Original Article

COMPARISON OF FLOW AND VOLUME ORIENTED INCENTIVE SPIROMETRY ON LUNG FUNCTION AND DIAPHRAGM MOVEMENT AFTER LAPAROSCOPIC ABDOMINAL SURGERY: A RANDOMIZED CLINICAL PILOT TRIAL

Gopala Krishna Alaparthi [1], Alfred Joseph Augustine *[2], Anand R [3], Ajith Mahale [4].

[1] Asst. Professor, Department of Physiotherapy,
[2*] Professor, Department of surgery,
[3] Professor, Department of Pulmonary Medicine.
[4] Professor, Department of Radiodiagonsis,
Kasturba medical college (A constituent institute of Manipal University) Mangalore-575004, India.

ABSTRACT

Objective: This study was designed to evaluate the efficacy of two types of incentive spirometer (flow and volume) on pulmonary function and diaphragm excursion in patients who underwent laparoscopic surgery.
Materials and Methods: Twenty sample sizes with eleven men and nine women who underwent laparoscopic surgery were randomly divided as follows: 10 subjects performed flow oriented incentive spirometer group, and other 10 subjects performed volume oriented incentive spirometer group. (Other therapies like bronchial hygiene therapy, Thoracic mobility exercise and mobilization performed both group) . All of them underwent evaluations of pulmonary function test with measurement of forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF) and diaphragm movement by ultra songraphy before the operation and first, second postoperative day(POD).
Results: pulmonary function and diaphragm movement values between preoperative and postoperative (first, second) days were found to be higher in the volume oriented incentive spirometer group when compared to flow oriented incentive spirometer group.
Conclusions: volume oriented incentive spirometry contributed towards early recovery of pulmonary function and diaphragm movement among patients who had undergone laparoscopic abdominal surgery.

KEYWORDS: Incentive Spirometry; Laparoscopic Abdominal Surgery; Flow Incentive Spirometry; Pulmonary Function Tests; Diaphragm Movements; Volume Incentive Spirometry.

Address for correspondence: Dr. Alfred Joseph Augustine[2], Head & Professor, Department of surgery, Kasturba medical college (A constituent institute of Manipal University), Mangalore-575004. India. **Email:** alfred.augustine@manipal.edu

Access this Article online

Quick Response code

International Journal of Physiotherapy and Research
ISSN 2321- 1822
www.ijmhr.org/ijpr.html

Received: 21-10-2013 Accepted: 18-11-2013
Peer Review: 21-10-2013 Published: 11-12-2013

INTRODUCTION

The associations between thoracic and abdominal surgeries and the high incidence of respiratory complications are already well documented in the literature and its main characteristics are: atelectasis, pneumonia, respiratory dysfunction and pleural effusion. [1]

Now a day's many abdominal surgeries are performed by the laparoscopic technique. [2] The advantages of the laparoscopic technique include les patient discomfort, shorter hospitalization, and short interval to return to full activities after operation. Pulmonary function is commonly altered after surgery,

particularly in patients who have had chest or abdominal surgery.[3]

The physiological changes are directly related to anaesthesia (general or regional) and to the type of incision and surgical technique employed and are reflected by decreases in total pulmonary capacities and volumes. Impairment of Pulmonary function is one of the most significant postoperative pulmonary complications of upper abdominal surgery.[4] It has been postulated that due to the minimal incisional discomfort, postoperative pulmonary function following laparoscopic surgery would be improved as compared to open abdominal surgery.[3]

Chest physiotherapy techniques of lung re-expansion have been recommended as strategies to prevent and/or to treat the postoperative complications, as well as to recover the ventilation function in the postoperative period. Techniques such as diaphragmatic breathing exercise, incentive spirometry and positive airway pressure exercises stimulate the generation of a large and sustained increase in the transpulmonary pressure, with consequent expansion of collapsed alveolar units.[5]

Incentive spirometer is activated by a inspiratory effort, that is, breathing is visualized by an uplifted ball in a transparent cylinder during sustained inspiration .on a calibrated scale on the cylinder, the uplifted ball on the spirometer displays either the inspired volume (a volume – oriented incentive spirometer) or the generated flow (a flow- oriented incentive spirometer) .The incentive spirometer has been widely used in clinical practice, especially in the management of patients in the pre and post-operative period of major abdominal and cardio-thoracic surgeries.[6]

Though chest physiotherapy is not specifically recommended for laparoscopic abdominal surgery, it stills a common practice in many treatment centres around the world. Study also shows that chest physical therapy contributed towards early recovery of pulmonary function and muscle strength among patients who had undergone laparoscopic cholecystectomy.[7]

Recently a randomized control trail studies shows that diaphragmatic breathing exercise contributed towards early recovery of pulmonary function and diaphragm excursion among patients who had undergone laparoscopic surgery.[8] The most recent study conclude that aerobic exercise to incentive spirometry helped in controlling postoperative pulmonary complications after laparoscopic cholecystectomy.[4]

However, there are no studies showing the effect of flow and volume oriented incentive spirometer on lung function and diaphragm movement after laparoscopic surgery. The present study aims to compare the effect of flow and volume oriented incentive spirometer on lung function and diaphragm movement following laparoscopic abdominal surgery, which has not been investigated previously.

MATERIALS AND METHODS

The study was approved by the Department of Physiotherapy Scientific Committee and the Institutional Ethics Committee of Kasturba Medical College Mangalore. The study included 20 patients aged 20-70 years undergoing laparoscopic abdominal surgery. Exclusion criteria was patients who were uncooperative, unstable cardiovascular system, Presence of any acute infection, and patients who underwent open abdominal surgery

The purpose of the study was explained to the participant and an informed consent was obtained. Patients were divided in two groups; (1) flow oriented incentive spirometry group (2) volume oriented incentive spirometry group. Each group contained 10 patients. Patients were selected through convenient sampling. Allocation of the group was done by block randomization.

Each subject was allocated a unique study number which corresponded to that on a sealed opaque envelope containing information about subjects' allocated flow (IS) or volume (IS) group. Once the allocation of the groups was done, the patient in the both exercise group was seen one day prior to the surgery and was given preoperative information and flow or volume (IS) Exercise were taught to the patient. Other therapies like bronchial hygiene therapy, Thoracic mobility exercise and mobilization were taught to every patient in both groups.

Pulmonary function test procedures were performed ensuring technical acceptability and reproducibility criteria recommended by the American Thoracic Society[9]. The following variables were recorded; Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV_1), FEV_1/FVC ratio,) these were taken in the preoperative period and it was measured again first and second day after surgery. The Ultra sonography for diaphragm movement was taken in the preoperative period in both groups and it was measured again on 1st postoperative day and at the time of the discharge. These measurements were taken by an experienced radiologist.

Method of performing flow oriented and volume oriented incentive spirometer

Incentive spirometer was given with the patient positioned in half lying (45^0) with a pillow under the knees. The patient was instructed to take a deep sustained breath with a breath holding for 5-10 seconds. Then the patient will be instructed to breathe out slowly and passively and to avoid any forceful expiratory maneuver. After the process is demonstrated to the patient, he/she will be asked to perform it to make sure that he/she had understood the process. Initially the therapist will hold the spirometer in front of the patient and give him ideas about the Inspiratory flow. But later the patient will hold the spirometer by himself/herself and practice the maneuver. For incentive spirometer, the patient was instructed to perform it for 5-10 breaths every hour while awake. The treatment was given by the therapist four times in a day and the patient had to perform the same maneuver unsupervised thereafter, which was recorded in a log book.[10]

Method of performing diaphragm movement

The probe was placed between the midclavicular and anterior axillary lines, in the sub-costal area, and directed medially, cranially and dorsally, so that the ultrasound beam reached perpendicularly the posterior third of the right hemi diaphragm. Diaphragm movements were recorded in M-mode. This maneuver begins at the end of normal expiration, and the patients were asked to inhale in as deeply as they possibly could do.

Data analysis

All statistical analysis was performed using the Statistical Package for Social Science (SPSS) version 13.0 software. P-value of < 0.05 with confidence interval of 95% was considered statistically significant. An analysis of variance (ANOVA) was used to compare the results of each group obtained pulmonary function (FEV1,FVC, FEV1/FVC) and diaphragm excursion in the pre-operative as well as for first and second post-operative (OP) days.

RESULTS

The characteristics of the 20 patients included in the data analysis were shown in (Table-1). The baseline analysis characteristics demographic data, including age, sex, height, weight,,10 patients took part in the flow oriented incentive spirometry group, in which 6 were females and 4 males, age 44.0 ±17.9 years old, and 10 engaged in the volume incentive spirometry group, 3 females and 7 males, age 40.4 ±18.3 years old.

The mean values for pulmonary function (FVC, FEV1, FEV1/FVC, PEF) and diaphragm movement in the preoperative period and on the first and second day after the surgery in both groups are shown in (Table-2, 3, 4, 5) one can observe a meaningful pulmonary function and diaphragm excursion reduction in the first postoperative in relation to the preoperative phase for all variables analyzed ($p<0.05$) for both groups, except in the relation FEV1/FVC, which did not show any significant differences. By comparing preoperative and second postoperative in both groups, the value found in the volume oriented incentive spirometry group were greater than those in the flow oriented incentive spirometry group.

Characteristics	Flow oriented incentive spirometry group	Volume oriented incentive spirometry group
N	10 (male 6, female 4)	10 (male 7, female, 3)
Age	44.2±15.5	40.6 ±14.8
Height	157.1± 10.8	162.5 ±9.46
Weight	60.0± 13.6	57.0±12.0
Laparoscopic cholecystectomy	5	5
Laparoscopic appendectomy	3	1
Laparoscopic hernioplasty	2	4

Table 1: Demographic data of the study participants.

	Pre OP	Post OP 1day	Post OP 2day	Difference (preminuspost1)	pvalue	Difference (preminuspost2)	P value
FVC	2.45±.90	1.78±1.10	2.07±.85	0.67±.56	0.005	0.38±.51	0.028
FEV1	2.07±.78	1.37±.70	1.64±.61	0.70±.51	0.005	0.43±.49	0.028
FEV1/FVC	83.9±8.0	80.2.4±8.0	83.2±7.0	0.30±.11	0.202	0.0±.09	0.61
PEF	4.24±1.90	2.72±1.60	3.57±1.24	1.52±1.35	0.007	.66±1.09	0.169

Table 2: Comparison of pulmonary function in flow oriented incentive spirometry group.

	Pre OP	Post OP 1day	Post OP 2day	Difference (preminuspost1)	pvalue	Difference (preminuspost2)	P value
FVC	2.81±.78	2.22±.66	2.53±.75	0.58±.55	0.017	0.28±.33	0.037
FEV1	2.34±.64	1.73±.52	1.94±.58	0.60±.38	0.005	0.40±.28	0.007
FEV1/FVC	83.5±6.0	77.1±6.0	77.3±7.0	0.64±.06	0.019	0.62±.06	0.028
PEF	4.86±1.16	3.30±1.26	3.65±1.30	1.56±1.08	0.007	1.21±1.17	0.074

Table 3: Comparison of pulmonary function in volume oriented incentive spirometry group.

FOIS	Pre OP	Post OP 1day	Post OP 2day	Difference (preminuspost1)	P value	Difference (preminusdischarge)	pvalue
Diaphragm movement	3.58±.99	2.60±1.23	3.49±.84	0.98±.55	0.008	0.09±.39	0.44

Table 4: Comparison of diaphragm movement in flow oriented incentive spirometry (FOIS) group.

VOIS	Pre OP	Post OP 1day	Post OP 2day	Difference (preminuspost1)	Pvalue	Difference (preminusdischarge)	pvalue
Diaphragm movement	3.76±.92	2.57±.66	3.82±.60	1.56±1.08	0.007	1.21±1.17	0.017

Table 5: Comparison of diaphragm movement in volume oriented incentive spirometry (VOIS) group.

DISCUSSION

This study was conducted to determine the efficacy of flow oriented incentive spirometer versus volume oriented incentive spirometer on pulmonary function and diaphragm excursion of patients who underwent laparoscopic abdominal surgery. It is necessary to point out that in the literature no such references were found for any works that linked the chest physiotherapy or laparoscopic surgery, which attests to the importance and pioneering nature of this pilot study.

The results of this study pointed out that pulmonary function (FVC, FEV1, FEV1/FVC and PEF) and diaphragm excursion between preoperative, first and second postoperative day were lesser in the flow oriented incentive spiro-meter group compare to volume oriented incentive spirometer group.

During normal respiration, large intermittent breaths, three times the normal tidal volume, are inspired approximately ten times each hour. During post-operative, such sighing is absent. Shallow, monotonous breathing may decrease ventilation to the dependent lung regions and may contribute to the development of atelectasis. Incisional pain, residual anesthetic effects, and assuming the recumbent position for prolonged periods promote decreased resting lung volume.[12]

In addition, when patients remain recumbent for long periods, especially during the first 24 hours postoperatively, their abdominal content limits diaphragmatic movement.

Both the recumbent position and a change in breathing pattern may decrease FRC. Diminished expiratory lung volumes are associated with decreased lung compliance, which increases the elastic work of breathing. to minimize this work patients take shallow, frequent breaths which may further decrease lung volume.[12]

Incentive spirometry is widely used clinically as an adjunct to chest physiotherapy; the theoretic basis on which the incentive spirometer was proposed was that it encourages patients to maximally inflate their lungs and to sustain that inflation. Maximal lung inflation is thought to open collapsed alveoli, and thereby, prevent and resolve atelectasis. Maximal lung inflations increase transpulmonary pressure during inspiration. If the re-expanded alveoli remain inflated during expiration, FRC will be increases.[13]

Volume oriented incentive spirometer achieved a larger lung volume than did patients using flow oriented incentive spirometer. To attain this goal, a sustained and prolonged inspiratory phase is needed to meet the increased demand of the time constant in collapsed alveoli. The inspiratory volume indicated in flow oriented incentive spirometer is determined by peak inspiratory flow rate to attain the maximal possible inspiratory volume.[13]

In addition, patients might not sustain a sufficient inspiratory phase to counteract the increased time constant to expand the alveoli. In contrast, the inspiratory volume indicated on volume oriented incentive spirometer is determined by the volume inspired. Patients may adjust their inspiratory flow rate and inspiratory time to inflate their high time-constant alveolar units. Therefore volume oriented incentive spirometer may be more suitable for lung expansion therapy.[13]

One of the limitations of study is small sample size. Further research is needed studies with large sample size and comparing diaphragmatic breathing exercise and different breathing exercise devices (flow IS and volume IS) in laparoscopic surgery.

In conclusion, Volume oriented incentive spirometry contributed to the early recovery of both the pulmonary function and diaphragm movement of the patients who underwent laparoscopic abdominal surgery.

Conflicts of Interest: None

REFERENCES

1. Dias CM, Plácido TR, Ferreira MFB, Guimarães FS, Menezes SLS. Incentive spirometry and breath stacking: effects on the inspiratory capacity of individuals submitted to abdominal surgery. Rev. bras. fisioter. 2008;12(2):94-9.
2. M. Fagevik Olsen, K.Josefson, H.Lonroth. Chest physiotherapy does not improve the outcome in laparoscopic fundoplication and vertical-banded gastroplasty. Surg Endosc 1999; 13: 260–263
3. Ravimohan SM, Kaman L,Jindal R, Singh R, Jindal SK. Postoperative pulmonary function in laparoscopic versus open cholecystectomy: prospective, comparative study. Ann Surg. 2005; 241(2):219-26.
4. Ashraf A. El-Marakby, Ashraf D, Ehab A, Ahmed M, Sal-wa R. E , Riziq Al, Gaowgzeh, A Jad. Aerobic Exercise Training and Incentive Spirometry Can Control Postoperative Pulmonary Complications after Laparoscopic Cholecystectomy. Middle-East Journal of Scientific Research 13 (4): 459-463, 2013.
5. Carvalho Celso R. F., Paisani Denise M., Lunardi Adriana C.. Incentive spirometry in major surgeries: a systematic review. Rev. bras. Fisioter 2011;15(5):343-50.
6. Weindler J, Kiefer RT. The efficacy of postoperative incentive spirometry is influenced by the device-specific imposed work of breathing Chest. 2001 Jun;119(6):1858-64.
7. Gastaldi AC, Magalhaes C. Benefits of postoperative respiratory kinesiotherapy following laparoscopic cholecystectomy. Rev Bras Fisioter. 2008;12(2);100-106.
8. Alaparthi G K, Augustine A J, R Anand, Mahale A. Chest physiotherapy during immediate postoperative period among patients undergoing laparoscopic surgery- A Randomized Controlled Pilot Trail. IJBAR: 2013;04(02);118-122.
9. M.R Miller, J Hankinson, V.Brusasco, F. Burgos R. Casaburi et al, Standardisation of spirometry. European respiratory journal 2005; 26; 319-338.
10. AARC (American Association for Respiratory Care) clinical practice guideline. Incentive spirometry. Respir Care. 1991;36(12):1402-5.
11. Boussuges A, YoannGole. Diaphragmatic Motion studied by M-Mode Ultrasonography: methods, reproducibility, and normal values. Chest 2009; 135:391-400.
12. Celli BR, Rodriguez KS, Snider GL. A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgery. Am Rev Respir Dis. 1984;130(1):12-5.
13. Ho SC, Chiang LL, Cheng HF, Lin HC, Sheng DF, Kuo HP, Lin HC. The effect of incentive spirometry on chest expansion and breathing work in patients with chronic obstructive airway diseases: comparison of two methods. Chang Gung Med J. 2000 Feb;23(2):73-9.

How to cite this article: Gopala Krishna Alaparthi, Alfred Joseph Augustine, Anand R , Ajith Mahale. Comparison of flow and volume oriented incentive spirometry on lung function and diaphragm movement after laparoscopic abdominal surgery. A randomized clinical pilot trial. Int J Physiother Res 2013;05:274-78.