Nigerian Journal of Clinical Practice,
December 2001 Vol. 4 (2); 91–95

EFFECTS OF BREATHING EXERCISE TRAINING ON SELECTED PULMONARY INDICES IN POST-ABDOMINAL SURGERY PATIENTS

A. O. Sanya, A. O. Akinremi
Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria

SUMMARY

This study investigated the effects of pre and post-operative breathing exercise training on the vital capacity and peak expiratory flow rate of upper and lower abdominal surgery patients. 55 male and female volunteer abdominal surgery patients were recruited for this study as they became available. The patients were divided into 4 groups. Groups I comprised 16 elective lower abdominal surgery patients. Group II had 17 elective lower abdominal surgery patients, Group III comprised 10 emergency upper abdominal surgery patients and Group IV had 12 emergency lower abdominal surgery patients. The breathing exercise training programme included: Apical; lateral-costal; postero-basal and diaphragmatic breathing exercises. The elective abdominal surgery patients received exercise training for two days pre-surgery and for six days post surgery, while the emergency abdominal surgery patients received the training for six days post operation only. Vital capacity and peak expiratory flow rates were measured daily after each exercise training session.

The data obtained were analyzed using descriptive statistics of mean and standard deviation, inferential statistics of student's t-test and one way ANOVA at 0.05 alpha level. The analysis showed a significant difference in the pre-and post-training vital capacity and peak expiratory flow rate for each of the four groups ($p<0.05$). The elective abdominal surgery group had significantly higher post-training vital capacity and peak expiratory flow rate than the emergency abdominal surgery groups ($P<0.05$). The study concluded that breathing exercise training improved vital capacity and peak expiratory flow rate of the abdominal surgery patients. It was therefore recommended that breathing exercise training should be carried out on abdominal surgery patients and post-surgical operation.

KEYWORDS: ***Abdominal Surgery, Breathing Exercise, Pulmonary Indices.***

INTRODUCTION

The respiratory system, comprising the air passages and lung tissues, may be divided into an upper and a lower tract. The upper respiratory tract comprises of the nasal passages, the pharynx, the larynx and the upper part of the trachea. The lower respiratory tract comprises of the lower part of the trachea, the bronchial and the alveoli[1]. The extent to which the lungs can be inflated is affected by the muscles responsible for the three dimensional increase in lung volume. During quiet breathing, the expiratory phase is passive, but the abdominal muscles contract thus contributing to active expiration when needed. The contraction of the abdominal muscles increases the intra-abdominal pressure by lowering the ribs and flattening the abdomen, thereby pushing the diaphragm upward to achieve a better expiration. The abdominal muscles also help accelerate the expiratory flow rate and to decrease the end-expiratory lung volume by moving the diaphragm further upward into the thorax than would occur if expiration were entirely passive. This action of the abdominal muscles also enhances the inspiratory phase of ventilation[2].

The efficacy of the lung performance can be assessed by conducting pulmonary function tests of pulmonary ventilation volumes and capacities. Such tests measure one or more of the respiratory functions[3]. In the practice of respiratory medicine, the common tests of choice include vital capacity (VC) and forced expiratory volume in one second (FEV_1). These provide overall assessment of the function of the lungs. They also permit the identification of ventilatory defect and indicate if such a defect is due to restriction to the lung movement or due to air way obstruction[3]. It has been established that the most useful basic function test involves standard respiratory maneuvers such as forced vital capacity and peak expiratory flow rate, which are not part of the normal breathing process but gives useful clinical information about the integrity of the lung function and properties[4].

The administration of anaesthetic agents for surgery results in the triad effects of unconsciousness, muscle relaxation and analgesia. The activity of the respiratory muscles is impaired due to the block in the neuro-transmission process. The block causes the relaxation of the respiratory muscles, especially the diaphragm which assumes the relaxed dome shape[5]. Anaesthesia and surgery, particularly abdominal and thoracic surgery are usually associated with a reduction in Functional Residual capacity (FRC) and vital capacity (VC) after abdominal surgery; FRC may fall to about

*Correspondence: Dr. A. O. Sanya

70% of its pre-operation level and may remain repressed for several days[5]. Pain emanating from the effect of surgical incision also results in ventilatory depression due to fear of more pain. The pulmonary function in abdominal surgery patients is such that the closer the incision is to diaphragm, the higher the tendency of alteration in pulmonary mechanism, the lung volumes and capacities.

The thoracic cage movement is not unconnected with the contraction of the fibers of the diaphragm when the central tendon is fixed[6]. Breathing exercise actively exerts the ventilatory muscles; and through the recruitment of more units increase the strength of the ventilatory muscles. The increase in the strength of the abdominal muscles in turn enhances ventilatory activity.

Contraction of the abdominal muscles depresses the lower ribs and flattens the abdomen thereby pushing the abdominal contents upward. This indirectly pushes the diaphragm more into the thorax. Improved abdominal muscle strength can be used to achieve maximum lung emptying.

This study was therefore designed to evaluate the effect of breathing exercise training on some respiratory function indices of abdominal surgery patients.

MATERIALS AND METHODS

Materials

Subjects: A total of 55 volunteer adult abdominal surgery patients from the surgical and obstetrics and gynaecology wards of the University College Hospital (UCH)., Ibadan participated in this study. They were recruited over a period of three months as they become available and were grouped into four as follows: Group 1 consisted of 16 elective upper abdominal surgery patient; Groups II had 17 elective lower abdominal surgery patients while group III consisted of 10 emergency upper abdominal surgery patients and Group IV had 12 emergency lower abdominal surgery patients. None of the patients in this study had respiratory disorder or any condition for which deep breathing exercises were contraindicated.

Instruments: A portable simple spirometer was used to measured the vital capacity of the patients in milliliters while a portable peak flow meter was used to measure the peak expiratory flow rate of the patients in litres per minutes (L/min).

Methods

Informed consent was sought and obtained from the patients. The ethical approval was sought and obtained from the Joint Ethical Committee of the University of Ibadan and University College Hospital, Ibadan before commencing the study. Age of the patient as at last birthday was recorded. Procedures for the pulmonary function tests and breathing exercise training were explained and demonstrated to the patients during the first visit to enable them understand and master the techniques.

The training and measurements for the elective abdominal surgery patients; (i.e. groups I and II,) commenced two days before surgery and continued from the first day post-surgery through the sixth day post operation. For emergency abdominal surgery patients, (i.e groups III and IV), breathing exercise training started from first day after surgery and continued through the sixth day post-operation. The vital capacity and peak expiratory flow rate of each patient was measured daily after the training session.

Vital Capacity

The vital capacity measurement was taken with the patient assuming the full support sitting position. This was to allow maximum relaxation of the patient. The patient was instructed to clamp his lips tightly around the mouthpiece of the spirometer and then take a deep breath in through the nose and then blow out as much as possible through the mouthpiece into the spirometer. The spirometer manoeuvres were performed thrice and the highest of the three values was recorded in litres[7].

Peak Expiratory Flow Rate

For the expiratory flow rate measurement, the patient assumed full-support sitting position with the lips tight clamped round the mouthpiece of the peak flow meter to prevent leakage of air from the sides of the mouthpiece. The patient was instructed to inhale maximally, then to blow out quickly and forcefully into peak flow meter. The highest of the three trials was recorded in litres per minutes[7].

Breathing Exercise Training

The patient was in a crook Iying position and adequately supported for the breathing exercise training. The relationship between the thoracic and abdominal airflow was explained to the patients to enable them concentrate on the desired movement pattern.

For the apical expansion breathing training, both hands of the researcher were placed in the upper part of the thoracic wall, just below the clavicle. The patient was instructed to breathe in and expand the chest upward against the pressure of the researcher's hand. Full inspiration was held for a moment before the patient exhaled slowly through the mouth.

For the lateral costal expansion technique, the researcher's hands were placed on the midaxillary line over the lower ribs of the patient. The patient then exhaled, allowing the lower ribs to sink down and in . This movement was performed slowly and gently. For the posterior-basal expansion training firm pressure was applied against the chest while the patient inhaled maximally concentrating on the expansion of the lower ribs against the resistance offered by the researcher's hand . The pressure was released at the end of the inspiration but the researcher still maintained palm contact with the patient's chest. Pressure was re-applied when patient was ready to breathe-in again thus concentrating on one phase of breathing at a time while trying to stimulate increased ventilation after abdominal and thoracic surgery.

In the case of diaphragmatic training, the patient was still in crook-lying position and the resistance of the researcher's hand on the patient's abdomen. The patient then concentrated on gentle expansion of the anterior abdominal wall. The patient was instructed to exhale slowly through the mouth. Emphasis was laid on gentle breathing with minimum effort[8].

DATA ANALYSIS

Data collected was analysed using descriptive statistics of mean and standard deviation. Inferential statistics of paired t-test was used to compare the pre-and post-training vital capacity and peak expiratory flow rate between:

(i) Elective upper and lower abdominal surgery patients;
(ii) Emergency upper and lower abdominal surgery patients;
(iii) Elective upper and emergency upper abdominal surgery patients;
(iv) Elective lower and emergency lower abdominal surgery patients.

The one-way analysis of variance (ANOVA) was used to compare vital capacity and peak expiratory flow rate across the four groups for any significant difference. The level of significance was set at 0.05.

RESULTS

A total of 55 adult post abdominal surgery patients who satisfied the inclusion criteria took part in this study. The patients were made up of 26 post upper abdominal surgery patients and 29 post lower abdominal surgery patients. The upper abdominal surgery patients consisted of 14 males and 15 females.

Table 1: **Classification of Subjects into various Abdominal Surgery Groups**

	Male	Female	Total
Group I	9	7	16
Group II	7	10	17
Group III	6	4	10
Group IV	7	5	12

Key
Group I *Elective Upper Abdominal Surgery*
Group 11 *Elective Lower Abdominal Surgery*
Group III *Emergency Upper Abdominal Surgery*
Group IV *Emergency Lower Abdominal surgery*

Table 4: **Post-Training Respiratory Indices of Elective Upper & Lower Abdominal Surgery Patient**

	VC (litre) X± S.D	PEFR (litre/minute) X± S.D
Group 1 (n=16)	2.83± 0.24	382.50± 26.20
Group 11 (n=17)	2.83± 0.35	418.24± 47.86
t-level	0.42	2.64
P-value	D>0.05	P<0.05

Key
Group I *Elective Upper Abdominal Surgery*
Group 1I *Elective Lower Abdominal Surgery*

Table 1 shows the number of subjects in the various classifications for abdominal surgery. Table 2 shows the age and vital signs of patients studied in this work. Table 3 shows the pre- and post-training vital capacity and peak expiratory flow rate for the four groups. A statistically significant difference was noted between the pre- and post-training respiratory indices. Table 4 shows the mean post-training vital capacity and peak expiratory flow rate of elective upper and lower abdominal surgery patients. The mean vital capacity for the elective abdominal surgery was higher but there was no statistically significant difference in the vital capacity of the two groups (p>0.05). A significant difference between the post-training expiratory flow rate of the two groups was observed (p<0.05). The

Table 5: **Post-Training Respiratory Indices of Emergency Upper and Lower Abdominal Surgery Patients**

	VC(litre) X+ S.D.	PEFR (litre/min) X±S.D.
Group III (n=10)	2.23±0.31	296.0±47.66
Group IV (n=12)	2.53±0.26	393.33±37.50
t-level	2.48	5.37
P-value	P<0.05	P<0.05

Key
Group 111 *Emergency Upper Abdominal Surgery*
Group IV *Emergency Lower Abdominal Surgery*

Table 6: **Post-Training Respiratory Indices of Elective and Emergency Abdominal Surgery Groups**

	VC (litre) X±S.D.	PEFR (litre/min) X±S.D.
Group I (n=16)	2.83±0.23	382.50±26.20
Group III (n=10)	2.83±0.35	296.00±47.66
t-level	5.63	6.00
P-value	P<0.05	P<0.05
Group II (n=17)	2.23±0.31	418.24±47.86
Group IV	2.53±0.25	393.33±37.50
t-level	2.46	1.50
P-value	P<0.05	P>0.05

Key
Group I *Elective Upper Abdominal Surgery*
Group 1I *Elective Lower Abdominal Surgery*
Group 111 *Emergency Upper Abdominal Surgery*
Group IV *Emergency Lower Abdominal Surgery*

Table 2: **Age and Resting Vital Signs of Patients Before Commencement of the Breathing Exercise Training**

	AGE X±S.D.	P.R.(heat/min) X+S.D.	R.R.(/min) X±S.D.	S.B.P.(mmHg) X±S.D	D.B.P. (moHg) X±S.D.
Group 1 (n=16)	39.6±9.8	71.3±6.1	2S.1±3.0	121.3±8.0	83.8±6.2
Group II (n=17)	38.2±10.1	72.5±3.1	23.2±3.9	120.6±8.3	81.8±7.3
Group III (n=10)	34.2±10.1	80.8±8.7	25.6±3.7	130.5±6.9	80.0±6.7
Group IV (n=12)	39.8±9.0	80.0±8.7	24.2±3.0	122.5±9.7	81.7±8.3

Key

R.R. Respiratory Rate
P..R. Pulse Rate
D.B.P. Diastolic Blood Pressure
S.B.P. Systolic Blood Pressure

Group I — *Elective Upper Abdominal Surgery*
Group II — *Elective Lower Abdominal Surgery*
Group 111 — *Emergency Upper Abdominal Surgery*
Group IV — *Emergency Lower Abdominal Surgery*

Table 3: **Pre- and Post-Training Vital Capacity (VC) And Peak Expiratory Flow Rate** (c/min)

		Pre-training X+ S.D.	Post-training X+ S.D.	t-value	p-level
Group I	VC (litres)	0.806± 0.18	2.83± 0.,23	56.67	0.05
(n=16)	PEFR(ltr/min)	151.88± 29.49	382.50± 26.20	37.47	0.05
Group II	VC (litres)	0.97± 0.23	2.83± 0.35	40.92	0.05
(n=17)	PEFR(ltr/min)	191.18± 24.47	18.24± 47.86	27.49	0.05
Group III	VC (litres)	0.44± 0.18	2.23± 0.31	25.93	0.05
(n=10)	PEFR(ltr/min)	99.00± 12.87	2.96± 47.66	15.68	005
Group IV	VC (litres)	0.89± 0.21	2.53± 0.26	23.16	0.05
(n=12)	PEFR(ltr/min)	132.50± 34.94	393.33± 37.20	37.20	0.05

Key

Group I — *Elective Upper Abdominal Surgery*
Group II — *Elective Lower Abdominal Surgery*
Group III — *Emergency Upper Abdominal Surgery*

post-training respiratory indices of emergency, upper and lower abdominal surgery patients are shown in table 5. A significant difference was observed in the vital capacity of the two groups (P<0.05). Similarly, there was a significant difference in the peak expiratory flow rate of emergency upper and emergency lower abdominal surgery groups. As shown in Table 6, there was a also significant difference in vital capacity of emergency lower and elective lower abdominal surgery groups. The peak expiratory flow rate of elective upper and emergency upper abdominal surgery groups was significantly different (P<0.05) but there was no statistically significant difference in the peak expiratory flow rate of elective lower and emergency lower abdominal surgery groups (P>0.05).

DISCUSSION

The resting blood pressure of patients who participated in this study was within the range considered to be for normotensive individuals. This implies that the clinical conditions for which surgery was indicated in the patients did not cause significant increases in their blood pressure as well as the pulse and respiratory rates.

The statistically significant difference in vital capacity and peak expiratory flow rate pre and post- breathing exercise training in all the groups implies that breathing exercise training improved the pulmonary function of the patients. This observation can be explained by the fact that breathing exercises actively exert the ventilatory muscles, thereby increasing the strength of the ventilatory muscles through motor units recruitment. Increase in strength of abdominal muscles enhances their ventilatory activity.

There was statistically significant difference in the peak expiratory flow rate of the elective upper and lower abdominal surgery patients in this study. The elective lower abdominal surgery patients had significantly higher peak expiratory flow rate than the elective abdominal surgery patients. Peak expiratory flow rate requires a sudden and forceful expiration brought about by strong contraction of the upper portion of the abdominal muscle group. The closer the incision site is to the diaphragm, the higher the tendency to alteration in pulmonary mechanism due to pain accompanying incision which reduces the contraction of the muscle group[5,8].

There was no significant difference between the post-training vital capacity of the elective upper and lower abdominal surgery patients. This can be explained by the fact that vital capacity only requires as near lungful inspiration as possible. It is brought about largely by diaphragmatic movement. In the emergency upper and lower abdominal surgery patients, there was significant difference in both vital capacity and peak expiratory flow rate. However, there was significantly higher mean value obtained for peak expiratory rate than the vital capacity.

This implies that irrespective of location of incision in the emergency abdominal surgery patients, there was significant difference in their peak expiratory flow rate and vital capacity.

A comparison of post-surgery pulmonary function of the elective and emergency upper abdominal surgery patients showed that the elective upper abdominal patients had a significantly higher vital capacity and peak expiratory flow rate than the emergency upper abdominal surgery patients. This may be explained by the fact that elective upper abdominal surgery patients received breathing exercise training before surgery. It has been reported that breathing exercise is the most effective prophylactic regimen against respiratory complications after surgery. Breathing exercise also supplement post - operative function[9].

Vital capacity showed a significantly higher value for emergency lower abdominal surgery patients than emergency upper abdominal surgery patients, while no significant difference was observed in the peak expiratory flow rate of the emergency and elective lower abdominal surgery patients. This may be due to the fact the lower abdominal muscles have a minimal effect on the respiratory function as reported by previous studies which indicate that respiratory function is more affected in upper abdominal surgery than in lower abdominal surgery[5,8].

CONCLUSIONS AND RECOMMENDATION

This study concludes that:

a. Breathing exercises training increase the vital capacity and peak expiratory flow rate of abdominal surgery patients.
b. Pre-surgery breathing exercises training enhanced the vital capacity and peak expiratory flow rate of the abdominal surgery patients after the operation.
c. Lower abdominal surgery patients had significantly higher improvement in vital capacity and peak expiratory flow rate than the upper abdominal surgery patients.

This study therefore recommends that pre-and post-operative breathing exercise training should be carried out routinely on abdominal surgery patients, especially the elective surgery patients.

REFERENCES

1. **Thompson A. Skinner A. Piercy J.** Tidy 's Physiotherapv. 1 2th ed. Oxford, Butterworth-Heinemann; 1991.

2. **Slonium NB. Hamilton LH.** Respiratory physiology ~ 4th ed. Philadelphia, C.V Mosby Company; 1994.

3. **Laszo L.** Pulmonary fuction. Cambridge, Cambridge University Press; 1994.

4. **Taylor CA. Render K. Hyatt RA., Parker JC.** Clinical Respiratorv Phvsiolo~v Toronto, W.B. Saunder Company; 1989.

5. **Cashman. JN.** Anaesthesia and Intensive Care. London, Edward Arnold; 1991.

6. **Casciari RJ. Faishter RO. Harrison A.** Effect of breathing retraining in patients with chronic obstructive pulmonary diseases. Chest; 79, 393-398. 1981.

7. **Braun SR. Knight L. Siddiqui KA.** Pulmonary function tests. In Braun S.R., Everrett E.D., Perry M.D (eds) Textbook of Pulmonarv Medicine New York, Elservier Sciences Publishing, 1989.

8. **Rezeignia S. Jayr G.** Prevention of respiratory complication after abdominal surgery. Annales Francaises d ' Anaesthesia et de reanimation; 15(5) 623–46. 1996.

9. **Mc Mahin AJ. Russell LT. Ramsay G. Sunderland H. et al.** Laparoscopic and minilaparatopmy cholecystechtomy in a randomised trial campaign post-operative pain and pulmonary function. Surgerv. 115 (5) 533–39. 1994.