with following the instructions of the investigator step by step and performing practice as guided, more familiarity and understanding of the technique, reinforcement of sessions, uses of multiple media as booklet with colorful and laptop to increase clarification and understanding.

These findings were in the same line with **Unver et al., (2018)** emphasized that a strong positive correlation was found between receiving education and performing exercises and show that total practice was improved 7.96 times greater among patients who received information about exercises than among those who did not.

Concerning regression model of predictors for pain among the studied patients the present study revealed that pain intensity in the studied patients was best predicted by knowledge, practice and respiration rate, accounting about half of the variance of pain intensity. This finding may be attributed to diaphragmatic breathing technique is simple, easy to be learned by any person.

These results at the same line with **Sasongko et al., (2019)**. Emphasized that when people did the DBT correctly, it would reduce oxygen consumption, respiratory rate, heart rate and muscle tension. This would help the body to be at a high concentration so that it would activate alpha waves in the brain these alpha waves can stimulate the release of β -endorphins and serotonin which have a role in the analgesia.

Also, congruent with study done by **Joseph et al., (2022)** about "Effects of slow deep breathing on acute clinical pain in adults" showed that DB was significantly associated with lower pain scores compared to other non-pharmacological controls and presents that pain intensity in the studied patients was best predicted by knowledge and practice.

Furthermore, this finding was correspondent to **Vahedian et al., (2021)** in a study entitled "Effect of deep breathing exercise on oxygenation of patients under major abdominal surgery" who clarified that simple and short procedures, such as deep breathing exercises can be an effective nursing intervention for the reduction of pain in the surgery site and the improvement of respiratory parameters

Finally, the study results documented that, the studied patients showed significant improvement of the knowledge and practices resulting in improving their performance and patients' pain decreased after application of the diaphragmatic breathing technique post one month period and follow up as compared to pre implementation of technique, which supports the study hypotheses.

Conclusion

Applying of diaphragmatic breathing technique was very effective in reducing pain intensity for post orthopedic surgery patients, which was best predicted by knowledge and practice scores and respiration rate that can be recommended as a pain relief technique, which supports the study hypotheses.

Recommendations

1- Conducting in-service training programs periodically to all health care providers to teach patients about the effects of diaphragmatic breathing technique on decreasing pain intensity post orthopedic surgery.

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2- Posters should be found to remind patients about DBT and to improve patients' knowledge and practices.

3- Hospitals are recommended to use the DBT alongside other treatments to alleviate pain intensity for post orthopedic surgery patients.

4- Replication of the study on larger probability sample from different geographic distribution for generalization of the result for post orthopedic surgery patients.

Further researches:

1- The study can be repeated on a large random sample in different settings for generalization of the findings.

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