Journal Healthcare Treatment Development
Vol: 03, No. 01, Jan-June 2023
ISSN: 2799-1148, DOI: 10.55529/jhtd.31.21.28

Research Paper

A study to assess the effectiveness of thoracic expansion exercise and diaphragmatic breathing exercise in post-operative hernia patients to improve pulmonary functions with and without incentive spirometry — a comparative study

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Article Info

Article History:
Received: 26 September 2022
Revised: 02 December 2022
Accepted: 10 December 2022
Published: 24 January 2023

Keywords:
Hernia
Incentive Spirometry
Thoracic Expansion Exercise
Diaphragmatic Breathing Exercise
Obesity

ABSTRACT

Background: Hernia is the protrusion of abdominal content through the abdominal wall. The causes of the hernia are overstraining, lifting of overweight, chronic cough, chronic constipation, obesity, urinary causes or old age people with benign prostrate hypertrophy and carcinoma prostate, young age with stricture urethra and also pregnancy. Atelectasis is one of the common pulmonary complications in any abdominal surgery. Incentive spirometry is an adjunct to chest physiotherapy as a portable & hand-held device prescribed after postoperative lung complications. Either flow-oriented or volume-oriented IS devices are available. The chamber of a flow-oriented IS device has three connected columns, and inside are floats made of lightweight plastic. A flexible tube is joined to the chamber. IS seems to be an effective tool to improve lung function.
Objective: To compare the effects of thoracic expansion exercise and diaphragmatic breathing exercise with and without incentive spirometry on pulmonary function and thoracic expansion in post-operative hernia patients over a 10-day intervention period.
Methodology: 46 samples were divided into 2 groups. Group A & Group B each group has 23 subjects. Group A received thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry and Group B received thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry for a period of 10 days. The pre and post-test - pulmonary function and thoracic expansion measurements were recorded both before and after the intervention of 10 days.
Results: The results suggest that there is a significant improvement in pulmonary function and an increase in thoracic expansion in both groups (Group A and B). But it is improved significantly in those who underwent thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry

(Group A) than in those who underwent thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry (Group B).

Conclusion: The conclusion of this study is that the effects of thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry show significant improvement among post-operative hernia patients, increase the pulmonary function and thoracic expansion when compared to those who underwent thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry.

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1. INTRODUCTION

The protrusion of abdominal contents via an opening in the abdominal wall is known as a hernia. As a result of obesity, muscle atrophy, surgery, illness, or the failure of some structures to close after birth, it may manifest later in life. Another possibility is congenital. The groin, umbilicus, diaphragm, and surgical incisions are the most typical herniation sites [1].

Hernias are more likely to occur in children who have one or more of the risk factors listed below: a newborn hernia in a parent or sibling, cystic fibrosis, developmental dysplasia of the hip, undescended testes, abnormalities of the urethra, marked obesity, heavy lifting, coughing, straining during defecation or urination, peritoneal dialysis, ventricular peritoneal shunt, chronic obstructive pulmonary disease and family history of hernias [1].

The word "hernia" comes from a Latin word that means "rupture". Abdominal hernias are frequently encountered in surgical practice accounting for 15% - 18% of all surgical procedures. [2], [3] Inguinal hernias are more common on the right side. In a recurrent inguinal hernia, direct type is twice as common as indirect [2] Worldwide, more than 20 million hernias are operated on per year [4].

Incidence rates of abdominal wall hernia range from 100 to 300/100000 per year depending on the country. [4] Approximately 75% of cases of all abdominal wall hernias belong to the groin. [5] Men have a 15-27% lifetime risk of getting an inguinal hernia, whereas women have a 3% lifetime risk. [6] Although males are affected more commonly (7:1), the incidence of femoral hernia is four times higher in females and rare [7] indirect hernia is twice as common as a direct hernia. Inguinal hernias are more common among all hernias. Incisional hernias are more common in males. [8] the most frequent type of abdominal wall hernia after inguinal hernias are midline ventral hernias. These are further divided into umbilical, para-umblical, and epigastric hernia depending on where they occur. Traumatic and obturator hernias are rare [9].

Abdominal wall hernias are common, with a prevalence of 1.7% for all ages and 4% for those aged over 45 years. inguinal hernia count for 75% of abdominal wall hernias, with all lifetime risk of 27%in man and 3% in women [10].

Inguinal hernia is a groin condition (the area between the abdomen and thigh) [11], [12]. The umbilical fibro muscular ring is where the umbilical hernia occurs. [13], [14] In 2-10% of all abdominal

procedures, an incisional hernia develops. Reducible hernias allow the hernia's contents to pass back through into the abdominal cavity; irreducible hernias prevent this from happening. The most significant and potentially dangerous hernia consequence is strangulation. Laparoscopic surgery, transabdominal peritoneal hernia surgery, and completely extraperitoneal surgery are only a few of the different methods of surgery. The most common incisions for transabdominal surgery are upper midline, subcostal, or paramedian. The medical term for the procedure to treat a hernia is herniorrhaphy. Steel mesh or wire may be used to reinforce weak areas. Hernioplasty is the name of the procedure. Hernias do not go away on their own over time and frequently worsen, growing larger and causing more agony [15], [16].

Widespread incentive spirometry (IS) prescriptions are given to stop respiratory problems following surgery. The Bartlett-Edwards IS device was developed in 1973 to encourage deep breathing by giving patients visual light feedback when they reach their target inspiratory volume. In 1975, the Spiro care device further enhanced the electronic IS visual feedback by putting the display lights on a scale indicating increasingly larger inspiratory volumes, attempting to gamify patient engagement and adherence.5 These electronic IS devices were in use for many years but have been replaced by less expensive, disposable units [17].

The three chambers in a sequence that make up the flow-oriented incentive spirometer (also known as the Tri-flow device) each contain a ball. The ball rises in the chamber when the patient's effort creates a sub-atmospheric pressure above it. The first ball must be raised with an inspiratory flow of 600 mL/s, the first and second balls must be raised with an inspiratory flow of 900 mL/s, and all three balls must be raised with an inspiratory flow of 1200 mL/s. The small, 4000 mL volume-oriented incentive spirometer incorporates a one-way valve to stop exhalation from entering the device. An inspiratory flow guide instructs the subject to breathe slowly, and a sliding pointer displays the recommended inspiratory volume [18], [19].

Either flow-oriented or volume-oriented IS devices are available. The chamber of a flow-oriented IS device has three connected columns, and inside are floats made of lightweight plastic. A flexible tube is joined to the chamber that the patient inhales, attempting to raise the floats through inspiratory flow created by negative intra-thoracic pressure. It is also known as sustained maximal inspiration [20], [21].
Diaphragmatic breathing exercises are used to improve the descent of the diaphragm during inhalation and the ascent of the diaphragm during expiration. As a result of diaphragmatic breathing, the alveoli expand, postoperative hypoxemia is reversed, ventilation and oxygenation are improved, the work of breathing is reduced, and the diaphragm's excursion is increased [22], [23].

Thoracic expansion exercise is also known as the deep breathing exercise. they help the lung to expand more effectively and allow air to get behind any secretions so that they be pushed the airway towards the mouth. The breath should be slow and deeper. At the end of the breath is held for a few seconds and breathe out [24].

The most common postoperative pulmonary complications include atelectasis, hypoxemia, pneumonia, respiratory dysfunction and pleural effusion. The factors that are directly related to physiological changes include anaesthesia (general or regional), the type of incision, and the surgical technique employed. Reduced total pulmonary capacities and volumes, such as a decline in the Forced Vital Capacity (FVC) and Forced Expiratory Volume in First Second, are indicative of the changes (FEV1).
Pulmonary dysfunction leads to pulmonary complications which include atelectasis, pneumonia, tracheobronchial infection, and respiratory failure. These might negatively affect how long a patient stays in the hospital. On the basis of functional changes, reports of decreased pulmonary function forced vital capacity (FVC) and forced expiratory vital capacity have been made. Impairment of diaphragmatic function has been identified as the pathogenesis of postoperative pulmonary dysfunction.

1.1. Study Settings

The study was conducted in Government Headquarters Hospital Cuddalore.

1.2. Selection of Subjects

46 post-operative hernia patients were selected through a convenient sampling method who fulfilled the inclusion and exclusion criteria were divided into.

Table 1. Comparison of Exercise Protocols Between Experimental and Control Groups

Experimental Group (Group A- 23 Subjects)	Control Group (Group B- 23 Subjects)
Incentive spirometry exercise. Thoracic expansion exercise. Diaphragmatic breathing exercise	Thoracic expansion exercise. Diaphragmatic breathing exercise

1.3. Variables

Independent Variables:

- Incentive spirometry exercise.
- Thoracic expansion exercise.
- Diaphragmatic breathing exercise.

Dependent Variables:

- Forced vital capacity (pulmonary function test).
- Thoracic expansion measurement.

Table 2. Variables and Their Corresponding Measuring Tools

Variables	Measuring Tools
Forced Vital Capacity (FVC)	Spirometer
Thoracic Expansion Measure (Tem)	Inch Tape

- **Study Design:** The study design was a comparative study.
- **Sampling:** The sampling of the study is Convenient sampling.

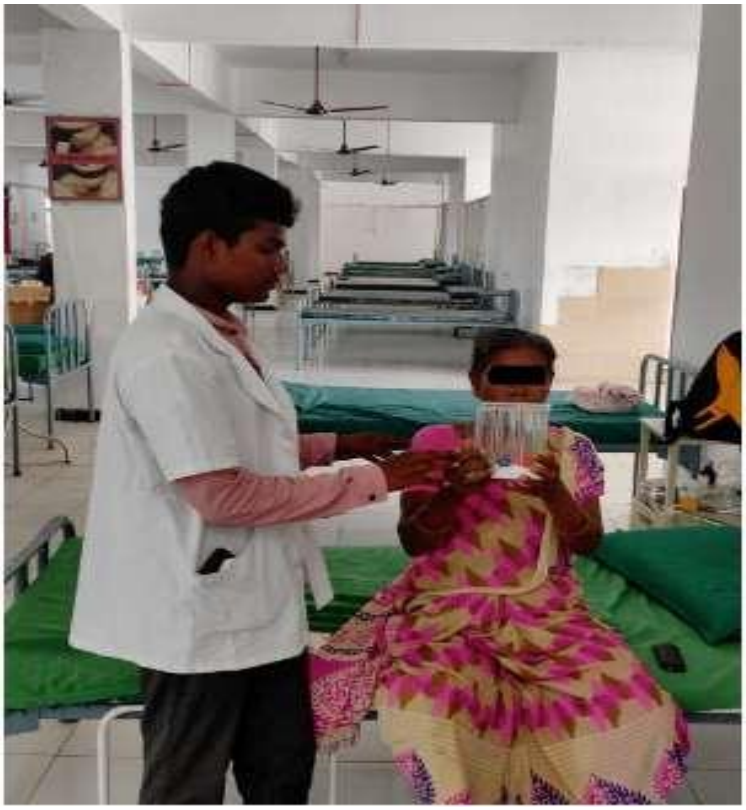

Figure 1. Incentive Spirometer Demonstration

2. RESULTS AND DISCUSSION

This study compared the effectiveness of the integration of thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry versus thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry among post-operative hernia patients. 46

patients with hernia were selected for the study. The subjects were randomly divided into two groups. Group A (n = 23) subjects were treated with thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry. Group B (n = 23) subjects were treated with thoracic expansion exercise and diaphragmatic breathing exercise. There was a significant improvement in pulmonary function (forced vital capacity) and an increase in thoracic expansion in both groups. But the improvement was significant in group A, who received thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry than that of thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry. Hence, the study was statistically significant at a 5 % level of significance. The statistical interpretation of mean and standard deviation shows the improvement in pulmonary function and increase in thoracic expansion among patients with post-operative hernia.

2.1. Discussion

The findings of this study indicate that there is a significant improvement in pulmonary function in both groups (Group A and Group B). There is also a marked increase in thoracic expansion in group A than in group B. But it is more effective in those who underwent thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry (Group A) than those who underwent thoracic expansion exercise and diaphragmatic breathing exercise without incentive spirometry (Group B). Among pulmonary function, forced vital capacity is improved in Group A (thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry), and the pulmonary function was assessed by RMS Helios 401 spirometer. also showed that there was a significant improvement in patient's pulmonary functions (forced vital capacity) who had undergone abdominal surgery.

3. CONCLUSION

The findings of this study showed that, 10 days of intervention with thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry to group A and thoracic expansion exercise and diaphragmatic breathing exercise to group B among post-operative hernia patients. Group A showed marked improvement in pulmonary function and thoracic expansion. There was a remarkable difference in the improvement of pulmonary function among both groups. Therefore, it is concluded that thoracic expansion exercise and diaphragmatic breathing exercise with incentive spirometry were very much useful in improving pulmonary function as well as thoracic expansion among post-operative hernia patients. Hence, the result of this study proves the hypothesis.

Acknowledgments

The authors have no specific acknowledgments to make for this research.

Funding Information

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Kadiervel K	✓	✓	✓	✓		✓		✓	✓	✓	✓			
Dr. K. S. I. Muralisankar		✓	✓	✓	✓			✓	✓	✓	✓		✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

Not Applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to Cite: Kadiervel K, Dr. K. S. I. Muralisankar. (2023). A study to assess the effectiveness of thoracic expansion exercise and diaphragmatic breathing exercise in post-operative hernia patients to improve pulmonary functions with and without incentive spirometry — a comparative study. Journal Healthcare Treatment Development (JHTD), 3(1), 19–26. https://doi.org/10.55529/jhtd.31.21.28

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