Original article:

Efficacy of incentive spirometer in improving pulmonary functions after upper abdominal surgery

***Dr. Sanjeev Kumar Khanna**

Name of Institute: College of Physiotherapy, Christian Medical College, Ludhiana, India

ABSTRACT:

Introduction: Incentive spirometer(IS) is widely used in prevention and treatment of postoperative pulmonary complications after upper abdominal surgery. The aim of study was to evaluate efficacy of Incentive spirometer in improving pulmonary functions after upper abdominal surgery.

Methodology: Patients in Incentive spirometer group were given three supervised sessions of IS daily. Patients were also told to use IS 10 times during each waking hour .Patient in Deep breathing exercise group (Control Group) were taught deep breathing exercises preoperatively and encouraged to do deep breaths with 10 times during every waking hour. Spirometric values of FEV1, FEV6, and PEFR were obtained one day before surgery, three days after surgery and five days after surgery.

Results and conclusions: A marked reduction in pulmonary function variables of PEFR, FEV1, and FEV6 were present after surgery. The patients in Incentive spirometer group have better pulmonary functions as compared to deep breathing exercise group after three days and five days of surgery. So incentive spirometer improves the pulmonary functions earlier than Deep breathing exercise group after upper abdominal surgery.

Keywords: Incentive Spirometer, Abdominal surgery, Breathing Exercise.

Introduction:

Upper abdominal Surgery is associated with decreased lung volumes, adoption of rapid shallow pattern of breathing. There has been a decrease in maximum inspiratory and expiratory muscle pressure observed after abdominal surgery.[1]The vital capacity is reduced by 50-60% and functional residual capacity (FRC) by 30%[2]. Diaphragmatic activity is reduced in the postoperative period, with a shift from predominantly abdominal to thoracic breathing[3]. The vital capacity after upper abdominal procedures remains depressed for at least 10-14 days. [2,4]There is a restrictive pattern with severely reduced inspiratory capacity (IC), vital capacity (VC), plus smaller but more important decrease in functional residual capacity (FRC) following abdominal surgery. [5,6] This suppression of pulmonary functions is more pronounced after open abdominal surgery than laparoscopic procedure. [7, 8,9,10.]

Rapid shallow breathing causes uneven ventilation of lungs.[11.] The rapid shallow breathing may lead to development of microatelectasis and if sustained for long enough it may be the starting mechanism for pulmonary inefficiency. [12] Due to decreased

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functional residual capacity (FRC) and altered relation of functional residual capacity (FRC) to closing capacity (CC), the alveolar- arterial PO2 difference is increased following upper abdominal surgery. This results in hypoxemia. [6,13]Post operatively forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1) is reduced. [7,8,10,14,15,16] .There is significant correlation between the atelectacic area and reduction in FEV1, FVC[15]and partial pressure of arterial oxygen. [15,16] These impairment of respiratory muscle functions after surgery may lead to postoperative pulmonary complications. The postoperative pulmonary complications increases the medical expenditure in terms of hospital stay as well as morbidity and mortality in post surgical patients[2,17]

K. Westwood et al in their study recognizes the importance of FEV1, FVC and PEFR and stated that these measurements can be employed to investigate the recovery of respiratory functions following abdominal surgery. [18]

The basic mechanism of postoperative pulmonary complications (PPC) is a lack of lung inflation that occurs due to shallow breathing, temporary diaphragm dysfunction, and prolonged recumbent position.[12] Mucocilliary clearance is also impaired postoperatively which along with the decreased cough effectiveness[19], increases the risk of postoperative pulmonary complications.

Pulmonary complications have been reported in 20% to 70% of patients undergoing upper abdominal and thoracic operations compared with a 2-5% incidence of pulmonary complications after urologic or orthopedic surgery. [20, 1, 6] The most frequent pulmonary complications are hypoxemia, atelectasis, aspiration of gastric contents, thromboembolism, pneumonia and respiratory failure. [2'21.]Despite the advancement in anesthesia and surgery the postoperative pulmonary complications are still a significant problem in modern practice.[22, 10]

The various physiotherapy techniques used to prevent and treat atelectasis are intermittent positive pressure breathing (IPPB), Continuous Positive Airway Pressure (CPAP), incentive spirometer (IS), chest physical therapy, deep breathing exercises. The incentive spirometer has been used prophylactically as well as for treatment of atelectasis in 95% of hospitals in America. [22] A respiratory maneuver of high alveolar inflating pressure applied for a long time, to achieve the maximum inspired volume can be used to prevent or treat atelectasis[23]. The incentive spirometer assures reproducible sustained maximal inspiration, is well accepted by patients, and records the frequency.

There are limited studies that have been done on clinical efficacy of incentive spirometers after upper abdominal surgery in Indian set up. With this background in mind,we planned present study to evaluate efficacy of Incentive spirometer in improving pulmonary functions after upper abdominal surgery.

Materials & Methods:

This was an experimental study. Sixty patients were selected through convenient sampling based on inclusion criteria and than put in to one of the two groups through randomisation. The patients having open surgical procedure of upper quadrant of abdomen or having surgical procedure via single upper or combined upper and lower midline abdominal incisions and of age 20-50 years were included in the study.

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The patients having history of pulmonary disease,smoking or having laproscopic procedure or combined thoracic incision or on ventilator support and non cooperative patients were not included in the study.

Instrumentation-

1) Incentive spirometer (fig. 4.1)

Flow oriented single ball incentive spirometer is used in the study.

2) Spirometer

Variables-

A) Independent variables

1) Incentive spirometer
2) Deep breathing exercises

B) Dependent variables

1) PEFR
2) FEV1
3) FEV6

Experimental hypothesis

Incentive spirometer would improve the pulmonary functions after upper abdominal surgery.

Null hypothesis

Incentive spirometer would not improve the pulmonary functions after upper abdominal surgery.

Procedure

Patients posted for open upper abdominal surgery were selected. The patients were assessed by standard assessment performa and patients who fulfilled inclusion and exclusion criteria were included in the study. Total number of 60 patients were selected.

Patients were divided in to two groups of Group1- Incentive spirometer group, Group 2- Deep breathing exercises group (Control group). There were 30 patients in each group. A brief description of procedure was given to patients was given according to their group. All queries are dealt with satisfactorily and written consent was obtained for participation in the study. Spirometric values of FEV1, FEV6 and PEFR are obtained one day before surgery, three days after surgery and five days after surgery.

Group1- Incentive spirometer group

The patient was given treatment in upright sitting position, [24,25,26]

Patients in Incentive spirometer group were given three supervised sessions of treatment. In one sessions of treatment patients were made to do 10 sustained maximal inspirations with 3 seconds hold through Incentive spirometer.

Patients were encouraged to use the incentive Spirometer 10 times during each waking hour.

Group 2- -Deep breathing exercises group (Control group) -

Patient in Deep breathing exercise group were (Control Group) taught deep breathing exercises preoperatively. Patients were encouraged to practice deep breaths with 3 seconds hold for 10 times during every waking hour after surgery.

Results & Data Analysis

Data and statistical analysis were performed by using SPSS 10 software. The significance level is set at $p \leq 0.05$.The test of paired sample t-test was used to analyze the data. The confidence limits were kept at 95%.Preoperatively patients in both groups are homogenous with respect to Age, height, weight & pulmonary function variables of PEFR, FEV1, FEV6 one day before surgery between the groups is insignificant.

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Table 6.1: Comparison of values of PEFR between incentive spirometer and deep breathing group, preoperatively, 3 days after surgery, 5 days after surgery.

Time	Group	Mean ± SD	t-value	P- value*
One day before surgery	Incentive spirometer group	344.667 ± 28.752	-0.742	**0.470**
	Deep breathing exercise group	352.000 ± 18.974		
Three days after surgery	Incentive spirometer group	214.667 ± 19.223	3.650	**0.003**
	Deep breathing exercise group	193.333 ± 11.127		
Five days after surgery	Incentive spirometer group	274 ± 23.845	3.309	**0.005**
	Deep breathing exercise group	246 ± 16.389		
*** Significant at P ≤ 0.05**				

The difference for values of PEFR one day before surgery between the groups is insignificant.

The difference for p-value of PEFR three days & five after surgery between the groups is significant.

Table 6.2: Comparison of values of FEV1 between incentive spirometer and deep breathing group preoperatively, 3 days and 5 days after surgery.

Time	Group	Mean ± SD	t-value	P-value*
One day before surgery	Incentive spirometer group	1.811 ± 0.159	-0.577	**0.573**
	Deep breathing exercise group	1.8480 ± 0.176		
Three days after surgery	Incentive spirometer group	1.187 ± 0.104	3.405	**0.004**
	Deep breathing exercise group	1.050 ± 0.108		
Five days after surgery	Incentive spirometer group	1.428 ± 0.129	3.853	**0.004**
	Deep breathing exercise group	1.267 ± 1.23		
*** Significant at P ≤ 0.05**				

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Table 6.3: Comparison of values of FEV6 between incentive spirometer and deep breathing group preoperatively, 3 days and 5 days after surgery.

Time	Group	Mean ± SD	t-value	P-value*
One day before surgery	Incentive spirometer group	2.292 ± 0.128	-0.266	**0.794**
	Deep breathing exercise group	2.305 ± 0.125		
Three days after surgery	Incentive spirometer group	1.428 ± 0.103	3.853	**0.002**
	Deep breathing exercise group	1.299 ± 0.110		
Five days after surgery	Incentive spirometer group	1.691 ± 0.101	3.912	**0.002**
	Deep breathing exercise group	1.559 ± 1.03		
*** Significant at P ≤ 0.05**				

The difference for values of FEV6 one day before surgery between the groups is insignificant.
The difference for values of FEV6 three & five after surgery between the groups is significant.

Discussion:

There is significant difference for the values of PEFR, FEV1, FEV6 three & five days after surgery in patients of incentive spirometer & Deep Breathing Exercise groups. The incentive spirometer group shows better improvement.

These findings of our study are consistent with various previous studies in foreign setup by. Minchaert et al 27, RH Barlet e t a1971 28, MI Gold et al 29, K.Westwood et al 18, which confirms the role of incentive spirometer in prevention of post operative pulmonary complications abdominal surgeries. So the results of our study are supported by previous studies.

There may be the many reasons for better pulmonary functions in incentive spirometer group. The patients in incentive spirometer group were supervised by physiotherapist which may be the major factor of increasing pulmonary volumes, by maintaining accuracy of doing exercise with incentive spirometer, as well as patient's interest and compliance to treatment.

Conclusion:

The result of this study shows the efficacy of incentive spirometer in improving pulmonary functions after upper abdominal surgery.

Our suggestion is that incentive Spiro meter should be assigned routinely to upper abdominal surgery patients under the supervision of physiotherapist.

Limitation of study-

Only three aspects of pulmonary functions PEFR, FEV1, FEV6, are taken in this study.

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List of Abbreviations

DBEX - Deep breathing exercises

FEV1 - Forced Expiratory Volume in I Second

FEV6 - Forced Expiratory Volume in 6 Second

IS - Incentive Spirometer

PEFR - Peak Expiratory Flow Rate

PFT - Pulmonary function test

PPC - Post operative pulmonary complications

References:

1. N.M. Siafakas,I Mitrouska, D Bouros, D Georgopoulos el al 'Surgery and respiratory muscles' Thorax 1999; 54:458-465

2. Dr. Jane Braverman, Post-operative pulmonary complications in the adult patients- causes effects and therapeutic strategies .Business briefing global surgery 2004.

3. Ford GT, Whitelaw WA, Rosenan TW, Cruse PJ, Guenter CA et al ,Diaphragm function after upper abdominal surgery in humans.American Review Respire Dis1983 Apr;127(4):431-6.

4. B.Dureuil, J.P Cantineau, J.M. Desmonts et al, Effects of upper or lower abdominal surgery on diapragmmatic functionDepartment of anaesthesia,Hospial Bichat 46,Paris

5. Craig et al 'Postoperative recovery of pulmonary function'. Anaesthesia and analgesia Vol 60, No.1, January 1981

6. RW Wahba et al Perioperative functional residual capacity Canadian journal of anaesthesia, Vol 38, 384-400

7. Putensen C, Lammer H, Aigner F, Benzer H et al 'Comparision of postoperative respiratory function after laproscopy or open laprotomy' Anaesthesiology,1992 oct;77(4):675-80

8. M. Ravimohan, S Kaman Lileswar, Jindal Ravul, Jindal SK, Singh Rajinder Postoperative pulmonary function in laparoscopic versus open cholecystectomy Indian journal of gastroenterology,yr 2005, vol 24,issue 1,page 6-89.

9. W. Schwenk, Jochan M Muller et al Pulmonary functions following laparoscopic or conventional colorectal resection. Arch surg 1999; 134:6-12

10. E.Crema, A.G.Benelli et al Assessment of pulmonary functions before and after laparoscopic and open esophagogastric surgery. Springer New York, volume19, Number 1, Jan 2005

11. J.S Haldane, J.C. Meakins, J. Priestley et al The effects of shallow breathing. J Physiol 1919; 52:433-453.

12. B.A Zikria, J.L.Spencer, J.M.Kinney et al 'Alteration in ventilatory function and breathing pattern following surgical trauma' Annals of surgery, vol 179, January 1974

13. J.L.Alexander, A.A.Spence, R.K.Parikh, B.Stuart et al, "The role of airway closure in postoperative hypoxemia" Brit.j.Anaesth (1973), 45, 34

14. R C Frazee, J.W Roberts, G.C Okenson et al "Open versus laparoscopic cholecystectomy. A comparison of postoperative pulmonary functions".Ann Surg. 1991 June; 213(6): 651-654

15. Ronald G. Latimer MD, Gunn CPT, et al Ventilatory patterns and pulmonary complications after upper abdominal surgery determined by preoperative and postoperative computerized spirometry and blood gas analysis. The American journal of surgery volume122 Issue 5, November 1971, Pages 622-632.

16. Lindberg P et al 1992 Atelectasis and lung function in the postoperative period Acta anaesthesiol Scand 1992 Aug; 36(6):546-53

17. Lawrence VA et al 'Incidence and hospital stay for cardiac and pulmonary complications after abdominal surgery' J Gen Intern. Medicine.1995 Dec; 10(12):671-8

18. K. Westwood et al, , "Incentive spirometry decreases respiratory complications following major abdominal surgery", Journal of Royal College of Surgeons of Edinburgh & Ireland. December 2007 Vol 5 No 6

19. Gamsu G.et al 'Postoperative impairment of mucous transport in the lung.' American Review Respire Dis 1976 Oct; 114(4):673-9.

20. Ramona L.Doyle, "Assessing and Modifying the Risk of Postoperative Pulmonary Complications". Chest 1999; 115; 77-8

21. Alan K et al 'Pulmonary complications of general surgery'Ann. Rev. Med. 1977. 28:211-21

22. WJ O Donohue et al 1985 'National survey on usage of lung expansion modalities for prevention and treatment of postoperative atelectasis following abdominal and thoracic surgery' Chest 1985; 87; 76-80

23. RH Bartlett, P Krop, EL Hanson, FD Moore ,Physiology of yawning and its application to postoperative care. Surgical Forum 1970; 21; 222-223.

24. Gale GD, Sanders DE. et al 'The Bariett-Edwards incentive spirometer; a Preliminary assessment of its use in prevention of atelectasis after cardiopulmonary Bypass 'Can Anaesth Soc j.1977may;24(3):408-16

25. Beatrice Tucker et al'The effect of breathing exercises with body positioning on regional lung ventilation' AJP 42:219-227

26. W. S. Druz et al' Activity of respiratory muscles in upright and recumbent humans' Journal of Applied Physiology, Vol 51, Issue 6 1552-1561

27.Minschaert M. et al 'Influence of incentive spirometry on pulmonary volumes after laprotomy'Acta Anaesthesiol Belg.1982; 33(3):203-9

28. RH Bartlett, T Gerathy, and AB Gazzaniga'the yawn maneuver: prevention and treatment of postoperative pulmonary complications. Surgical Forum 1971; 22; 196-198

29. S Dohi and MI Gold et al "Comparison of two methods of postoperative respiratory care" Chest 1978:73:592-595

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