Effect of Incentive Spirometry Versus Non Invasive Intermittent Positive Pressure Breathing After Mitral Valve Replacement on Blood Gases

Zeinab M. Helmy*, Ali Hassan Taher**
* Department of Cardiovascular Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University.
** National Heart Institute.

ABSTRACT

The aim of this study was to investigate the effect of incentive spirometery (IS) and noninvasive intermittent positive pressure breathing (IPPB) on arterial blood gases post mitral valve replacement. Also to compare between the effect of I.S and non invasive IPPB on arterial blood gases post mitral valve replacement in the intensive care unit. Forty patients who had been operated on for mitral valve replacement participated in this study and divided into two equal groups. First group received incentive spirometery and the second group received non-invasive intermittent positive pressure breathing. Partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), and H^+ ion concentration (pH) were recorded at different time intervals. Significant improvement of PaO_2 had been shown two hours after treatment in IS group and non significant improvement of PaO_2 had been shown two hours after treatment in IPPB group. Comparison between two groups showed that non of the two modalities is superior to the other.

Keywords: *Incentive spirometry, non invasive intermittent positive pressure breathing, mitral valve replacement.*

INTRODUCTION

Mitral valve replacement is an open heart procedure that can be done by using mechanical valves or bioprothetic valves[3]. Mitral valve replacement is indicated in about 20-30% of cases as an initial operation in patients with mitral stenosis. It is generally performed when mitral valvotomy has been failed to control the patient's symptoms.

Also it is indicated as an initial operation in patients with significant mitral regurgitation, especially in older patients with calcified valves. Until recently, mitral valve replacement was the treatment of choice in almost all cases of mitral incompetence[6]. It is will know that the recovery from major surgeries especially open heart surgeries is mainly affected by postoperative pulmonary complications (PPCs) e.g. atelectasis, pneumonia, or pulmonary dysfunction which remain the major causes of postoperative morbidity and mortality[22]. On the other hand, patients with long standing mitral valve disease will develop pulmonary congestion and pulmonary hypertension and thus interstitial pulmonary edema which lead to reduced compliance of the lung and reduced vital capacity and increased exposure to chest infection. These pathophysiological changes may aggravate postoperative pulmonary complications[4,16], therefore the oxygen transport systems mainly the lung in those patients were the most threatening target. Chest physiotherapy has long been an established mode of treatment for pulmonary complications after cardiac surgery. However, despite research in the field for nearly forty years, controversy still exists over the best

method of respiratory prophylaxis. The diverse conclusions of many studies which investigated the efficacy of chest physiotherapy have led to much confusion over which modalities should be used or whether physiotherapy is necessary at all in certain patient groups[5,8,15,22,25,26,33]. Therefore this study has been an attempt to compare the effectiveness of the clinical application of I.S and NIPPB in the intensive care unit, second post operative day.

MATERIALS AND METHODS

Subjects

Forty patients (19 males and 21 females) with mitral valve replacement through median sternotomy were recruited from the Surgical Department at the National Heart Institute. Their ages ranged between 20-30 years with a mean value 26.2 ± 2.77 years. The initial medical and laboratory data of each participant were obtained to ensure that non had previous conditions that interfere with the results. They were divided randomly into two equal groups: according to the modality, where group I received incentive spirometry (I.S) and group II received intermittent positive pressure breathing (IPPB). Patients who had developed hemodynamic complications (e.g. intra-operative myocardial infarction, using pacemaker, extraordinary use of medications and those who had been intubated longer than 24 hours). Also patients with preoperative chest disease, obesity, diabetes mellitus and pulmonary hypertension were withdrawn from this study.

Procedures of the study

Two days pre-operatively, all patients were instructed about the post operative treatment program (incentive spirometry and intermittent positive pressure breathing) and other traditional chest physical therapy modalities including (deep breathing exercises – cough mechanism – bed mobility and ambulation). The aims of the pre operative meeting were to make the patients acquainted with therapeutic procedures to gain high level of cooperation and performance and to be informed about the risk of pulmonary complications after open heart surgeries in addition to chest physical as preventive treatment. Post-operative physical therapy program was started once the patient had been extubated from mechanical ventilation and hemodynamically stable for blood pressure, respiratory rate, and heart rate at the second post operative day in the intensive care unit. The patient, who received incentive spirometry (Group I) was in the long sitting position and was instructed to use the incentive spirometry (DHD, Cliniflo., Medimark) as the patient had learned in the pre-operative meeting. the patient was instructed to inhale slowly and as deep as possible through the mouth piece of the I.S device, for five to ten times slow maximal inspiratory maneuver over fifteen minutes with the volumetric incentive spirometry which represent about 70 percent of the pre-operative deep breathing that he can take[15]. During treatment the patient was connected to oxygen nasal cannula. The patient was in half lying position. During the application of intermittent positive pressure breathing (IPPB., Respi Care Drager London), the unit was connected to the oxygen adaptor that provide oxygen supply according to the following criteria, peak inspiratory airway pressure equals 15 cm H2O to provide a sufficient widening of the thoracic cage diameter, the duration of application was 15 minutes, percentage of inspiratory phase equals 20%, the tube of IPPB was connected to the face mask and finally the unit was set to activate the alarm after fifteen minutes of

treatment period[23]. Through out the two hours of the study in the intensive care unit, all patients were under close observation for the need of other conventional chest physical therapy modalities (deep breathing, percussion). Those who needed additional interventions were excluded from the study. The blood sample was drawn through the radial artery cannula for blood gases analysis using acid-base analyzer (ABL, radiometer, Copenhagen).

Data Collection and analysis

Blood sample was analysis for PaO_2, Pa CO_2, bicarbonate ($HCO_{3)}$ and pH, before application and immediately, half an hour and two hours after session of I.S or IPPB session. These data were expressed as mean ± standard deviation. Paired t-test has been utilized to compare and identify the changes that took place in each group of the study within different reading times for blood gases. The threshold of significance was fixed at 0.05 level.

RESULTS

This study comprised forty patients (19 males and 21 females) who had been operated upon for mitral valve replacement through median sternotomy. Those patients were divided into two groups: Group (I): consisted of twenty patients received incentive spirometry. Group (II): consisted of twenty patients received non invasive intermittent positive pressure breathing.

Results of IS group

As shown in table (1) the mean values of PaO2 (immediately before session, immediately after, half an hour after, two hours after session) in ICU for this group were (172.97 ± 73.22 mmHg, 139.24 ± 59.86 mmHg, 175.09 ± 74.46 mmHg, 197.56 ± 79.72 mmHg) respectively. The mean values of PaCO2 (immediately before session, immediately after, half an hour after, two hours after session) in ICU for this group were (40.09 ± 5.94 mmHg, 40.31 ± 6.69 mmHg, 40.98 ± 7.19 mmHg, 39.72 ± 6.02 mmHg) respectively. The mean values of pH (immediately before session, immediately after, half an hour after, two hours after session) in ICU for this group were (7.43 ± 0.039, 7.42 ± 0.043, 7.42 ± 0.051, 7.42 ± 0.045) respectively. Table (2) showed that the mean difference between immediately before session and immediately after session records was 33.73 ± 29.16 mm/Hg. This indicated a significant decrease of PaO_2, $P < 0.05$. On the other hand, the mean difference between before session and half an hour after session records were -2.125 ± 34.90 mm/Hg with a non significant increase of PaO_2, $P > 0.05$. The mean difference between before session and two hours after session records were -24.59 ± 36.37mm/Hg with a significant increase of PaO_2.

Table (1): Shows mean, standard deviation of the different measured variables in I.S group.

	Before session	**Immediately after session**	**After 1/2 hour**	**After 2 hours**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
PaO_2 mm/Hg	172.97 ± 73.22	↓139.24 ±59.86	↑175.09 ± 74.46	↑197.56 ± 79.72
$PaCO_2$ mm/Hg	40.09 ± 5.94	↑40.31± 6.69	↑40.98 ± 7.19	↓39.72 ± 6.02
pH	7.43 ± 0.039	7.42 ± 0.043	7.42 ± 0.051	7.42 ± 0.045

The mean difference of $PaCO_2$ between immediately before session and immediately after session records was -0.2200 ± 4.758 mm/Hg as observed in table (2) with a non significant increase, P > 0.05. The mean difference between immediately before session and half an hour after session records was -0.8900 ± 5.235 mm/Hg with also a non significant increase of $PaCo_2$ mm/Hg, P > 0.05. The mean difference between immediately before session and two hours after session records was 0.3650 ± 4.679 mm/Hg with a non significant decrease, P > 0.05.

Table (2): Statistical evaluation and level of significance of the changes occur in mean values of blood gases in I.S group.

Time of evaluation	Variable	Mean ± SD	t-value	P-value
Immediately after session	PaO_2	↓ 33.37 ± 29.16	5.173	0.001
After half an hour		↑-2.125 ± 34.90	-0.272	0.788
Two hours after session		↑-24.59 ± 36.37	-3.024	0.007
Immediately after session	$PaCO_2$	↑-0.2200 ± 4.758	-0.207	0.838
After half an hour		↑-0.8900 ± 5.235	-0.760	0.456
Two hours after session		↓ 0.3650 ± 4.679	0.349	0.731
Immediately after session	pH	0.0021 ± 0.0463	0.203	0.841
After half an hour		0.00175 ± 0.0564	0.139	0.891
Two hours after session		0.00275 ± 0.044	0.279	0.783

As shown in table (2) the mean difference of pH between immediately before session and immediately after session records was 0.0021 ± 0.0463. The mean difference between immediately before session records and after half an hour of session records was 0.00175 ± 0.0564. The mean difference between before session and two hours after session records was 0.00275 ± 0.044. All these data obtained showed that there was a non-significant change of pH values (immediately after, half an hour and two hours) after session.

Table (3): Mean, standard deviation of the different measured variable in IPPB group.

	Before session	Immediately after session	After 1/2 hour	After 2 hours
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
PaO_2 mm/Hg	195.33 ± 59.78	164.34 ± 50.18	200.52 ± 67.49	206.01 ± 53.42
$PaCO_2$ mm/Hg	39.29 ± 5.77	39.14 ± 5.85	39.75 ± 5.24	39.28 ± 4.12
Ph	7.43 ± 0.042	7.43 ± 0.035	7.43 ± 0.036	7.42 ± 0.038

Results of IPPB group

The mean values of PaO2 immediately before session, immediately after session, half an hour after session and two hours after session in ICU for IPPB group were (195.33 ± 59.78 mm/Hg, 164.34 ± 50.18 mm/Hg, 200.52 ± 67.49 mm/Hg and 206.01 ± 53.42 mm/Hg.) respectively as represented in table (3). The mean values of PaCO2 immediately before session, immediately after session, half an hour after session and two hours after session in ICU for this group were (39.29 ± 5.77 mm/Hg, 39.14 ± 5.85 mm/Hg, 39.75 ± 5.24 mm/Hg and 39.28 ± 4.12 mm/Hg.) respectively. The mean values of pH immediately before session, immediately after

session, half an hour after session and two hours after session in ICU for this group were (7.43 ± 0.042, 7.43 ± 0.035, 7.43 ± 0.036 and 7.42 ± 0.038) respectively.

Table (4): Statistical evaluation and level of significance of the changes occur in mean values of blood gases in IPPB group.

Time of evaluation	Variable	Mean ± SD	t-value	P-value
Immediately after session	PaO_2	30.99 ± 28.104	4.93	0.001
After half an hour		-5.19 ± 37.22	-0.623	0.540
Two hours after session		-10.685 ± 31.869	-1.499	0.150
Immediately after session	$PaCO_2$	0.1500 ± 3.712	0.181	0.859
After half an hour		-0.465 ± 4.0119	-0.518	0.610
Two hours after session		0.005 ± 3.594	0.006	0.995
Immediately after session	pH	-0.0078 ± 0.0295	0.203	0.252
After half an hour		-0.00025 ± 0.0253	0.139	0.965
Two hours after session		-0.00275 ± 0.0298	0.279	0.685

As shown in table (4) the mean difference between immediately before session and immediately after session records was 30.99 ± 28.104mm/Hg for Pao_2 with a significant drop, $P < 0.05$. The mean difference between before session and half an hour after session records was -5.19 ± 37.22mm/Hg with a non significant increase of PaO_2.The mean difference value between before session and two hours after session records was -10.685 ± 31.869mm/Hg with a non significant increase of PaO_2, $P > 0.05$. The mean difference between immediately before session and immediately after session records was 0.1500 ± 3.712 mmHg in $PaCO_2$. The mean difference between immediately before session and half an hour after session records was -0.465 ± 4.0119 mmHg with a non significant increase of $PaCO_2$, $P > 0.05$. The mean difference between immediately before session and two hours after session records was 0.005 ± 3.594mmHg with a non significant decrease of $Paco_2$ $P > 0.05$. The mean difference between immediately before session and immediately after session records was -0.0078 ± 0.0295. The mean difference between immediately before session and half an hour after session records was -0.00025 ± 0.0253. The mean difference between immediately before session and two hours after session records was 0.00275 ± 0.0298. There was a non significant change of pH values (immediately, half an hour, two hours) after session.

DISCUSSION

Forty patients with mitral valve replacement were assigned into two groups, group one received incentive spirometry and group two received non invasive intermittent positive pressure breathing in the second post operative day. The result of the present study revealed that in I.S group, the application of I.S led to significant reduction of PaO_2 by 19.5% immediately after session, while there was a significant increase of PaO_2 by 14.2% two hours after session in relation to pre-treatment values. There was also non significant increase in $PaCO_2$ by 0.5% immediately after session following I.S application and non significant reduction of $PaCO_2$ 0.9% two hours after session. On the other hand in IPPB group concerning the

changes of PaO_2 there was a significant reduction of PaO_2 by 15.9% immediately after session, while there was a non significant improvement of PaO_2 by 5.5% two hours after session. The results also showed non significant reduction $PaCo_2$ by 0.4% immediately after session and by 2% two hours after session in IPPB group. Comparison between patients in both groups showed no significant difference between PaO_2, $PaCO_2$, and pH values at different evaluation times. Hypoxaemia is often seen during the first 48 hours after most major operations[21] Within 24 hours of cardiac surgery, there is a reduction in arterial oxygen tension by > 30%, and an increase of the alveolar-arterial oxygen gradient of > 150%, and an increase in the pulmonary shunt fraction from abase line of 3% to 19%. The reduction of PaO_2 is most pronounced in the second post operative day and then shows a gradual improvement. The variables responsible about these changes is questionable. Different factors contribute to these changes such as using topical slush to protect myocardium which leads to phrenic nerve paralysis in > 30% of patients and also result in left lower lobe collapse of > 80% of patients. Long duration of cardio pulmonary bypass has also some relationship [31] Administration of anesthetic agents and narcotic analgesia for pain control can result in depression of the respiratory drive leading to hypoventilation and increased areas of decreased ventilation-perfusion ratio causing pulmonary venous admixture which in turn leads to hypoxemia[24]. The significant reduction of partial pressure of oxygen immediately after the application of I.S may be due to increased oxygen consumption during deep breathing with the IS. But for IPPB application the hypoxaemia may result from ventilation/ perfusion mismatch due to passive over ventilation of apical alveoli at the expense of basal alveoli, which receive less ventilation because lung compliance is lower at the bases at low lung volume. This would increase the proportion of venous admixture due to shunted blood from the poorly ventilated lung bases[13]. Postoperative hypoxemia reduced by I.S due to its ability to encourage long, slow, sustained deep inspiration which leads to achieve maximal inflating pressure in the alveoli and maximal inhaled volume, and also to maintain the patency of the smaller airways. It can also improve inspiratory muscle performance and stimulate normal patterns of pulmonary hyperinflation[2,9,19,22,36]. Non invasive IPPB as a from of ventilatory support play a role in improving pulmonary function after open heart surgery. It increases tidal volume and minute ventilation, by passively ventilating the patient with reduced inspiratory effort and less inspiratory muscle loading and also work of breathing is reduced, both of which improve blood gases. It was found that voluntary hyperventilation had a higher metabolic cost than the passive ventilation of IPPB[7,10,18]. Based on the results of the current study, it could be pointed out that incentive spirometry and non invasive intermittent positive pressure breathing are equal in efficacy on arterial blood gases post mitral valve replacement. These findings are consistent with some previous related researches and studies that conducted by the following investigators. The equal effects of I.S and IPPB in this study concerning the changes of arterial blood gases post operatively confirm the findings of Oikkonen et al.,[25] who examined the effects of I.S and IPPB on PaO_2, pulmonary function and incidence of atelectasis in 52 patient following coronary artery bypass graft. The period of treatment was 4 to 5 days, receiving I.S, 8 timers daily and IPPB 4 occasions daily. There was no difference between the efficiency of I.S

and IPPB on PaO_2, but also there was no improvement of PaO_2 by using I.S and IPPB. It was recommended that great attention should be paid to optimizing the frequency of practicing the devices and to supervision of their proper use. Also the results of the current study were consistent with that of Gale et al.,[13] who compared the treatment with IPPB and I.S in 109 patients after open heart surgery. The treatment period was 3 days, 4 times daily for both I.S and IPPB. Their results showed no significant difference between both groups regarding vital capacity, incidence of atelectasis and arterial oxygen tension. Concerning the changes of arterial oxygen tension there was significant reduction of PaO_2, 10 minutes after I.S and IPPB application which is consistent with our result but 1 hour post treatment, PaO_2 was not significantly different from pre treatment values. These results of Gale et al.,[13] opposed the results of this study concerning the significant improvement of PaO_2 two hourly after the application of I.S. This difference may be because they chose population sample included different types of operations whose vital capacity fell to 44% of preoperative values and this great reduction of VC result in high rate of atelectasis and hypoxaemia. Celli et al.,[5] compared the effect of I.S, IPPB and deep breathing on prevention of post operative pulmonary complications following abdominal surgery of 172 patients. Thomas et al.,[33] applied I.S, IPPB and deep Breathing 4 times daily. Preoperative chest roentgenogram and pulmonary function was obtained and reevaluation were done 4 days after surgery. The results of this study revealed no significant difference between three treatment regimens. But I.S has been shown to decrease length of hospital stay. The latter study showed that there were no statistically significant differences among the different modalities (i.e., IS, deep breathing exercises and intermittent positive pressure breathing). However there have not more studies evaluate and compare between the effect of I.S and IPPB on arterial blood gases post-operatively. On the other hand Crowe and Gosselink et al.,[8,15] have investigated the effect of combined I.S with chest physical therapy, and chest physical therapy alone on pulmonary function and the occurrence of pulmonary complications after cardiac surgery and they have found that there was significant improvement of pulmonary function and significant reduction of occurrence of pulmonary complications in both groups, and these findings confirmed our results. Also Jenkins et al.,[20] have investigated the effect of the addition of breathing exercises or incentive spirometry to a regimen of early mobilization, huffing and coughing on pulmonary function, arterial blood gases and the occurrence of pulmonary infection and they found that there are not any difference between the treatment groups. Concerning the effect of IPPB, Pavia et al.,[27] studied the effect of IPPB on mucus clearance. They compared conventional physiotherapy, IPPB and combined treatment. It was found that there is no significant difference in tracheobronchial clearance between the three methods of treatment. Some pervious related researches and studies prefer IS as a method of treatment and other supported use of IPPB as a mechanical chest physical therapy modalities[36]. Stated that there is an indication for specific respiratory muscle training and IS done before and after operations, it may improve post operative lung function significantly, also it was evidenced that any maneuver which emphasizes inflation will increase lung volume and maintain patency of the smaller airways. Incentive spirometry is the most widely prescribed technique for preoperative and postoperative

lung expansion[11]. stated that deep breathing exercises in conjunction with chest percussion and postural drainage, IPPB and IS as chest physical therapies have benefits in reducing pulmonary complications and are of equivalent efficacy, given the relatively low cost and simplicity of self-administrated incentive spirometry, it is likely the most reasonable intervention among these therapies for reducing the risk of pulmonary complications[12]. Stated that incentive spirometry is superior to routine pulmonary physical therapy, intermittent positive pressure breathing and deep breathing exercises, so that IS has become common therapy during the post operative period[17] showed that incentive spirometry was the most efficient prophylaxis against pulmonary complications in high risk patients after Abdominal surgery and Weindler et al.,[35] speculated that the effectiveness of I.S depends on the selection of patients, careful instruction and supervision of patients during I.S application, and sufficient self-administration of the I.S. Concerning the studies supporting usage of IPPB, Webber et al.,[34] found that for patients who are very breathless and who have excess secretions, IPPB may reduce the work of breathing and rest the patient. The rest allow them to produce more effective cough to clear their secretion. Confirming the finding of Pavia and Webber et al.,[27,34] stated that non-invasive IPPB may have a role to play in patient with copious secretions where conventional chest physical therapy is not possible. Perezdleliano et al.,[29] have showed that in 54 patients with acute hypercapnic respiratory failure due to obesity hypoventilation syndrome, the application of nasal intermittent positive pressure ventilation for a minimum of 1 year with a day time sessions lasted from 3 to 6 hours can improve blood gases, significantly increase Pao_2 by 25% and decrease $PaCO_2$ by 20% and improve subjective sleepless and decrease dyspnea. Gonzalez et al.,[14] studied 16 patients with sever kyphoscliosis who have chronic hypoventilation, they apply nocturnal IPPB over a period of 36 month. Their results revealed that there were significant improvement of blood gases and pulmonary functions, significant improvement of inspiratory muscle strength and reduced hospitalization days. These previous both studies contradict the results of the current study and this may be attributed to increased treatment time over 1 year and 36 months and also to the different population sample. HighCock et al.,[18] confirm the results of the previous study, they found that regular nocturnal IPPB improve over night oxygen saturation, day time blood gas tension, and the patients symptoms in patients with respiratory failure. Also Brabe et al.,[1] have evidenced that non-invasive IPPB improves sleep-disordered breathing and day time arterial blood gas values by preventing the development of atelectasis and increasing lung compliance in patients with neuromuscular disease and Stiller et al.,[32] found that lung expansion with IPPB in acute quadriplegic patients has been shown to increase tidal volume and vital capacity, allowing improved lung inflation and ventilation, improve chest wall mechanics and pulmonary compliance. However, Pontoppidan et al.,[30] opposed the previous studies and concluded that non-invasive IPPB as mechanical aids to lung expansion in non-intubated surgical patients has a little or no evidence documenting its efficacy. A current disadvantage of non-invasive IPPB is that the significant success observed in theoretical bases is not always duplicated in clinical practice. This variability may be related to differences in patient selection criteria, lack of familiarity with or commitment to the technique of non invasive IPPB in some care

settings, improper mask fitting. Although the results of this study showed that (IS) incentive spirometery is not superior than (IPPB) in treatment of postoperative hypoxemia post mitral valve replacement, but taking into consideration the relatively low cost and simplicity of self-administered incentive spirometry and on the other hand, the adverse effect of IPPB like cross contamination, gastric distension, tension pneumothorax, decrease in functional residual capacity (FRC), increase airway resistance and hypotension. Incentive spirometry is the preferred treatment as there are no complications of its use.

Conclusion

The conclusion derived from the present study were in accordance with the results of other previous investigations in the field of physical therapy, using incentive spirometry and non invasive intermittent positive pressure breathing, showed no superiority of any one over the other although there is significant improvement of PaO_2 two hours after treatment in incentive spirometry group.

REFERENCES

1- Barbe, F., Togores, B., Rubi, M., Pons, S., Maimo, A. and Agusti, A.: Noninvasive ventialatory support does not facilitate recovery from acute respiratory failure in chronic obstructive pulmonary disease, Eur respire J; 9: 1240-1245, 1996.

2- Baskin, M.W.: Respiratory care practice review IN principles and practice cardiopulmonary physical therapy 3rd ed. St. Louis, Mosby Year Book Inc. PP 749: 760, 1996.

3- Bojar, R.M.: Valve heart disease including hypertrophic cardiomyopathy, Adult cardiac surgery. Black Well Scientific pub. 155-240, 1992.

4- Braunwald, E.: Valvular heart disease. Heart disease 5th ed. W. B. Saunders company PP 1007-1076, 1997.

5- Celli, B.R., Katharine, S., Rodriguez and Snider, G.L.: A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgeries. Am Rev Respi Dis; 130: 12-15, 1984.

6- Cheitlin, M.D., Sokolow, M. and Mcllroy, M.B.: Valvular heart disease; Mitral valve disease, clinical cardiology 6th ed. Alange Med. Book. 407-437, 1993.

7- Cordova, F.C.: Using NIPPV to manage respiratory failure, part 2. J Respir Dis; 21: 366-369, 2000.

8- Crowe, J.M. and Bradley, C.A.: The effectiveness of incentive spirometry with physical therapy for high-risk patients after coronary artery bypass surgery. Phys Ther; 17: 260-268, 1997.

9- Dean, E., Hammon, W.E. and Hobson, L.: Acute medical conditions IN principle and practice of cardio pulmonary physical therapy 3rd ed, St. louis Mosby YEAR BOOKS, Inc 469-494, 1996.

10- Denehy, L. and Berney, S.: The use of positive pressure devices by physiotherapists. Eur Respir J; 17: 821-829, 2001.

11- Doyle, R.L.: Assessing and Modifying the risk of postoperative pulmonary complications. Chest 1999; 115: 775-781, 1999.

12- Dull, J.L.: Are maximal inspiratory breathing exercises or incentive spirometery better than early Mobilization after cardio pulmonary bypass? Phy. Ther. 63: 655-660, 1983.

13- Gale, G.D. and Sander, D.E.: Incentive spirometery its value after cardiac surgery. Can aneathe Soc J; 27: 475-480, 1980.

14- Gonzalez, C., Ferris, G., Diaz, J., Fontana, I., Nunez, J. and Marin, J.: kyphoscoliotic ventilatory insufficiency effect of long-term intermittent positive pressure ventilation. chest; 124: 857-862, 2003.

15- Gosselink, R., Katleen, S., Philippe, C., Hilde, W., Thierry, T., Antoon, L., Georges, D. and

Mare, D.: Incetive spirometry does not enhance recovery after throacic surgery. Crit Care Med; 28: 679-683, 2000.
16- Groves, P.: surgery of valve disease: late result and late complications. Heart; 86: 715-721, 2001.
17- Hall, J.C., Tarala, R.A. and Tapper, J.A.: prevention of pulmonary complications after Abdominal surgery: a rondomised clinical trial. BMJ; 312: 148-152, 1996.
18- High Cock, M.P., Simth, I.T. and Shneerson, J.M.: The effect of non invasive intermittent positive pressure ventilation during exercise in sever scoliosis:. Chest, 121; 1555-1560, 2002.
19- Hilling, L., Bakow, E., Eink, J., Kelly, C., Sobush, D. and Soulhorn, P.: AARC clinical guidelines incentive spirometry. Respire care; 36" 1402-1406, 1991.
20- Jenkins, S.C., Soutar, S.A., Loukota, J.M., Johnson, L.C. and Moxham, H.: Physiotherapy after coronary artery surgery: are breathing exercises necessary? Thorax; 44: 634-639, 1989.
21- Johnson, J.L. and Hirsch, C.S.: Aspiration pneumonia: recognizing and managing a potentially growing disorder. Post grad Med; 113: 99-112, 2003.
22- Josef, W., Ralph, T.K. and Josef, W.: The efficacy of postoperative incentive spirometry is influenced by the device specific imposed work of breathing. Chest; 119: 1858-1864, 2001.
23- Mehta, S. and Hill, N.S.: Non invasive ventilation. Am J Respir Crit care med; 163: 540-577, 2001.
24- Needleman, J.P., Benjamin, L.S., Sykes, J.A. and Aldrich, T.K.: Breathing patterns during vaso-occlusive crisis of sickle cell disease. Chest; 122: 43-46, 2002.
25- Oikkonen, M., Karjalainenk Kahara, V., Kuosa, R. and Schavikin, L.: Comparison of incentive spirometry and intermittent positive pressure breathing after coronary artery bypass graft. Chest; 99: 60-69, 1991.
26- Overned, I.J., Anderson, C.M., Lucy, D.B. and Timmermans, C.: The effect of incentive spirometry on postoperative pulmonary complications. Chest; 120: 971-978, 2001.
27- Pavia, D.: The role of chest physiotherapy in mucus hypersecretion. Lung, 128 (supple) 614-621, 1990.
28- Pavia, D., Webber, B. and Agnew, J.: The role of intermittent positive pressure breathing in bronchial toilet. Eur respire J; 1: 250S, 1988.
29- Perezdeliano, L.A., Golpe, R., Piquer, M.O. and Rocmonde, A.V.: Short term and long term effects of Nasal intermittent positive pressure ventilation in patients with obesity hypoventilation syndrome. Chest; 128:587-594, 2005.
30- Pontoppidan, H.: Mechanical aids to lung expansion in non-intubated surgical patients. Am rev respir Dis; 122: 109-119, 1980.
31- Stephan, F., Boucheseiche, S., Holland, J., Flahault, A., Cheffi, A. and Bonnet, F.: pulmonary complications following lung resection, 2000.
32- Stiller, K.: The effect of intermittent positive pressure breathing on lung volumes in acute quadriparesis. Paraplegia; 30: 121-126, 1992.
33- Thomas, J.A. and Malntosh, J.M.: Are incentive spirometry, intermittent positive pressure breathing, and deep breathing exercises effective in the prevention of postoperative pulmonary complications after upper abdominal surgery? A systemic overview and Meta-analysis. Phy Ther; 74: 3-14, 1994.
34- Webber, B.A. and Pryor, J.A.: physiotherapy skills: Techniques and adjuncts in physiotherapy for respiratory and cardiac problems. London: churchill livingstone J PP. 113-172, 1993.
35- Weindler, J. and Kiefer, R.T.: The efficacy of post operative incentive spirometry is influenced by the device-specific imposed work of Breathing. Ches; 119: 1858-1864, 2001.
36- Weiner, P., Man, A. and Weiner, M.: The effect of incentive spirometry and inspiratory muscle training on pulmonary function after lung resection. Thorac. Cardio-Vasc.surg. 113: 552-557, 1997.

الملخص العربى

تأثير جهاز الحافز التنفسي مقابل جهاز ضغط التنفس الإيجابي المتقطع الغير تداخلي على غازات الدم الشرياني بعد استبدال الصمام الميترالي

تهدف هذه الرسالة إلى دراسة التأثير الفوري لجهاز الحافز التنفسي وجهاز ضغط التنفس الإيجابي المتقطع الغير تداخلي على غازات الدم الشرياني بعد استبدال الصمام الميترالي ومقارنة تأثير هذين الجهازين على غازات الدم الشرياني بعد استبدال الصمام الميترالي . أجرى البحث على أربعين مريضاً قد أجرى لهم جراحة استبدال الصمام الميترالي- وقد تم تقسيمهم إلى مجموعتين متساويتين . المجموعة الأولى أجريت لها تمارين جهاز الحافز التنفسي والمجموعة الثانية أجريت لها جهاز ضغط التنفس الإيجابي المتقطع الغير تداخلي . وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية في قياس نسبة الأكسجين بالدم الشرياني بعد استخدام جهاز الحافز التنفسي . وبمقارنة المجموعتين- وجد عدم ظهور فروق ذات دلالة إحصائية بين مرضى المجموعتين . وبالتالي باستخدام جهاز الحافز التنفسي وجهاز ضغط التنفس الإيجابي المتقطع الغير تداخلي لا يوجد أي فائدة إضافية لأي من الجهازين على الآخر .