Effect of Lung Recruitment Maneuvers on Postoperative Respiratory Symptoms and Pain severity in Elderly Patients after Open Upper Abdominal Surgery

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Abstract

Background: Many factors influence the recovery of elderly patients who are undergoing abdominal surgery, such as, type of surgery, pulmonary function, and postoperative pain. **The aim** of the present study was to evaluate the effect of lung recruitment maneuvers on postoperative respiratory symptoms and pain severity in elderly patients after open upper abdominal surgery. **Subjects and methods:** A quasi-experimental design was used, where 80 elderly (40 cases & 40 controls) were enrolled using purposive sampling technique from Zagazig University Hospitals, Visual analogue pain scale, and Respiratory symptom assessment sheet were used at first, third, and fifth day after surgery. **Results:** the mean pain severity decreased gradually from severe to mild in the study group on the first, third, and fifth postoperative days (2.85±0.36, 2.33±0.53, 1.63±0.77 respectively) and in the control group (2.73±0.51, 2.25±0.71, 1.78±0.80 respectively), with a statistically significant difference between both groups (P<0.001). On the fifth postoperative day, a higher percentage of elderly in the study group had normal breathing pattern, no adventitious sounds, no dyspnea, and no sputum, with statistically significant differences between elderly patients in the study and control groups. **Conclusion:** Elderly patients who received pre-operative lung recruitment maneuvers training had adequate postoperative practice; decreased pain severity; fewer postoperative respiratory symptoms.

Key Words: Elderly, Lung Recruitment Maneuvers, Pain severity, Postoperative, Respiratory Symptoms, Upper Abdominal Surgery.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Introduction

Older adults aged 60 years and over are the fastest-growing segment of the population around the world **(Wolfe et al., 2020).** In addition, abdominal surgery has become an important part of global health care, which is estimated to have more than 320 million patients operated on yearly, and a growing proportion of these are elderly **(Staheli & Rondeau, 2021).** On the other hand, upper abdominal surgery was defined as a distinct scar above the umbilicus from which the operative procedure involves the upper portion of the peritoneal cavity, hilar area, and hepatoduodenal ligament **(Peng et al., 2019).**

In upper abdominal surgeries, the incidence of postoperative pain is higher, causing a voluntary reduction in movement of thoracic and abdominal wall muscles. It happens because of muscle splinting. There will also be restrictions on the movement of the diaphragm. Changes in amplitude and pattern of diaphragmatic activity due to noxious visceral stimuli are known as viscerosomatic reflexes and are seen in the postoperative period following abdominal surgeries. Because of these changes, the patient fails to take adequate and deep breaths. It results in decreased tidal volume, a decrease in functional residual capacity, vital capacity, and alveolar ventilation. It leads to atelectasis in the basal regions of the lungs associated with impaired gas exchange in the alveoli. Hence, it causes ventilation-perfusion mismatch, leading to hypoxemia **(Pradheepa, 2017).**

Pain in patients undergoing upper abdominal surgeries will limit the inspiratory movements and blow out air. General anesthesia will decrease the tone of respiratory muscles, lung volume, compliance, and increase resistance **(Hithesh, 2020).** Pain can also lead to postoperative pulmonary complications, such as weak abdominal and intercostal muscles, reduced respiratory rate, and inadequate lung expansion that led to decreased inspiratory capacity and volume due to ineffective coughing and immobility **(El–Naggar et al., 2020).**

Upper abdominal surgeries under general anesthesia will have postoperative effects on respiration. Surgery will limit the movements of the lungs because of the operative procedure and general anesthesia will reduce the tone of respiratory muscles and reduce the lung volume, which results in increased resistance, reducing compliance of the lung and pulmonary function **(Hithesh, 2020).** On the other hand, one of the primary responsibilities of the gerontological nurse is to educate the elderly patient about the lung expansion maneuvers before surgery, as well as, assess and monitor the patient's response to that education. The nurse should stand next to the elderly patient to guide them through the procedure **(DeLaune et al., 2019).**

Subjects & Methods

Design:

A quasi-experimental design was used to conduct the present study.

Settings:

The researchers collected the sample from inpatient surgical departments in Zagazig University Hospitals, Egypt.

Study Subjects:

The existing study enrolled 80 patients (40 cases & 40 controls) aged 60 years or above, undergoing laparotomy, have no cognitive impairment, and able to communicate.

Tools for data collection:

Three tools were used to fulfill the present study, they were:

Tool I: Observational checklist for patients' practice:

After extensive literature review, the second tool was designed by the researchers and guided by **Patman et al. (2017)** to assess the practice of the following lung recruitment maneuvers on the first, third, and fifth postoperative day (POD); (1) Breathing Retraining Exercises are included; Sustained Maximal inspiration with flow-oriented incentive spirometer, Pursed lip breathing, Diaphragmatic breathing, and Localized or Segmental breathing exercise. (2) Coughing or huffing with Splinting (3) Early Mobilization.

Tool II: Visual analogue pain scale (VAS) [Wewers & Lowe, 1990]

It is a self-reported scale consisting of a horizontal line used for subjective estimation of a patient's pain. It comprises a 10-point numerical scale, with "0" at one end representing no pain at all, and "10" at the other, representing the worst pain imaginable (ever experienced). The pain score consists of a measurement of the segment selected by the patient, with a higher score indicating more severe pain. The simplicity, reliability, and validity

of this instrument have made the VAS a good tool for describing pain severity or intensity **(Hawker et al., 2011).** Patients' pain intensity was recorded on the first, third, and fifth postoperative days.

Scoring system:

Pain scores were divided into three broad categories as follows:

Mild pain	Moderate pain	Severe pain
1 to 3 points.	4-6 points.	7-10 points.

Tool III: Respiratory symptom assessment sheet:

After extensive literature review, the third tool was designed by the researchers to document the patient's observed symptoms regarding the respiratory system on the first, third, and fifth postoperative day (POD); such as breathing frequency (breath/min), breathing pattern, presence of dyspnea, sputum, and adventitious breath sounds.

Field work:

The fieldwork was carried out within the period of nine months, starting from the mid of April 2021 to the mid of December 2021. The researchers randomly assigned the enrolled patients to either the intervention or control groups. Patients in the intervention group received preoperative lung recruitment maneuvers training, including sustained maximal inspiration, pursed-lip breathing exercise, diaphragmatic breathing, costal expansion exercise, coughing or huffing with splinting, and early mobilization. The control group received standard routine perioperative care without lung recruitment maneuvers. The researchers evaluated the effectiveness of the lung recruitment maneuvers training program following the study tool for all patients in the study and control group.

Validity:

It was ascertained by a panel of five experts in the field of community health nursing, medical and surgical nursing, community medicine, and physiotherapy who reviewed the content of the tools for clarity, relevance, comprehensiveness and understandability

Ethical consideration:

Firstly, the research protocol was approved by the Research Ethics Committee (REC) in nursing faculty, Zagazig University. Informed consent for participation was taken verbally from each of the patients after a full explanation of the aim of the study. Patients were given the opportunity to refuse participation and they were notified that they could withdraw at any time of the data collection interviews; also they were assured that the information would be confidential and used for the research purpose only. The researchers assured maintaining anonymity and confidentiality of the patients' data.

Statistical design

Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables and means and standard deviations for quantitative variables. Statistical significance was considered at p-value <0.05.

Results

The result in **Table 1** stratifies the severity of postoperative pain among elderly patients in the study and control groups throughout the first five postoperative days. As shown in the table, 85% and 75% of the elderly in the study and control groups experienced severe pain on the first postoperative day, respectively. On the fifth postoperative day, 55% and 45% of the elderly in the study and control groups experienced mild pain, respectively.

Figure 1 depicts that the mean pain severity decreased gradually from severe to mild in the study group on the first, third, and fifth postoperative days (2.85±0.36, 2.33±0.53, 1.63±0.77 respectively) and in the control group (2.73±0.51, 2.25±0.71, 1.78±0.80 respectively), with a statistically significant difference between both groups (P<0.001).

Referring to the distribution of the study and control groups according to the respiratory symptoms on the first postoperative day, **Table 2** demonstrates minimal differences with no statistically significant differences between elderly patients in the study and control groups regarding their respiratory symptoms as adventitious sounds, dyspnea, presence of sputum, breathing pattern, and frequency on the first post-operative day.

Pertaining to the distribution of the study and control groups according to the respiratory symptoms on the third postoperative day, **Table 3** reveals that 80% of the study group had a normal

breathing pattern compared to 60% of the control group. As regards adventitious sounds, 82% of the study group compared to 62.5% of the control group had no abnormal lung sounds. The same table also clarifies that 85% and 62.5% of the elderly patients in the study and control groups experienced dyspnea, respectively. As well, 50% of the study group and 32.5% of the control group had sputum. Differences observed between both groups aren't statistically significant.

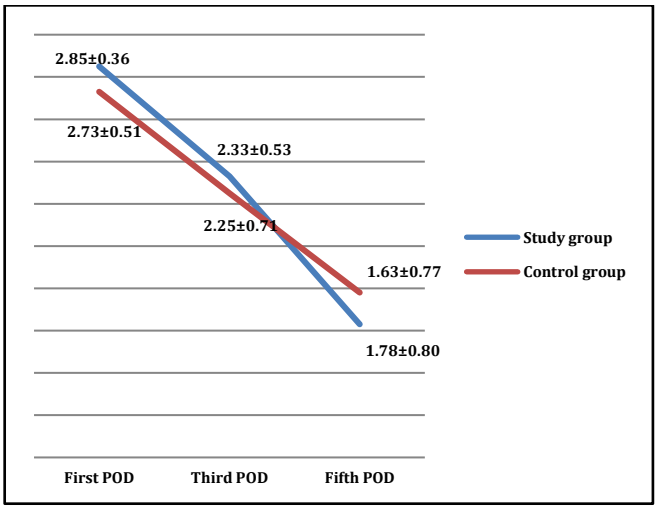
Table 4 demonstrates that on the fifth postoperative day, a higher percentage of elderly in the study group had normal breathing pattern, no adventitious sounds, no dyspnea, and no sputum, with statistically significant differences between elderly patients in the study and control groups regarding respiratory symptoms such as breathing frequency, pattern, adventitious sounds, dyspnea, and presence of sputum (P=0.009, P=0.015, P=0.019, P=0.00, P=0.014) respectively. According to **Table 5**, the results show statistically significant negative correlation was also found between elderly patients' practice and their breathing rate.

Considering multiple linear regression analysis for pain score, **Table 6** expounds that the intervention, LOS, and ambulation days were statistically significant independent positive predictors of elderly pain score. The time (postoperative days) was a statistically significant independent negative predictor of elderly pain scores (P<0.001). As time goes, the severity of the pain also declines. Precisely, the intervention of lung recruitment maneuvers, longer hospitalization, and postoperative late mobilization predict higher pain scores. The model explains 46% of the variation in this score, as the value of r-square indicates.

Table 1. Severity of postoperative pain among elderly patients in the study and control groups throughout the first five postoperative days (N=80)

Pain severity	Study group (n=40)						Control group (n=40)					
	1st POD		3rd POD		5th POD		1st POD		3rd POD		5th POD	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Mild	0	0.0	1	2.5	22	55	1	2.5	6	15.0	18	45.0
Moderate	6	15.0	25	62.5	11	27.5	9	22.5	18	45.0	13	32.5
Severe	34	85.0	14	35	7	17.5	30	75.0	16	40.0	9	22.5

POD; postoperative day; (*) Statistically significant at p<0.05



Chi square test;75.536 for study group & 33.843 for control group, P-value <0.001 for both groups, statistically significant at p<0.05

Figure 1: Postoperative pain severity among elderly patients in the study and control groups throughout the first five postoperative days (N=80)

Table 2. Table 2: Respiratory symptoms on the first postoperative day among elderly patients in the study and control (N = 80)

Respiratory symptoms	Study group (n=40)		Control group (n=40)		X² test	p-value
	No.	%	No.	%		
Breathing frequency: Mean±SD	22.2±4.0		21.9±2.9		t=0.383	0.703
Breathing pattern:						
Normal	27	67.5	31	77.5	1.704	0.426
Bradypnea	1	2.5	0	0.0		
Tachypnea	12	30.0	9	22.5		
Adventitious sounds:						
None	36	90.0	33	82.5	5.797	0.055
Crackles	4	10.0	2	5.0		
Wheezes	0	0.0	5	12.5		
Dyspnea:						
Absent	35	87.5	32	80.0	0.827	0.363
Present	5	12.5	8	20.0		
Sputum:						
Absent	20	50.0	17	42.5	0.453	0.501
Present	20	50.0	23	57.5		
Color:						
Purulent	17	85.0	20	87.0	1.374	0.712
Yellowish	1	5.0	1	4.3		
Greenish	0	0.0	1	4.3		
With blood	2	10.0	1	4.3		
Consistency:						
Thick	14	70.0	9	39.1	4.098	0.043*
Watery	6	30.0	14	60.9		

Table 3. Respiratory symptoms on the third postoperative day among elderly patients in the study and control groups (N=80).

Respiratory symptoms	Study group (n=40)		Control group (n=40)		X^2 test	p- value
	No.	%	No.	%		
Breathing frequency:						
Mean±SD	21.0±3.6		22.6±4.2		t=1.818	0.073
Breathing pattern:						
Normal	32	80	24	60.0	3.810	0.051
Tachypnea	8	20	16	40.0		
Adventitious sounds:						
None	33	82.5	25	62.5	5.037	0.081
Crackles	5	12.5	7	17.5		
Wheezes	2	5	8	20.0		
Dyspnea:						
Absent	34	85	25	62.5	5.230	0.022
Present	6	15	15	37.5		
Sputum:						
Absent	20	50	13	32.5	2.527	0.112
Present	20	50	27	67.5		
Color:						
Purulent	13	65.0	11	40.7	3.116	0.374
Yellowish	2	10.0	6	22.2		
Greenish	4	20.0	9	33.3		
With blood	1	5.0	1	3.7		
Consistency:						
Thick	8	40.0	20	74.1	5.539	0.019*
Watery	12	60.0	7	25.9		

Table 4. Respiratory symptoms on the fifth postoperative day among elderly patients in the study and control groups (N=80)

Respiratory symptoms	Study group (n=40)		Control group (n=40)		X^2 test	p-value
	No.	%	No.	%		
Breathing frequency:						
Mean±SD	19.9±3.8		22.4±4.6		2.689	**0.009***
Breathing pattern:						
Normal	33	82.5	23	57.5		
Tachypnea	7	17.5	17	42.5	5.952	**0.015***
Adventitious sounds:						
None	34	85	23	57.5		
Crackles	4	10	8	20		
Wheezes	2	5	9	22.5	7.911	**0.019***
Dyspnea:						
Absent	34	85	22	55		
Present	6	15	18	45	8.571	**0.003***
Sputum:						
Absent	24	60	13	32.5		
Present	16	40	27	67.5	6.084	**0.014***
Color:						
Purulent	9	56.2	10	37.0		
Yellowish	2	12.5	7	25.9		
Greenish	4	25.0	9	33.3	2.075	0.557
With blood	1	6.2	1	3.7		
Consistency:						
Thick	8	50.0	18	66.7		
Watery	8	50.0	9	33.3	1.167	0.280

(*) Statistically significant at p<0.05

Table 5. Correlations between the scores of practice among elderly patients in the study group and their pain and breathing rate scores.

Items	Practice score	
	r	p-value
Pain (VAS)	0.253	0.006
Breathing rate	-0.213	0.020*

(*) Statistically significant at p<0.05

Table 6: Best fitting multiple linear regression model for the pain score among elderly patients in the study group.

Items	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Constant	2.87	0.20		14.342	<0.001	2.48	3.27
Time (postoperative days)	-0.79	0.08	-0.49	-10.204	<0.001	-0.95	-0.64
Intervention	0.30	0.08	0.20	3.795	<0.001	0.14	0.46
University education	-0.17	0.07	-0.11	-2.296	0.023	-0.31	-0.02
LOS	0.08	0.01	0.34	5.955	<0.001	0.05	0.10
Ambulation days	0.27	0.06	0.23	4.196	<0.001	0.14	0.40

R-square=0.46; Model ANOVA: F=41.19, p<0.001; Variables entered and excluded: age, gender, chronic diseases, ICU admission

Discussion

Owing to the population aging rapidly, the proportion of surgeries involving elderly patients has shown an increasing trend worldwide **(Han et al., 2019).** In terms of demographic characteristics of the elderly in the study and control group, similar to a previous study in Jordan carried out by **Jalil et al. (2021),** the results of the present study revealed that there were no significant differences regarding gender, mean age, residence, educational level, income, and marital status. These results might be due to the fact that random allocation leads to the absence of selection bias between study and control groups.

Regarding the practice of the studied elderly after surgery, the current study revealed a high practice level among elderly patients with statistically significant improvement in the practice scores throughout the first five postoperative days. Specifically, most of the studied elderly had an adequate practice level on the fifth POD. Possible reasons for such results are: firstly, being educated improves awareness regarding the benefits of these exercises and their sense of empowerment if the training is given preoperatively. Secondly, offering elderly patients with visual feedback about the inspired air-flow through the use of an incentive spirometer device is thought to increase their motivation to be compliant with modalities.

Additionally, the severity of pain decreased gradually to become mild on the fifth post-operative day, enabling patients to be compliant with the exercises.

These findings are in accordance with a Turkish study, carried out by **Ünver et al. (2018),** who reported that receiving preoperative education about breathing exercises affected patients' exercise performance status positively (the exercise application rate among surgical patients). Likewise, **Kaur et al. (2020)** conducted a study in India and stated that the studied patients showed an adequate performance level after surgery.

As regards the severity of postoperative pain, the current study revealed that the mean of pain severity was significantly decreased gradually from severe to mild on the first, third, and fifth postoperative days in both study and control groups. This finding might be attributed to medical postoperative pain management, as all of the patients in the study received analgesics after surgery.

In the same context, previous studies carried out by **Sudhakara & Hamsalekha (2018)** in India, **Wikström et al. (2020)** in Sweden, Matthieu **Cachemaille et al. (2020)** in Switzerland, and **Svensson-Raskh et al. (2021)** in Sweden demonstrated that post-surgical pain severity score showed a statistically significant decrease in pain over time throughout the postoperative days. Furthermore, **Bartels et al. (2022)** in Brazil found a significant decrease in pain perception using the visual analogue scale in both study and control groups.

As regards the respiratory rate, the present study highlighted that the mean scores of breathing frequency were significantly lower in the study group than in the control group throughout postoperative days. This result might be due to the effect of breathing and coughing exercises. These findings are supported by **Tripathi et al. (2017)** in India and **Bartels et al. (2022)** in Santa Maria, Brazil, who found that practicing breathing exercises improved lung capacity and reduced respiratory rate.

Concerning the adventitious breath sounds, crackles and wheezes were the most common abnormal sounds in the study and control groups. This might be due to ciliary dysfunction, incisional pain that reduces the patient's ability to eliminate secretions, and prolonged hours that the patient spends in the operative room without lung inflation **(Badenes et al., 2015).**

Furthermore, the results of the current study revealed that crackles and wheezes on chest auscultation were lower in the study group than in the control group on the third and fifth postoperative days. This finding might be due to the significant role of these breathing and coughing exercises, besides the patient mobilization in enhancing chest clearance from sputum. These findings are emphasized by **Tripathi et al. (2017),** who conducted a study in India and found that breathing exercises are successful in reducing postoperative abnormal breathing sounds for patients undergoing UAS on the third or fifth POD.

Limitation of the Study

Purposive sampling technique could be considered as a limitation.

Conclusion

The current study results bring about the conclusion that: Hepatobiliary surgeries accounts for a large proportion of patients. There is evidence that elderly patients who received pre-operative lung expansion training had adequate postoperative practice and fewer respiratory symptoms. Furthermore, severe pain was most commonly reported on the first day following UAS, and after that, the severity decreased gradually throughout the first five postoperative days.

Conflict of interest

The author(s) declare(s) that there is no conflict of interest.

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