DOI: 10.7860/JCDR/2016/16164.7064

Original Article

Physiotherapy Section

Comparison of Flow and Volume Incentive Spirometry on Pulmonary Function and Exercise Tolerance in Open Abdominal Surgery: A Randomized Clinical Trial

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ABSTRACT

Introduction: Surgical procedures in abdominal area lead to changes in pulmonary function, respiratory mechanics and impaired physical capacity leading to postoperative pulmonary complications, which can affect up to 80% of upper abdominal surgery.

Aim: To evaluate the effects of flow and volume incentive spirometry on pulmonary function and exercise tolerance in patients undergoing open abdominal surgery.

Materials and Methods: A randomized clinical trial was conducted in a hospital of Mangalore city in Southern India. Thirty-seven males and thirteen females who were undergoing abdominal surgeries were included and allocated into flow and volume incentive spirometry groups by block randomization. All subjects underwent evaluations of pulmonary function with measurement of Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Peak Expiratory Flow (PEF). Preoperative and postoperative measurements were taken up to day 5 for both groups. Exercise tolerance measured by Six-Minute Walk Test during preoperative period and measured again at the time of discharge for both groups. Pulmonary function was analysed by post-hoc analysis and carried out using Bonferroni's 't'-test. Exercise tolerance was analysed by Paired 'T'-test.

Results: Pulmonary function (FVC, FEV1, and PEFR) was found to be significantly decreased in 1st, 2nd and 3rd postoperative day when compared with preoperative day. On 4th and 5th postoperative day the pulmonary function (FVC, FEV1, and PEFR) was found to be better preserved in both flow and volume incentive spirometry groups. The Six-Minute Walk Test showed a statistically significant improvement in pulmonary function on the day of discharge than in the preoperative period. In terms of distance covered, the volume- incentive spirometry group showed a greater statistically significant improvement from the preoperative period to the time of discharge than was exhibited by the flow incentive spirometry group.

Conclusion: Flow and volume incentive spirometry can be safely recommended to patients undergoing open abdominal surgery as there have been no adverse events recorded. Also, these led to a demonstrable improvement in pulmonary function and exercise tolerance.

Keywords: Incentive spirometer, Lung function test, Laparotomy, Six-Minute Walk Test

INTRODUCTION

Abdominal surgeries are performed routinely for the treatment and diagnosis of many diseases [1]. Postoperative pulmonary complications (PPCs) following abdominal surgery are frequent and are responsible for increased morbidity and mortality as well as length of hospital stay and health-related cost of care [2,3]. Upper abdominal surgical procedures are associated with a higher risk of complications more frequently than are lower abdominal surgeries [4,5]. The reported risk rates of postoperative pulmonary complications in upper abdominal surgery range from 17% to 88% [6].

Common postoperative pulmonary complications include atelectasis, hypoxaemia, pneumonia, respiratory dysfunction and pleural effusion [7,8]. The factors that are directly related to physiological changes include anaesthesia (general or regional), the type of incision, the surgical technique employed. The changes are reflected in decreases in total pulmonary capacities and volumes such as, for instance a reduction in the Forced Vital Capacity (FVC) and Forced Expiratory Volume in first second (FEV1) [9].

A basic postoperative complication is a lack of lung inflation which results from a change in breathing to a shallow, monotonous pattern without periodic sighs and temporary diaphragmatic dysfunction, caused by prolonged recumbent position, and impaired mucociliary clearance, along with the decreased cough effectiveness secondary to pain which increases the risks associated with retained pulmonary secretions [10].

Chest physical therapy plays an important role in the prevention and management of postoperative pulmonary complications. It includes deep breathing exercises, mobilization, postural drainage, percussion and vibration or shaking which were developed to improve bronchial drainage as well as the employment of mechanical breathing devices such as the Incentive Spirometer (IS) which has been introduced into clinical practice [11].

Incentive Spirometry (IS) is a lung expansion technique. It is designed to induce sighing or yawning by making the patient take long, slow deep breaths. It prevents and treats atelectasis in alert patients who have a predisposition for shallow breathing. It is simple and relatively safe method for doing so [12].

Spirometry works by encouraging the patient to achieve a pre-set volume or flow. The volume is determined from predicted values or baseline measurements. Incentive spirometer commonly includes Volume Displacement (Coach 2) Devices and Flow dependent devices (Triflo) [12].

The flow – incentive spirometer (Triflo) consists of a mouthpiece and corrugated tubing connected to a manifold composed of three flow tubes containing light weight plastic balls. The patient inhales

through the mouth piece thereby creating a negative pressure within the tubes. This causes them to rise. The number of balls and the level to which they rise depends on the magnitude of the flow achieved. At lower flows, the first ball rises to a level that depends on the magnitude of flow. As the inspiratory flow increases, the second ball rises, followed by the third ball [12].

The volume-incentive spirometer (Coach 2 device) enables the patient to inhale air through a mouthpiece and corrugated tubing which is attached to a plastic bellows. The volume of air displaced is indicated on a scale located on the device enclosure. After the patient has achieved the maximum volume, the individual is instructed to hold this volume constant for 3 to 5 seconds [12].

Earlier studies that have compared flow and volume oriented Incentive spirometry suggest that physiologically there is a difference in the effect of these two devices. Flow- oriented devices (Triflo device) impose more work of breathing, and increase muscular activity of the upper chest. Volume- oriented devices (Coach 2 device) impose less work of breathing and improve diaphragmatic activity [13].

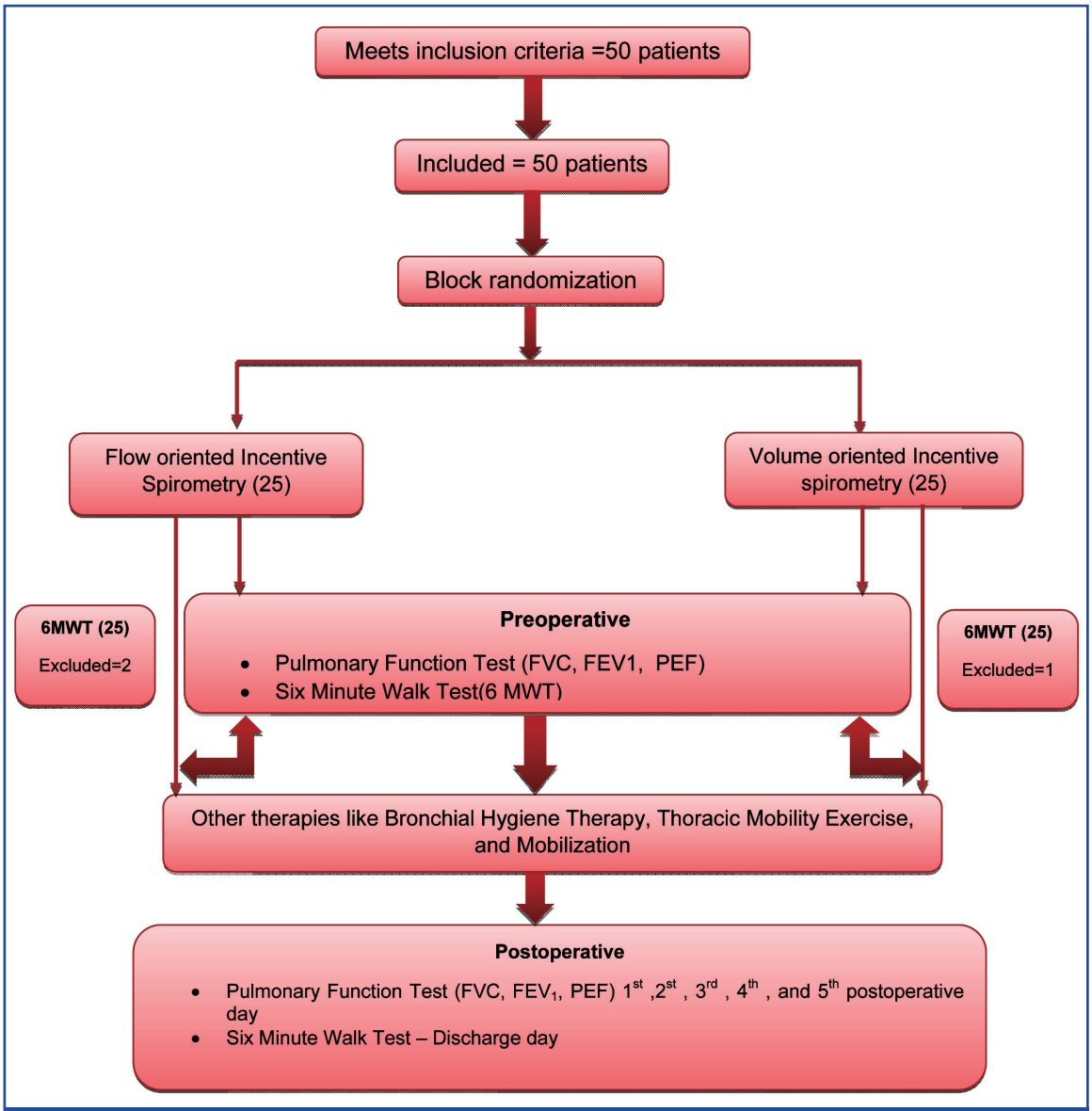
In a recent study it was observed that the volume incentive spirometry has resulted in early recovery of both pulmonary function and diaphragm movement in patients who undergone laparoscopic abdominal surgery [14].

An important component of care following open abdominal surgery and one that is widely practiced is early mobilization of the patient [15]. Exercise capacity and tolerance are the most important factors in assessment of the clinical condition and prognosis of patients. The Six-Minute Walk Test seems to be the most frequently used clinical test in research to assess the functional status of patients with cardiac and pulmonary disease. Few studies have tested its value in cardiac and pulmonary surgery. Despite the growing number of older subjects undergoing open abdominal surgery, there is little evidence of the use of Six Minute Walk Test (6MWT) in this population [16].

So far as we know, owing to poor evidence, the comparative assessment of these two kinds of incentive spirometers in patients who had undergone open abdominal surgery is inconclusive. So the present study aimed to compare the effects of flow and volume incentive spirometry on pulmonary function and exercise tolerance in patients undergoing open abdominal surgery.

MATERIALS AND METHODS

This randomized clinical trial (Trial registration number CTRI/2015/11/006336) was approved by the Scientific Committee and the Institutional Ethics Committee of Kasturba Medical College Mangalore, Manipal University. The purpose of the study was explained and the informed consent was taken from the willing participants. Study was carried out in a Kasturba medical college Hospital, Mangalore, Southern India, was conducted between March 2014 and March 2015. The sample size was calculated based on the values obtained from pulmonary function test in a pilot study (10 subjects; 5 in flow incentive spirometry group and 5 in



[Table/Fig-1]: Consort Flow Chart.

volume incentive spirometry group). The following formula was used for calculating the same.

$$n = \frac{2(z\alpha + z\beta)^2 \sigma^2}{d^2}$$

$Z\alpha = 1.96$ at 95 % C.I, $z\beta = 1.28$ at 90% power,

$\sigma = 0.42$, $d = 0.4$(effect size)

N = 23.12 (24 in each group), total 48 subjects.

A total of 50 patients were included in the study (37 males and 13 females). Allocation of members of the group was carried out by block randomization as follows: 25 subjects would perform flow incentive spirometry and the other 25 would perform volume incentive spirometry. In the flow incentive spirometry group 23 subjects were included preoperatively and postoperatively. In the volume incentive spirometry group 24 subjects were included preoperatively and postoperatively. Two subjects in the flow incentive spirometry group and 1 subject in the volume incentive spirometry group refused to walk pre and postoperatively. All subjects underwent evaluations of pulmonary function with measurement of Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Peak Expiratory Flow (PEF). The measurements were taken in the preoperative period and were repeated on the 1st, 2nd, 3rd, 4th and 5th postoperative day, for both groups. Exercise tolerance was measured by a Six-Minute Walk Test (6MWT) during the preoperative period and measured again at the time of discharge for both groups [Table/Fig-1].

Method of Performing Flow and Volume – Oriented Incentive Spirometry

Incentive spirometry was administered to the patient who has made to lie at 45°to the horizontal position i.e., half-lying. A pillow was placed beneath the patients knees. The patient then exhaled slowly and passively and avoided any forceful expiration. The process was first demonstrated to the patient just to ensure that he/she had understood the technique before performing it. Initially the spirometer was held in front of the patient by the therapist. The therapist gave the patient an explanation of inspiratory flow. Following the patient held the spirometer him/herself and practiced the manoeuver. The patient was instructed to perform 3 sets of 5 repeated deep breaths and do this exercise every waking hour. The treatment was administered to the patient four times a day and the patient was instructed to perform the same exercises on the rest of the day. A log book record was maintained of the same.

Six-Minute Walk Test (6MWT)

The 6MWT was performed according to the standardized procedure which was supervised by a physiotherapist. The patients were asked to walk at their own maximal pace along a 30m long, flat, and straight hospital corridor. The patient was not given any encouragement and the test was limited by the symptoms. Therefore, if any signs of significant distress such as dyspnea, dizziness, angina or skeletal muscle pain, the patient was asked to stop. However, the patient was instructed to resume walking as soon as possible. The distance covered by the patient was recorded in meters.

STATISTICAL ANALYSIS

Data was analysed using SPSS package version 17.0. The primary outcome measure pulmonary function was analysed by post-hoc analysis and was carried out using Bonferroni's t-test. The secondary outcome measure exercise tolerance was analysed by Paired 'T'-test.

RESULTS

A total of 50 patients were included in the study; 25 patients were allocated to the Flow Incentive Spirometry group and 25 patients to the Volume Incentive Spirometry group.

Baseline demographic characteristics of the participant's age, gender, height, weight, duration of surgery and anaesthesia and co-morbidities are presented in [Table/Fig-2]. There was no statistical difference seen between the Flow Incentive Spirometry and Volume Incentive Spirometry groups. The different types of abdominal surgeries and incisions in the Flow Incentive Spirometry and Volume Incentive Spirometry groups are summarized in [Table/Fig-3].

Variables	Flow - Incentive spirometry	Volume - Incentive spirometry	p-value
Age (Years) (Mean ± SD)	59.1 ± 14.1	53.0 ± 13.5	0.12 NS
Male (n)	19	18	0.74 NS
Female (n)	6	7	
Height (ChMs) (Mean ± SD)	158.1 ± 7.8	158.5 ± 7.2	0.83 NS
Weight (kg) (Mean ± SD)	51.0 ± 12.0	54.9 ± 18.5	0.38 NS
Duration of anaesthesia (Min) (Mean ± SD)	140.6 ± 67.6	195.0 ± 85.5	0.01 SIG
Duration of surgery (Min) (Mean ± SD)	122.6 ± 64.6	161.8 ± 83.7	0.06 NS
Co-morbidities			
Smoking	7	4	
Alcohol	5	4	
Diabetes	6	8	
Hypertension	10	5	

[Table/Fig-2]: Demographic characteristics of patients undergoing open abdominal surgery.
p=< 0.05 significant, NS= Not significant

Category	Types	Flow incentive spirometry	Volume incentive spirometry	Total (N=50)
Upper abdominal surgery	Cholecystectomy	2	2	4
	Ca gastro esophageal junction	2	3	5
	Ca pancreas	nil	4	4
	Intestinal obstruction	1	1	2
	Periampullary carcinoma	1	2	3
	Obstructive jaundice	1	nil	1
	Ca stomach	5	3	8
	Ca lung with esophagus stricture	nil	1	1
	Type 1 choledochal cyst	nil	1	1
	Chronic pancreatitis	1	nil	1
	Right renal cell carcinoma	nil	1	1
	Hepatocellular carcinoma	1	nil	1
Lower abdominal surgery	Ileocaecal growth With Intestinal Obstruction	nil	1	1
	Ca rectum	1	1	2
	Inguinal hernia	4	3	7
	Ca sigmoid colon	2	1	3
	Rectum prolapse	1	nil	1
	Incisional hernia	3	1	4
	Incisions	**Flow Incentive spirometry**	**Volume Incentive spirometry**	**Total (n=50)**
	Oblique	5	4	9
	Paramedian	2	4	6
	Subcostal	1	1	2
	Vertical midline	14	12	26
	Supraumbilical	2	3	5
	Supracostal	1	1	2

[Table/Fig-3]: Various types of abdominal surgeries and incisions in flow and volume – incentive spirometry groups.
N= number of subjects

For both the flow and volume–oriented incentive spirometry groups, a statistically significant decrease was seen in Forced Vital capacity (FVC) on the 1st, 2nd and 3rd postoperative day as compared with FVC during the preoperative period. However, on 4th and 5th

postoperative day statistically significant difference was not seen in both flow - and volume - incentive spirometry groups as patients had reached normal baseline values [Table/Fig-4].

Forced vital capacity (FVC)	Flow Incentive Spirometry (N=25)	Volume Incentive Spirometry (N=25)
Preoperative (Mean± SD)	1.92 ± 0.78	2.23 ± 0.90
Postoperative 1st day (Mean ± SD)	1.06 ± 0.45	1.23 ± 0.75
Postoperative 2nd day (Mean ± SD)	1.16 ± 0.53	1.50 ± 0.72
Postoperative 3rd day (Mean ± SD)	1.37 ± 0.54	1.58 ± 0.72
Postoperative 4th day (Mean ± SD)	1.52 ± 0.58	1.73 ± 0.73
Postoperative 5th day (Mean ± SD)	1.60 ± 0.61	1.85 ± 0.77
Mean difference between preoperative and postoperative 1st day		
Mean difference	0.86	1.0
% change	57.5 %	57.4 %
p-value	< 0.001 HS	< 0.001 HS
Mean difference between preoperative and postoperative 2nd day		
Mean difference	0.76	0.73
% change	49.5 %	39.0 %
p-value	<0.001 HS	<0.001 HS
Mean difference between preoperative and postoperative 3rd day		
Mean difference	0.55	0.64
% change	33.2 %	33.9 %
p-value	0.003 HS	0.005 HS
Mean difference between preoperative and postoperative 4th day		
Mean difference	0.40	0.50
% change	23.3 %	25.3 %
p-value	0.12 NS	0.70 NS
Mean difference between preoperative and postoperative 5th day		
Mean difference	0.32	0.38
% change	18.1 %	18.5 %
p-value	0.50 NS	0.66 NS

[Table/Fig-4]: Comparison of Forced Vital Capacity (FVC) before and after open abdominal surgery in flow and volume oriented incentive spirometry groups.
N= number of subjects, p=< 0.05 significance, HS= highly significance, NS= Not significance

Forced expiratory volume in one second (FEV_1) was compared with in the flow and volume incentive spirometry groups before and after open abdominal surgery. There was a statistically significant decrease seen in the Forced Expiratory Volume in one second (FEV_1) on the 1st, 2nd, 3rd and 4th postoperative day for both flow- and volume- incentive spirometry groups, when compared to the preoperative period. There was no statistically significant difference found on the 4th and 5th postoperative day in volume incentive spirometry groups when compared with preoperative day. But in Flow incentive spirometry group on 5th postoperative day there was no statistical significant difference found when compared with preoperative day. (Given in [Table/Fig-5])

Peak expiratory flow rate (PEFR) were compared with the flow and volume incentive spirometry groups before and after open abdominal surgery. When compared with the preoperative period there was a statistically significant decrease seen in the Peak Expiratory Flow Rate (PEFR) on the 1st, 2nd, 4th and 5th day for the flow- incentive spirometry group. However, on the 3rd postoperative day, a statistically significant difference in PEFR compared to the preoperative period was not seen for the flow-incentive spirometry group.

Forced Expiratory Volume in one second (FEV1)	Flow - Incentive Spirometry (N=25)	Volume - Incentive Spirometry (N=25)
Preoperative (Mean± SD)	1.60±0.67	1.68 ± 0.73
Postoperative 1st day (Mean ± SD)	0.87±0.38	0.94 ± 0.49
Postoperative 2nd day (Mean ± SD)	0.92±0.45	1.13 ± 0.63
Postoperative 3rd day (Mean ± SD)	1.15±0.53	1.24 ± 0.62
Postoperative 4th day (Mean ± SD)	1.24±0.54	1.34 ± 0.65
Postoperative 5th day (Mean ± SD)	1.25±0.54	1.42 ± 0.63
Mean difference between preoperative and postoperative 1st day		
Mean difference	0.73	0.74
% change	58.5 %	56.5 %
p-value	0.000 HS	0.002 HS
Mean difference between preoperative and 2nd postoperative day		
Mean difference	0.68	0.55
% change	53.8 %	39.1 %
p-value	0.001 HS	0.002 HS
Mean difference between preoperative and 3rd postoperative day		
Mean difference	0.45	0.44
% change	32.4 %	29.4 %
p-value	0.004 HS	0.030 SIG
Mean difference between preoperative and 4th postoperative day		
Mean difference	0.35	0.34
% change	24.3 %	21.9 %
p-value	0.01 SIG	0.51 NS
Mean difference between preoperative and 5th postoperative day		
Mean difference	0.36	0.26
% change	25.0 %	16.2 %
p-value	0.05 NS	1.00 NS

[Table/Fig-5]: Comparison of Forced Expiratory Volume in one second (FEV_1) before and after the open abdominal surgery, in flow – and volume-oriented incentive spirometry groups.
N= number of subjects, p=< 0.05 significance, HS= highly significance, NS= Not significant.

In volume incentive spirometry group there was a statistical significance decrease seen in PEFR in 1st postoperative day compared to the preoperative period. On 2nd, 3rd, 4th and 5th postoperative day as patients are reaching normal to baseline period [Table/Fig-6]. Both flow- and volume- incentive spirometry groups showed a statistically significant difference in the preoperative and postoperative distance covered in the 6MWT. Of the groups, the volume- incentive spirometry group showed values which were found highly significant. Mean of preoperative and discharge distance covered in both flow- and volume- incentive spirometry groups is [Table/Fig-7].

DISCUSSION

The study was conducted to determine the efficacy of flow and volume incentive spirometry on pulmonary function and exercise tolerance in patients undergoing open abdominal surgery. In our study we included 25 patients who had undergone open abdominal surgery. They varied from 18 to 90 years of age. The patients were equally and randomly assigned to 2 groups: a) the flow incentive spirometry group; b) the volume incentive spirometry group. Our research hypothesis is accepted as flow and volume incentive spirometry on pulmonary function and exercise tolerance showed a significant difference.

Peak Expiratory Flow Rate (PEFR)	Flow - Incentive Spirometry (N=25)	Volume - Incentive Spirometry (N=25)
Preoperative (Mean± SD)	3.48±1.81	3.14±1.49
Postoperative 1st day (Mean ± SD)	2.01±1.27	1.76±0.96
Postoperative 2nd day (Mean ± SD)	1.95±1.17	2.29±1.49
Postoperative 3rd day (Mean ± SD)	2.54±1.40	2.52±1.63
Postoperative 4th day (Mean ± SD)	2.29±1.15	2.93±1.63
Postoperative 5th day (Mean ± SD)	2.39±1.12	3.07±1.55
Mean difference between preoperative and postoperative 1st day		
Mean difference	1.47	1.38
% change	53.4 %	56.3 %
p-value	0.001 HS	0.01 SIG
Mean difference between preoperative and postoperative 2nd day		
Mean difference	1.53	0.85
% change	56.0 %	31.1 %
p-value	0.001 HS	0.33 NS
Mean difference between preoperative and postoperative 3rd day		
Mean difference	0.94	0.62
% change	31.1 %	21.9 %
p-value	0.12 NS	1.00 NS
Mean difference between preoperative and postoperative 4th day		
Mean difference	1.19	0.21
% change	41.0 %	6.9 %
p-value	0.01 SIG	1.00 NS
Mean difference between preoperative and postoperative 5th day		
Mean difference	1.09	0.07
% change	37.1 %	1.9 %
p-value	0.37 SIG	1.00 NS

[Table/Fig-6]: Comparison Peak Expiratory Flow Rate (PEFR) before and after the open abdominal surgery in flow – and volume – oriented incentive spirometry groups.
N= number of subjects, p=< 0.05 significance, HS= highly significance, NS= Not significant.

Variable	n	Distance covered preoperatively	Distance covered at Discharge	Pre- discharge distance (Mean ± SD)	p-value
Flow Incentive Spirometry	23	348.26	382.17	33.9 ± 73.6	0.038 SIG
Volume Incentive Spirometry	24	367.50	425.0	57.5 ± 52.2	0.001 HS

[Table/Fig-7]: Comparison of distance covered during the Six Minute Walk Test, preoperatively and on discharge, for flow – and volume – incentive spirometry groups following open abdominal surgery.
p=< 0.05 significance, n= number of subjects, SIG= significance, HS= highly significant.

Based on our study results, the pulmonary function {FVC, FEV1, and PEFR} on 1st postoperative day when compared to the preoperative period had a significant decrease in both flow- and volume- incentive spirometry groups. This is possibly owing to the fact that in the postoperative period there is shallow, monotonous breathing without periodic sighs and prolonged restraint in bed due to postoperative pain, incision site, analgesics, duration of anaesthesia and surgery, all of which decrease the ventilation to dependent lung regions [11].

In the immediate postoperative, the patient may present hypoventilation owing to the administration of anaesthesia which leads to ventilation-perfusion mismatch, hypoxaemia and shunt. Anaesthetic agents and narcotic analgesics depress the hypoxic ventilatory drive and suppress the normal periodic "sighing" respiration which is necessary for maintenance of normal lung inflation [17]. A reduction of the effectiveness of the cough reflex and increased risks associated with the retention of sputum are caused by impaired mucociliary clearance [8]. Direct trauma to the abdominal wall and the incision affect diaphragmatic function [5]. This is due to reflex inhibition of the phrenic nerve after the manipulation of abdominal viscera [18]. All these factors impair the function of respiratory muscles which lead to decrease in functional residual and vital capacity [17]. In a study it has been suggested that chest physiotherapy helps in improving the distribution of ventilation and increasing clearance of secretions in surgical patients [19].

Our results are in accordance with Ford et al., showed that reduction in diaphragmatic performance was the main determinant of impaired lung function [20]. Scholes et al., found that respiratory co-morbidity and the duration of anaesthetic were significantly associated with the increased risk of postoperative pulmonary complications after abdominal surgery [21]. Martinez et al., in their study found that anaesthesia and pain are responsible for respiratory muscle dysfunction [22]. Karine et al., found that the supine position, incision near respiratory muscles and the use of painkillers are responsible for the postoperative physiological changes in abdominal surgery [17].

There was a highly statistically significant improvement seen in pulmonary function groups of the flow- and volume- incentive spirometry groups, from the 2nd to 5th postoperative day, when compared to the preoperative period.

The possible reason for the improvement in pulmonary function in abdominal surgeries could be the use of incentive spirometry, which is a mechanical device used to encourage patients to take long, slow, sustained deep inspirations which leads to achieving maximal inflating pressure in the alveoli and maximal inhaled volume, and also helps to maintain the patency of the smaller airways. Postoperative hypoxaemia is reduced by using incentive spirometry which provides low-level resistance training to the diaphragm and minimizes fatigue thereby improving inspiratory muscle strength and enhancing lung inflation [9,23].

Our results are in accordance with Stephen et al., found that incentive spirometry is more effective than deep breathing exercise in restoring vital capacity to preoperative levels [24]. Westwood et al., concluded that incentive spirometry plays a significant role in preventing atelectasis and its complications in major abdominal surgeries [25]. It was found that abdominal surgery patients with surgical incisions close to the diaphragm were placed at a high risk of pulmonary complications. The researchers also stressed that incentive spirometry was effective as a pulmonary risk-reduction method [25]. Hall et al., showed that incentive spirometry was the most efficient prophylaxis against pulmonary complications in high risk patients after abdominal surgery [19]. Celli et al., compared intermittent positive-pressure breathing, incentive spirometry and deep breathing exercises in patients who had undergone abdominal surgery and concluded that incentive spirometry showed significantly lower incidence of postoperative pulmonary complications [23].

The next objective in our study was Six-Minute Walk Test (6MWT) which has been validated for use in preoperative and postoperative periods as a measure of recovery and physical capacity in flow- and volume- incentive spirometry groups [26]. There was a statistically significant improvement seen in the distance covered postoperatively when compared with preoperatively. Mobilization of postoperative patients with low intensity exercise aims at eliciting cardiopulmonary responses which enhances oxygen transport and assists in reduction of postoperative pulmonary complications [27].

An important recommendation, made to patients undergoing abdominal surgery is early mobilization. Early mobilization is shown to increase lung volume, prevent atelectasis and improve gas exchange. Our results are similar to the findings of Brasher et al., who have suggested that early mobilization seems more effective than deep breathing exercises in the prevention of postoperative pulmonary complications [3]. Breiger et al., reported early mobilization was observed to hasten recovery and reduce the incidence of postoperative pulmonary complications. A study carried out by Neilsen et al., concluded that mobilization involving an upright position is most beneficial in the early postoperative period and produces evidence of improvement in pulmonary function. Mackey et al., suggests that early mobilization may reduce the incidence of postoperative pulmonary complications [15].

LIMITATION

The limitation of the study was there was no control group and a smaller sample size; this limits the generalizability of the results. The same investigator recorded the Pulmonary Function Test and Six Minute Walk Test values. There was no blinding in the study procedure and postoperative pain and the type of analgesics used were not assessed by the investigator. This can affect the study findings. The patients' adherence to incentive spirometry was not assessed, as a result of which we are not sure that the patients have strictly followed the instructions. Further research can be done on a larger sample size with a control group. Similar, type of study can be done on cardiac and thoracic surgeries along with other techniques such as diaphragmatic breathing exercises and inspiratory muscle training can be focused in future researches.

Based on results from our study, flow and volume incentive spirometry can be safely recommended to patients undergoing open abdominal surgery as there are no adverse events recorded on the one hand and on other hand, these have shown demonstrable improvement in pulmonary function and exercise tolerance.

CONCLUSION

From our study we concluded that there is a significant decrease in pulmonary function in the flow- and volume- incentive spirometry groups on the 1st postoperative day when compared with the preoperative day. There is a significant improvement seen in the flow- and volume-incentive spirometry groups on the 2nd, 3rd, 4th and 5th postoperative day when compared with the preoperative day. From our study we also found that there was a significant increase in the Six-Minute Walk Test distance covered postoperatively when compared with the preoperative day in both flow- and volume-incentive spirometry groups.

ACKNOWLEDGMENTS

We would like to thank all the subjects who has been actively involved in the study.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Aug 09, 2015**
Date of Peer Review: **Nov 14, 2015**
Date of Acceptance: **Dec 07, 2015**
Date of Publishing: **Jan 01, 2016**