Efficacy of Post Operative Intermittent Positive Pressure Breathing on Lung Capacity after Cholecystectomy

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ABSTRACT

This study is designed to investigate the additional effect of intermittent positive pressure to chest physical therapy to improve lung functions and prevent pulmonary complications after cholecystectomy. Thirty patients schedualed for cholecystectomy were included in the present study. They were randomly assigned into two groups:
Group (A), fifteen patients who received routine postoperative physical therapy program only, and Group (B), included 15 patients who received routine postoperative physical therapy program in addition to non-invasive intermittent positive pressure breathing. Evaluation of post operative pulmonary complications included pulmonary function test to measure vital capacity value which recorded 48 hours preoperatively, 24 hours post operative, 5th day post operative and day before discharge.
The results of this study revealed a significant reduction in the vital capacity 24 hours post operative and gradual improvement at the end of fifth day post operative and day before discharge in the control group, but it was still below the pre operative values. Conversely there was a significant increase in the vital capacity at the day before discharge compared with pre operative value in the IPPB group, suggesting that intermittent positive pressure breathing plays an important role in improving chest expansion and mobility in forms of alternating lung capacity for patients who have had cholecyctectomy.

Key Words: Breathing exercises, cholecystectomy; intermittent positive pressure breathing; chest physical therapy.

INTRODUCTION

Cholecystectomy is defined as removal of the gall bladder. Most of these surgeries are due to cholecystitis (inflammation of the gall bladder). This inflammation is result of stones concentrated bile and secondary infection[8, 12].

Because of the proximity of the gall bladder to diaphragm and incisional placement, these patients are at particulary high risk for pulmonary dysfunctions[5].

The pulmonary function is commonly altered after surgery[27], Particulary in patients who have had chest or upper abdominal surgery. The physiological changes observed are directly related to anesthesia (general or regional) and to the type of incision and surgical technique employed and are reflected by decreases in total pulmonary capacity and pulmonary volumes[4].

The most common problem after upper abdominal surgery is respiratory dysfunction. The main cause of these complications may be due to diaphragmatic dysfunction and vital capacity impairments.

The diaphragm provides the major inspiratory pumping action and is well equipped for repetitive contraction during respiratory training[14].

Chest physiotherapy is routinely used after major abdominal and cardiothoracic surgery with the main aim of preventing postoperative pulmonary complications.

Regular chest physiotherapy significantly decreased the incidence of pulmonary complications after upper abdominal surgery (UAS)[25].

Non-invasive patient-triggered ventilation in the form of intermittent positive pressure breathing (IPPB) has been used as an adjunct to chest physiotherapy modalities are highly recommended for many years in patients who are not self-ventilating adequately, or are too confused weak or exhausted to cough effectively, or both[6].

To date, no known Egyptian studies investigating the efficacy of IPPB as a method of chest physical therapy following upper abdominal surgeries was reported.

The present study was undertaken to investigate whether the chest physiotherapy or IPPB significantly improved pulmonary capacity and volumes and decreased the incidence of pulmonary complications after cholecystectomy.

SUBJECTS, MATERIAL & METHODS

Subjects

This study was conducted on thirty male patients undergo cholecystectomy at Department of Surgery, Faculty of Medicine, their ages ranged from 30 to 50 years. A brief medical history of each patient was obtained to ensure that non had previous cardiopulmonary complications that might restrict their activity and influence the results of the study. The patients were assigned into two groups: Group (A) included 15 patients as control group who had cholecystectomy and received routine postoperative physical therapy program only and Group (B), included 15 patients as IPPB group who had cholecystomy and received routine traditional chest physical therapy in addition to non-invasive intermittent positive pressure breathing postoperatively. All patients in both groups, received the same kind of medications and physiotherapy program regularly and received one session daily started in intensive care unit and continue in physical therapy unit under supervision of the researchers. To be included in this study, the patients had to be (1) operated through open technique and not to be laproscopic technique (2) have no history of any abdominal surgery (3) have no history of cardiopulmonary or musculoskeletal problems.

Instrumentations

1- Non-invasive intermittent positive pressure (RTX modes)

(10 Downage, Respire Care Dragger, London)

It is a pressure cycle ventilator that triggered by a patient's inhalation to deliver ambient air or oxygen to the patient until a pre set pressure (15-20 cmH_2O) is reached through face make.

2- Morgan Transflow Test

(Kent, ME 87 ED, England)

It is a device that helps to evaluate the mechanical functions of the lungs. It is a computerized apparatus to measure pulmonary function test. The results of this test were printed out and save automatically on hard component.

Procedures of the Study

1- Measurement Phase

Patient's data including (name, age, height, weight, and date of birth) were recorded to obtain reference values from the software programs. Patient was placed in correct sitting position and therapist made sure that nose clip was in good place. Spirometer operation was done by using key board, mouse and special function key. Patient was instructed to place mouth piece and close lips around it. Patient was instructed take tidal breathing and when become regular, then the patient was ordered to inhale completely to total lung capacity. The patient was directed to exhale maximally without holding breath and was encouraged to force the air out as rapidly as possible and to continue exhaling until a plateau in the volume time of spirograme was achieved. The breath last at least 6 sec. or until there was no volume change for at least 1 sec.

This maneuver was terminated by using of key board, mouse and special function key.

At least three acceptable trials were recorded and saved for interpretive purposes.

All patients (in both groups) were reevaluated at different times. The vital capacity was measured 48 hours preoperatively, 24 hours post-operative, at the fifth day postoperative and day before discharge.

2- Treatment Phase

Preoperative Meeting

Two days preoperatively, patients were educated the postoperative program (breathing exercises, cough, bed mobility and ambulation) in addition to IPPB.

Postoperative Care

Postoperative physical therapy program started when the patient is extubated from mechanical pulmonary ventilator in the first day and continues every day, after that patients were placed in half lying position (Semi-flower) during practiced the breathing exercises, while non-invasive IPPB in half-lying position.

Post Operative Treatment Procedure for Group A

This group of patients were received deep breathing exercises which consisted of apical, costal (upper and lower patterns) and diaphragmatic breathing. During treatment session, the patient performed three to five deep breaths interspersed with periods of quiet breathing followed by three coughs with wound supported. Proprioceptive stimulation from the therapist's hand placement was given to stimulate breathing emphasis in the appropriate area. This maneuver was carried out at least 10 times over a 15 minutes period. Additional techniques such as positioning, bed mobility, chest wall percussion were used if breathing and coughing exercises were not effective to clear excessive pulmonary secretions. Patients were instructed to perform breathing and coughing exercises independently waking hour.

Postoperative Treatment Procedure for Group B

In this group, patients received routine postoperative physical therapy similar to group (A), in addition to non-invasive intermittent positive pressure breathing (IPPB) that started in the intensive care unit when the patient is extubated from mechanical ventilator nearly about 12 p.m. and was connected to oxygen adapter that provide oxygen supply. The intermittent positive pressure breathing administrated every day after that this technique was performed with the patients in the physical therapy unit without oxygen supply. To operate the IPPB, the unit was switch on, and the unit started self test for about one second to test the internal program memories, then IPPB parameters were selected from control panel as follow:

Peak inspiratory airway pressure equal 15 cm H2O to provide a sufficient widening of thoracic cage time. The intermittent IPPB was administrated through face mask. The time for application of this modality is equal 15 minutes.

RESULTS

The results of this study are presented under the following headings:

1- Results of the control Group (traditional P.T. group)

As shown in table (1) the mean value of vital capacity in this group (preoperative) was 3.49±0.38 L, while the mean values of vital capacity 24 hours post operative, at the end of the 5th day post operative and day before discharge were 2.25±0.22, 2.98±0.33, and 3.32±0.35 L respectively which represent 64.29%, 85.20%, and 95.05% of the preoperative value at the same sequence respectively.

As observed from table (3) in the traditional P.T. group, there were significant decrease in the vital capacity 24 hours, at the end of the fifth day post operative and day before discharge compared to those 48 hours preoperative ($P<0.05$). Fig. (1) shows the mean values of vital capacity of control group (pre and post operative values).

Table (1): Mean, S.D., and percentage of changes from pre operative for the vital capacity values in 3 times of evaluation post operatively (Control group).

Statistics	Vital capacity of control group			
	48 hours (pre operative)	24 hours post-operative (post 1)	5th day post-operative (post 2)	Day before discharge (post 3)
$\bar{X}$	3.49	2.25	2.98	3.32
S.D. ±	0.38	0.22	0.33	0.35
% of pre	-	64.29%	85.20%	95.05%
% of change from pre	-	35.71%	14.80%	4.95%

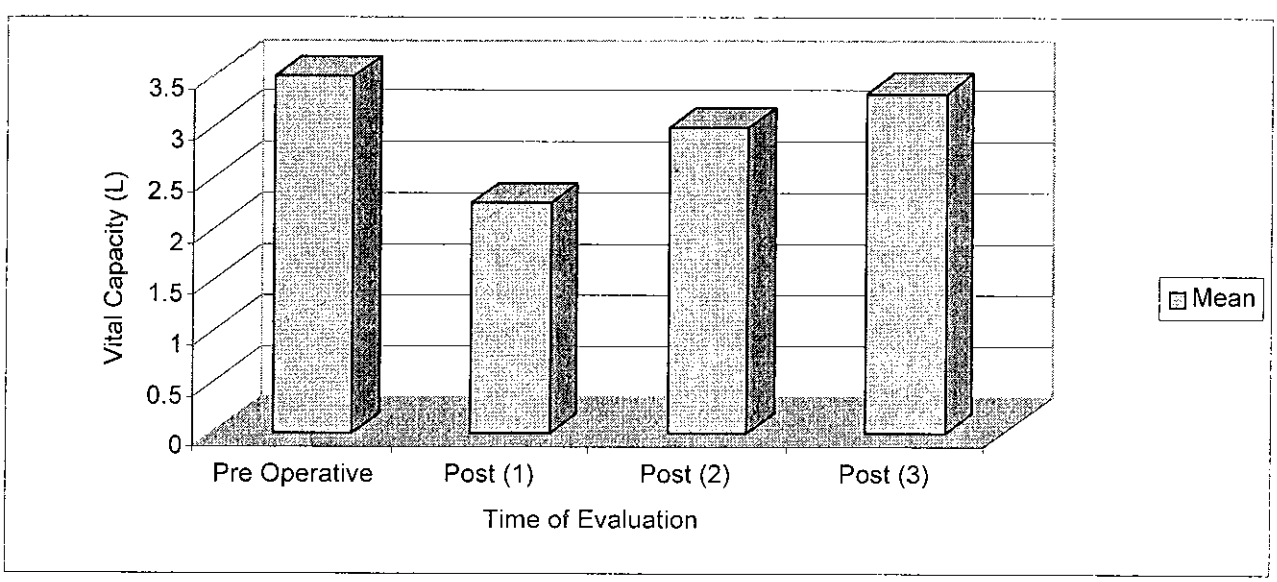

Fig. (1): The mean values of vital capacity of control group (pre and post- operative values).

2- Results of IPPB group

As observed from table (2), the mean value of vital capacity in this group (pre operative) was 3.55±0.56 L, while the mean values of vital capacity 24 hours post operative, at the end of the fifth day post operative and day before discharge in the IPPB group were 2.34±0.39, 3.27±0.58, and 3.74 ± 0.58L respectively which represent 66.04%, 92.10%, and 105.31% of the pre operative value at the same sequence respectively. As illustrated from table (3), there were significant reduction in the vital capacity 24 hours post operative, and at the end of the 5th day post operative when compared with those 48 hours pre operative ($P<0.05$). Conversely there was a significant increase in the vital capacity at the day before discharge compared to those 48 hours pre operative ($P<0.05$). Fig. (2) shows the mean values of vital capacity of IPPB group (pre and post operative values).

Table (2): Mean, S.D., and percentage of changes from pre operative for the vital capacity values in 3 time of evaluation post operatively (IPPB group).

Statistics	Vital capacity of IPPB group			
	48 hours (pre operative)	24 hours post operative (post 1)	5th day post-operative (post 2)	Day before discharge (post 3)
$\bar{X}$	3.55	2.34	3.27	3.74
S.D. ±	0.56	0.39	0.58	0.58
% of pre	-	66.04%	92.10%	105.31%
% of change from pre	-	33.96%	7.90%	5.31%

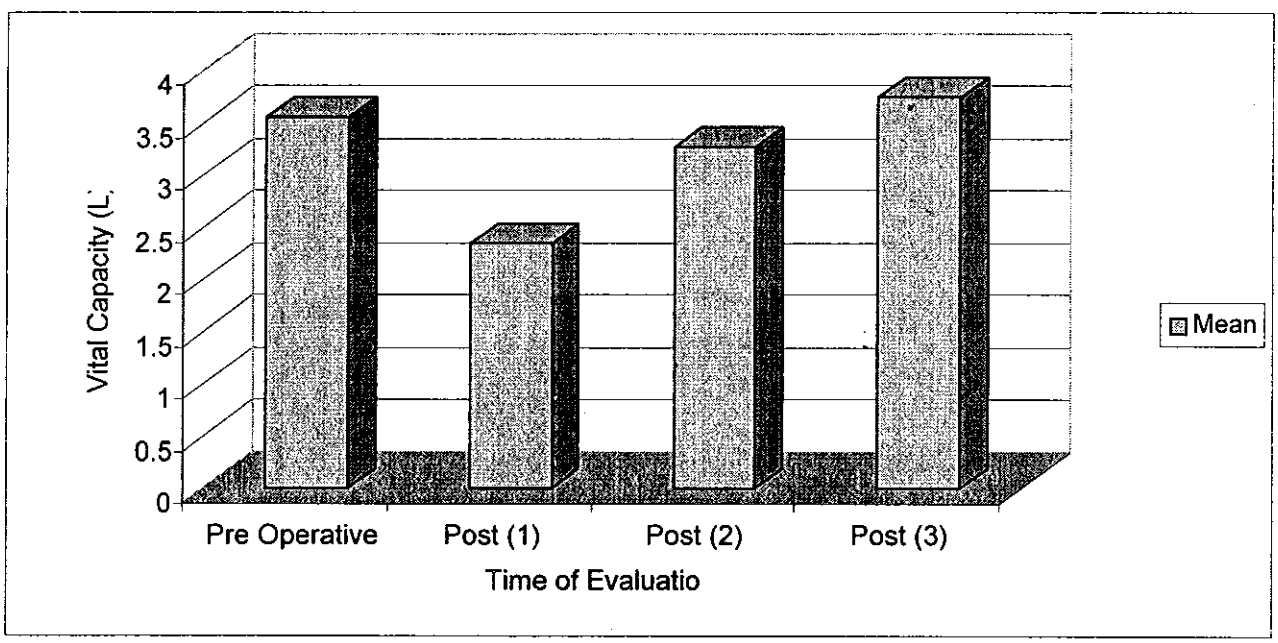

Fig. (2): The mean values of vital capacity of IPPB group (pre and post operative values).

Table (3): The statistical analysis of the differences of vital capacity in the two groups of the study (pre and post operative values).

Statistics variables	Vital capacity											
	Control (traditional P.T.) group						IPPB					
	48 h pre	24 h post	48 pre	5th post	48 h pre	Day bef. disch.	48 h pre	24 h post	48 pre	5th post	48 h pre	Day bef. Disch
$\overline{X}$	3.49	2.25	3.49	2.98	3.49	3.32	3.55	2.34	3.55	3.27	3.55	3.74
S.D. ±	0.38	0.22	0.38	0.33	0.38	0.35	0.56	0.39	0.56	0.58	0.56	0.58
Difference	+1.2482		+0.5175		+0.1733		+1.2047		0.2805		-0.1887	
t-value	26.62		37.58		24.95		26.34		10.06		-5.40	
p. value	0.00		0.00		0.00		0.00		0.00		0.00	
Level of significant	S		S		S		S		S		S	

3- Comparison and analysis of the mean values of vital capacity for the two different groups of patients (at 48 hours preoperative, 24 hours post operative, 5th day post operative and day before discharge

This part of comparison between mean values of vital capacity for two different groups (traditional P.T. and IPPB groups) suggested the following results: there were no significant difference in the vital capacity between control and IPPB groups at 48 hours post operative, 5th day post operative and day before discharge respectively P>0.05, (Table 4).

Table (4): The statistical analysis of differences of vital capacity in the control and IPPB groups (48 h pre operative, 24 hours post operative, 5th days post operative, and day before discharge).

Statistics	Vital Capacity							
	48 h pre operative		24 hours post operative		5th day post operative		Day before discharge	
	Control	IPPB	Control	IPPB	Control	IPPB	Control	IPPB
$\overline{X}$	3.49	3.55	2.25	2.34	2.98	3.27	3.32	3.74
S.D.+	0.38	0.56	0.22	0.39	0.33	0.58	0.35	0.58
t. test	-0.30		-0.83		-1.68		-2.35	
p. value	0.77		0.41		0.11		0.028	
Level of significant	N.S.		N.S.		N.S.		N.S.	

DISCUSSION

The results of the current study showed that a considerable difference in the obtained data for vital capacity pre and post operative in patients who have had cholecytectomy (in both traditional PT and IPPB groups). These differences were consistent with those reported by Wahba[28] and Ali[1].

Wahba[28] stated that the pattern of the lung function following cholecystectomy is characterized by transient reduction in lung volumes and capacities with a restrictive breathing pattern and the loss of the abdominal contribution to breathing.

Ali[1] concluded that following cholecystectomy, the inspiratiory and expiratory vital capacities are severely

reduced, and there is clinically clear reduction in functional residual capacity of around 20% immediately after surgery.

The findings of the present study indicated that patients in the control group (traditional P.T.) had significant postoperative reduction of the recorded values (24 hour, 5th day postoperative and day before discharge) of vital capacity in relation to preoperative value, i.e. patients who had cholecystectomy tended to make a significant decrease in vital capacity after 24 hours postoperative (in both control and studied groups). These findings are consistent with some studies that reported by Mang[15].

Mang[15] stated that after thoracic or/major upper abdominal surgery, all lung volumes and capacities (immediately postoperative) decrease due to the following physiological reasons:

1- Impairment of the cage movement.
2- Changes in the chest wall muscle tone.
3- An increase in lung recoil and airway closure.

As no significant differences of vital capacity was recorded in the 48 hours preoperative in both groups (traditional and IPPB groups), i.e. the postoperative reduction or changes in vital capacity is actually due to surgical intervention and not due to subjects variability.

The clear differences between 48 hours pre operative and 24 hours postoperative in vital capacity of patients who had upper abdominal surgery (cholecystectomy) may be also due to anaethetic effects as reported by Jones[10], intubation as stated by Kisner and Colby[11] and incisional pain as observed by Tisi[27].

Jones[10] stated that general anaesthesia decreases the normal ciliary action of the tracheobronchial tree and depress the respiratory portion of the central nervous system.

Kisnear and Colby[11] stated that intubation process postoperative decreases the normal ciliary action in the pulmonary tree which leads to pooling of secretions.

Tisi[27] stated that pain (postoperative) due to surgical incision causes muscle spasm which splint the chest muscles and lead to shallow weak breathing.

Another factor which might have affected the vital capacity postoperative after cholecystectomy was diaphragmatic dysfunction. This explanation was supported from the observation recorded by Alison and Ellis[2] who noted that a reflex arising from abdominal viscera may cause diaphragmatic inhibition, these reflexes may be mediated by supraspinal centers decreasing the output to the diaphragm muscle during breathing process.

The findings of the present study recommended that intermittent positive pressure breathing was equally effective method postoperative after cholecystectomy to improve vital capacity and minimize pulmonary complications, this concept is supported and in agreement with some related previous researches conducted by Bott[3],Goldstein[7], Kramer[13], Meduri[16, 17], Oikkonen[19], O, Donohure[18], Pavia[22], Pang[20], Pennock[23] and Thomas and McIntoch[26]. Their results and conclusions of the present work are consistent with that IPPB:

1- Can improve arterial blood gas tension.
2- Can improve ventilation.
3- Can reduce the effort and work of breathing.
4- Avoids the need for the intubation.
5- Decreases rate of mortality postoperative.
6- Improves vital signs and sense of dyspnea.

7- Is used to improve lung expansion and prevent postoperative atelectasis associated with abdominal or thoracic surgery.

8- Plays a vital role in improving the inspiratory muscle endurance.

Based on results of this study, it could be point out that using IPPB as a treatment of postoperative pulmonary complications following cholecystectomy is not superior method than traditional physical therapy management after postoperative cases i.e. non-invasive IPPB without physical therapy program would produce different forms of the result and did enhance vital capacity. This conclusion goes hand in hand with the studies and researches observed by Inversion[9], Paul and Downs[21] and Schuppisser[24].

From the previous discussion and scientific explanations of these findings and results and according to the related research studies conducted in this field by large number of investigators, it can be concluded that there was clear reduction in vital capacity after cholecystectomy and significant improvement in vital capacity after application of chest care methods and intermittent positive pressure breathing for cholecystectomy patients. The additional non-invasive IPPB to a regimen of chest physical therapy packages did enhance postoperative vital capacity improvement especially at day before discharge. IPPB had a little effect than chest care physical therapy and it is possible to recommend that additional non-invasive IPPB to regiment of chest physical therapy did not make postoperative vital capacity improve more rapidly than chest physical therapy care only.

CONCLUSION

According to the results of the present study supported by previous studies conducted at different literatures, it can be concluded that IPPB can be considered as an effective form of post operative physical therapy modality for patients with cholecystectomy, peripherally to be used as an adjunct to other classical physical therapy modalities.

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الملخص العربي

فعالية جهاز الضغط التنفسي الإيجابي المتقطع غير التداخلي على الوظائف الرئوية بعد جراحة استئصال المرارة

الهدف من البحث:
أجري هذا البحث لدراسة تأثير استخدام جهاز الضغط التنفسي الإيجابي المتقطع غير التداخلي مع بعض وسائل العلاج الطبيعي التنفسية التقليدية على الوظائف الرئوية بعد إجراء جراحة استئصال المرارة ، لتجنب مشاكل الجهاز التنفسي لهؤلاء المرضى والتقليل من المضاعفات المترتبة عليها والتي قد تؤثر على الحياة المعيشية لهؤلاء المرضى.

مواد وأساليب البحث:
لقد اشترك في هذه الدراسة ثلاثون مريضاً ممن أجرى لهم عملية الاستئصال الجراحي للمرارة والذين تتراوح أعمارهم بين الثلاثين والخمسين عاماً وقد تم تقسيمهم إلى مجموعتين متماثلتين في العدد:

المجموعة الأولى: وعددهم خمسة عشر مريضاً وقد تم تطبيق برنامج العلاج الطبيعي التقليدي عليهم بعد عمليات استئصال المرارة (وتسمى المجموعة الضابطة).

المجموعة الثانية: وعددهم خمسة عشر مريضاً وفي هذه المجموعة تم تطبيق جهاز الضغط التنفسي الإيجابي المتقطع إلى جانب تطبيق نفس البرنامج الخاص بالعلاج الطبيعي التقليدي المطبق على المجموعة الضابطة ونسمى هذه المجموعة (المجموعة العلاجية) وبرنامج العلاج الطبيعي يتمثل في أداء التمرينات التنفسية والأوضاع المختلفة والنقر الصدري الذي يساعد على تطهير الرئتين من البلغم المخزون. من خلال هذا البحث تم استخدام وسائل التقييم في صورة قياس السعة الحيوية للرئتين قبل العملية بـ ٤٨ ساعة وبعد العملية لـ ٢٤ ساعة وفي اليوم الخامس بعد العملية ثم اليوم السابق للخروج من المستشفى وذلك لقياس السعة الرئوية لمرضى استئصال المرارة بواسطة جهاز الوظائف الرئوية.

النتائج: قد أظهرت نتائج هذه الدراسة ما يلي:

١- إن هناك انخفاض ذو دلالة إحصائية للسعة الحيوية للرئتين بعد ٢٤ ساعة من إجراء العملية وفي خامس يوم بعد العملية وقبل الخروج بـيوم للمجموعة الأولى. وكان التحسن تدريجياً في السعة الحيوية للرئتين إلى أن وصل إلى أعلى مراحل في اليوم السابق للخروج ولكن متوسط التحسن كان أقل من مستوى قبل العملية لمرضى استئصال المرارة للمجموعة الأولى.

٢- أن هناك انخفاض ذو دلالة معنوية للسعة الحيوية للرئتين بعد ٢٤ ساعة من إجراء العملية وفي خامس يوم بعد العملية. أما بالنسبة لليوم السابق للخروج فكان التحسن ملحوظاً وكانت الزيادة في السعة الحيوية للرئتين أعلى من مستوى قبل العملية لمرضى استئصال المرارة للمجموعة الثانية التي استخدمت جهاز الضغط التنفسي الإيجابي المتقطع مما يعكس فعالية هذا الجهاز على زيادة السعة الحيوية للرئتين.

وعليه يمكن استنباط التالي:
أن إضافة استخدام جهاز الضغط التنفسي الإيجابي المتقطع إلى برنامج العلاج الطبيعي التنفسي التقليدي قد تؤدي إلى تحسن ملحوظ في الوظائف الرئوية والسعة الحيوية مما يعمل على تقليل المضاعفات التنفسية لمرضى جراحة استئصال المرارة.