Effect of Proprioceptive Neuromuscular Facilitation Versus Incentive Spirometer on arterial Oxygen Pressure After Open Heart Surgery

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ABSTRACT

The immediate and late effect of a single session of incentive spirometer versus proprioceptive neuromuscular facilitation on the arterial oxygen pressure in patients received mitral valve replacement has been investigated. Twenty patients, 11 males and 9 females represent the sample of this study. Their age was ranging from 25 to 30 years. They were randomly devided into two groups of equal number (A and B). Patients in group (A) were instructed to practice incentive spirometry while group (B) received proprioceptive neuromuscular facilitation technique. For every patient in both groups arterial blood samples were taken for gas analysis before, immediately after treatment session, half an hour and two hours later. The results of this study suggested that application of incentive spirometry leads to significant improvement in the arterial oxygen pressure (PaO_2)after two hours of application.

INTRODUCTION

The lungs are a target organ for complications following open heart surgery[1]. The pulmonary complications are the most frequently occurring complication following cardiac surgery, with reported frequencies up to 75% of all patients, which is considered as main causes of post operative morbidity and mortality[2].Anesthesia, surgery, and trauma have a detrimental effect on pulmonary function by altering the patient's breathing pattern which in turn decrease the respiratory drive and depress cough reflex. Also, pain associated with surgery and muscle spasm restricts the patient's ability to breath deeply[3,7].

Patients with excessive amount of secretions, inspessated mucus defective mucocillary transport and ineffective cough, require secretion mobilization and clearance maneuvers[4,8]. Inadequate or absent respiratory care program can profound the problem and sometimes leads to irreversible complications[5]. Chest physical therapy encompasses three major treatment areas[6]: (a) clearance of secretions from the tracheobronchial system, (b) improvement of respiratory muscle function and (c) maintenance of muscoskeletal mobility. Incentive spirometer (I.S.) is widely used as an adjunct to postoperative chest physiotherapy that provides the patient with

visual feedback of the volume of air inspired during a deep breath[5,11].

Techniques of proprioceptive neuro-muscular facilitation (P.N.F) may be applied as means of stimulating effects and strengthening muscles related to respiratory stimulation of respiratory muscles and increased range of motion of the chest and diaphragm are achieved by direct application on the lateral chest wall[6,12].

The aim of this study was to investigate the effects of selected physical therapy modalities (incentive spirometer and P.N.F techniques) on arterial oxygen pressure in patients received mitral valve replacement.

PATIENTS, MATERIALS AND METHODS

Patients

Twenty patients, 11 males and 9 females with age ranging from 25 to 30 years represent the samples of this study. All received mitral valve replacement through median sternotomy. Patients were selected from National Heart Institute. Patients who had radiological evidence of pleural effusion and/or lobar atelectasis were excluded from this study. They were assigned randomly into two groups of equal number (A and B). Group (A), ten patients (6 males and 4 females) with age ranged from 26 to 28 years received I.S. technique, while group (B), ten patient (5 males and 5 females) with age ranged from 25 to 30 years received P.N.F. technique. During procedures, all patients were disconnected from oxygen mask but they were monitored for E.C.G trace.

Equipment

1. Incentive spirometer (Voldyne Volumetric).

It is a respiratory therapy device that provides visual feed back in terms of volumetric success as a patient performs a deep breath. It is considered as a mechanical aid to lung expansion. It is manufactured by Sherwood Medical Company, U.S.A.

2. Hewlett Packard Monitor

It is a device used to monitor the electrical activity of the cardiac muscle as well as heart rate, arterial blood pressure and temperature to detect haemodynamic changes during chest physical therapy program.

3. Acid-Base Analyzer

It is a computerized device used to measure partial pressure of oxygen in arterial blood sample PaO_2 .

Procedure

The patients were in a relaxed semi-sitting position, then arterial blood samples were drawn from the radial artery before and three times after the chest physical therapy session for each patient. In group (A) the incentive spirometry training started while the patient was in the relaxed comfortable sitting position with back supported. The therapist was standing beside the patient at his knee level facing him. The patient was asked to close his mouth tightly around the mouth piece of the device and a minimum of ten breaths at volume of 50% to 70% of the preoperative volume with enough rest time in between. P.N.F technique was conducted according to Kigin[10] protocol at which the patients in the semifowler position, pillow under the knees, back unsupported and perskin. The therapist was standing behind the patient facing his back. The therapist hands were located firmly on lower costal area at the level of ninth costal

cartilage following the movement of the chest wall on patient own breathing rhythm. During expiration, a firm stretch for intercostal muscles downward and inward with shaking of lower ribs was applied, then a sudden pressure release at the beginning of inspiration was done but therapist hands still in contact with the patient's chest wall. This procedure was continued until approximately 70% of pre operative chest expansion was attained . Either chest physiotherapy technique was conducted on the second post operative day. Arterial blood samples for gas analysis were drawn before and after chest physical therapy intervention in both groups. The changes in PaO_2 as a result of modality intervention were recorded and calculated.

RESULTS

The results of this study are presented under the following headings:

1. Results of the Incentive Spirometry Group (A)

As shown in table (1) and illustrated in figure 1-A, the mean values and standard deviation of PaO_2 mm Hg in this group before application was 79.20 ±10.14, while after application, it was 66.92±8.12, 74.09±7.49 and 89.05±7.32 mm Hg recorded immediately after half an hour and two hours later respectively. An initial acute drop in PaO_2 mm Hg is noticed immediately after application when Compared to the baseline value recorded before the treatment session ($p<0.0001$). After half an hour of the application recovering in PaO_2 mm Hg started but did not reach the baseline value and after two hours, recording showed significant increase in PaO_2 mm Hg when compared with the baseline value ($p <0.0001$).

2. Results of the P.N.F Group (B)

As shown in table (1) and demonstrated in figure1-B , the mean values and standard deviation of PaO_2 mm Hg in this group before the treatment session was 82.05 ±10.87 while after application it was 73.75 ±13.67 , 74.83 ±10.42 and 83.71 ±10.70mm Hg recorded immediately after half an hour and two hours later respectively. An initial acute drop in PaO_2 mm Hg is recorded immediately after the session when compared with the baseline value obtained before the treatment session ($p <0.000$). After half an hour of the session a significant recovery ($p>o.05$) in PaO_2 mm Hg was recorded. It was only after two hours of the treatment session full recovery was recorded in PaO_2 mm Hg but it did not show significant increase when it was compared with the baseline value ($p>0.05$).

3. Comparison Between the Results of Both Groups

As shown in table (2) and illustrated in figure(2) in comparison with the baseline values of either group, A showed more drop in PaO_2 mm Hg (12.28) than group B (8.30) when results were obtained immediately after the session ($p<0.0001$). Recording after half an hour, significant recovery was recorded in group A (7.17) but non significant recovery was recorded in group B (1.08). After two hours from the session, significant recovery was recorded in group A (14.96) and in group B (8.88). At this stage Comparing with the baseline values, significant improvement in PaO_2 mm Hg was recorded in group A ($p<0.001$) but non significant improvement was recorded in group B ($p>0.05$).

Table (1): The mean values and standard deviation of PaO_2 mm Hg recorded before, immediately and after the termination of the treatment session, half an hour and two hours later of the incentive spirometer (I.S.) and P.N.F. groups

patients group	Statistical value	Recording time			
		Before Application	immediately after	after half an hour	after two hours
A I.S.	mean and standard deviation	79.2 ±10.14	66-92±8-12	74.09 ± 7.49	89.05±7.32
B P.N.F.	mean and standard deviation	82.05±10.87	73.75±13.67	74.83±10.42	83.71±10.70

I.S. Incentive spirometry
P.N.F. Preprioceptive neuromuscular facilitation

Table(2): In Comparison with baseline value recorded before application in either group, the mean change of PaO_2 mm Hg recorded at different time period after termination of the treatment session and the difference between mean value in each group.

Patients group	Time of recording		
	immediately after the session	half an hour later	two hours later
Group A I.S. (mean change)	-12.28	-5.11	9.85
P value	< o.0001	< 0.005	< 0.001
Difference between recording periods	Difference between after the session and half an hour later		Difference between half an hour and 2 hours values
	7.17		14.96
P value	< 0.0001		< 0.0001
	< 0.0001	< 0.0001	
Group B P.N.F. (mean change)	- 8.30	- 7.22	1.66
P value	< 0.0001	< 0.0001	> 0.05
Difference between recording periods	Difference between after the session and half an hour later		Difference between half an hour and 2 hours later
	1.08		8.88
P value	> 0.05		< 0.0001

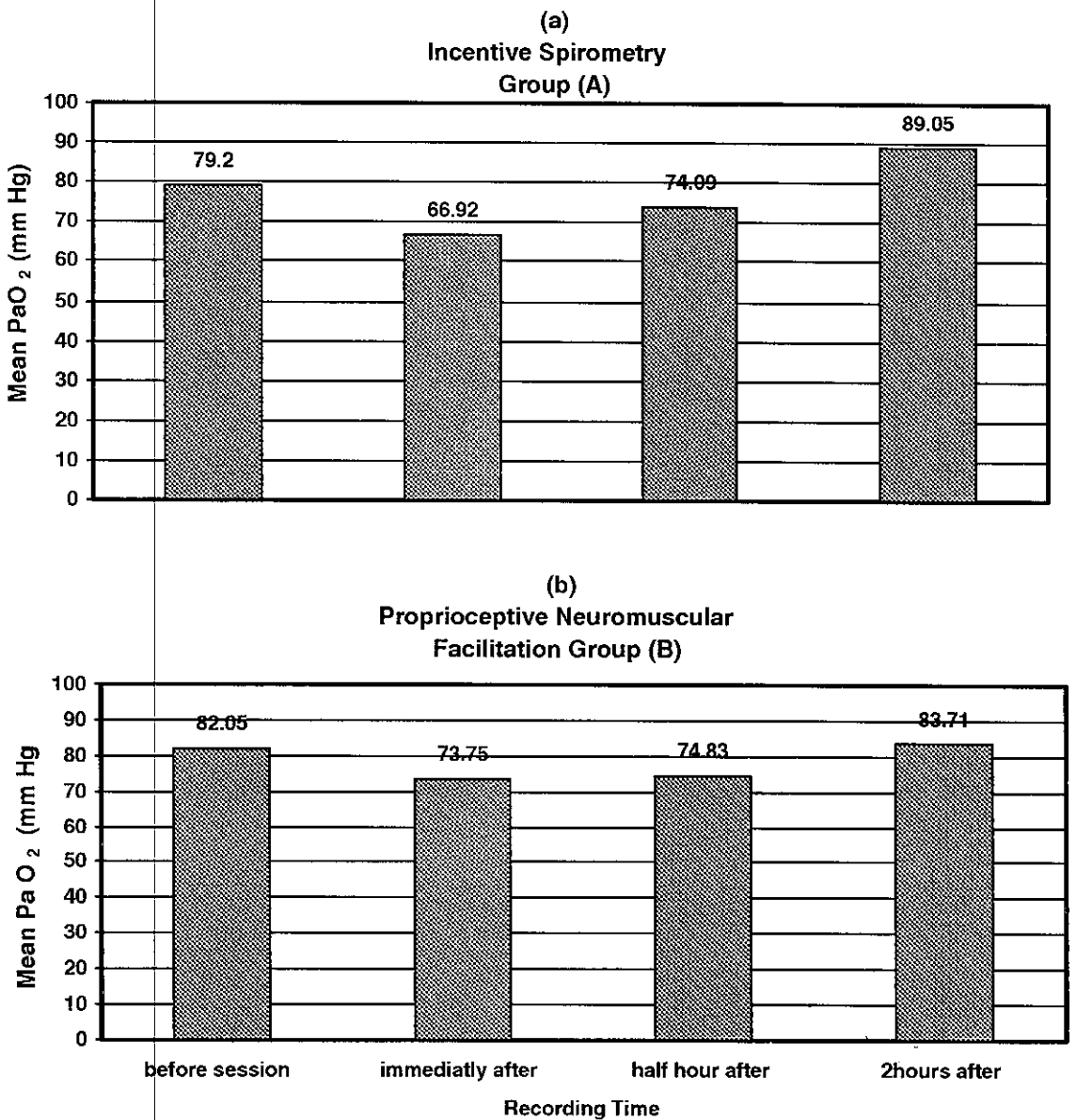

Figure 1: (a) Mean Pa O_2 values of spirometry group recorded before, immediatly after, half an hour and two hours later (b) Mean Pa O_2 values of P.N.F.group recorded before , immediatly after, half an hour and two hours later.

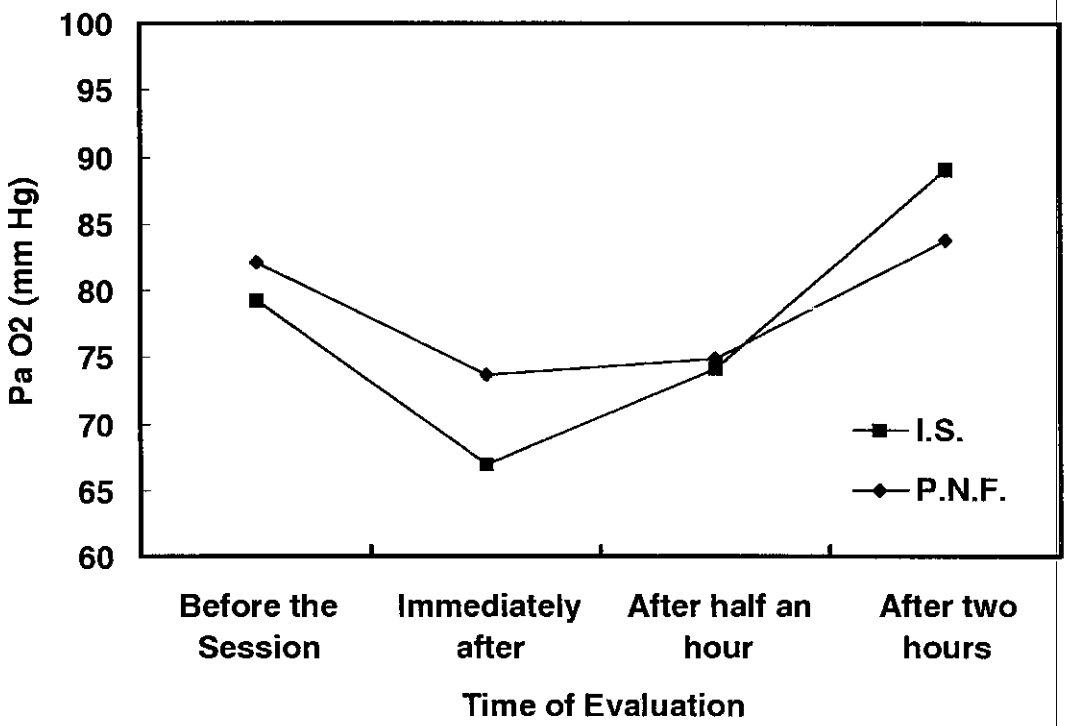

Figure2: The baseline values and mean changes in Pa O_2 mm Hg recorded at different pe of time after the treatment sessions in both groups.

DISCUSSION

The effect of two selected physiotherapy modalities, namely Incentive Spirometer and Proprioceptive Neuromuscular Facilitation, on arterial oxygen pressure, in young adult cardiac patients was studied in the immediate postoperative period, after mitral valve replacement. The patients were randomly subdivided into two groups (A and B) of each number (10 each). Group (A) received one session of incentive spirometer and group (B) received one session of proprioceptive neuromuscular facilitation. The PaO_2 mm Hg was measured in all patients before the session, then immediately after, half an hour and two hours later. The results of this study revealed that both modalities resulted in significant drop of PaO_2 mm Hg immediately following either application, the drop was more pronounced in group (A) who received incentive spirometry. After half an hour initial recovery of PaO_2 was recorded in both groups but the baseline recorded before application. At this stage, the recovery in group (A) was much faster than in group (B). After two hours from the session, the mean results in group (A) was significantly improved when compared with the mean results of the baseline before application. In group (B), although full recovery was recorded, PaO_2 mm Hg level was not significantly higher than the mean baseline of value of this group. Drop of PaO_2 mm Hg was recorded immediately after application in

different studies as breathing exercises and incentive spirometer were tried on two different groups, in which profound arterial hypoxaemia was recorded immediately after application in both groups[10]. In another study the effect of incentive spirometry compared to control group was investigated, in which more reduction in PaO_2 mm Hg was recorded in the incentive spirometry group than the control group[16]. Also in group of patients received incentive spirometry and in another group received conventional chest physical therapy postoperatively, the PaO_2 mm Hg values were similarly reduced on the first three postoperative days[15,17].

According to the results of research studies of different investigators, it was concluded that chest physiotherapy in acutely ill patients with large amount of secretions and /or lobar atelectasis is always associated with hypoxaemia[3, 4, 7, 10]. The results of these studies coincide with our results in the immediate recording following chest physiotherapy applications. Reduction of the PaO_2 mm Hg values immediately after physiotherapy session can be interpreted in different ways. The incentive spirometer is characterized by active recruitment of the diaphragm and other inspiratory muscles which are provided by this method[4,9,10]. This may lead to an increase in the intrathoracic pressure and/or increase in the oxygen consumption[8]. Also in similar studies, increase in oxygen consumption and carbon dioxide production during chest physiotherapy in adults after surgery were suggested to be due to increased work of breathing[11,18] which suggested that the work of breathing during incentive spirometry and P.N.F. in our study may contribute to acute reduction of PaO_2 mm Hg. In other studies, investigators observed that chest physiotherapy in acutely ill patients with large amount of secretions and/or lober atelectasis is associated with hypoxaemia, inadequate ventilation was suggested as the main cause of PaO_2 acute reduction after application[9, 17]. So the immediate drop of PaO_2 mm Hg and the recovery which started after half an hour observed in our study may reflect in part changes in lung function which took place as a result of chest physiotherapy used. Other reasons which may clarify the causes of immediate drop of PaO_2 after chest physiotherapy and later on recovery include:
a- Shifting of mucus from peripheral airways to large central airways. **b-** Bronchospasm.
c- Lung compression due to chest squeezing may cause narrowing of airways or even premature airway closure resulting in smaller lung volumes and hypoventilation of these areas[3].

Several additional theories may explain the association between hypoxaemia and chest physical therapy[8]: **a-** An increase in intrathoracic pressure causing a decrease in cardiac output. **b-** An increase in shunt effect. **c-** As increase in oxygen consumption.

In our result, the recovery was significantly higher two hours using incentive spirometry than when P.N.F was used, which suggest using of incentive spirometry as an effective chest physiotherapy modality causing sequential improvement of PaO_2 mm Hg level in postoperative cardiac patients.

SUMMARY

This study was designed to investigate the effect of incentive spirometer and P.N.F on PaO_2 mm Hg value in 20 young adult patients ranging in age from 25 to 30 years and received mitral valve replacement and the difference between the effects of the two chest physiotherapy techniques. Each technique was used with one group of 10 patient's each. The

results revealed significant reduction of PaO_2 immediately after application of either technique followed by gradual recovery. After two hours significant improvement was recorded only in the group who received incentive spirometry, which is attributed mainly to the clearance of the respiratory pathways.

CONCLUSIONS

Chest physiotherapy and in particular incentive spirometry is highly recommended to produce significant reduction in lung complications and improve PaO_2 mm Hg postoperative cardiac patients.

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الملخص العربي

تأثير التسهيلات العصبية العضلية مقابل المقياس الرئوي الحافز على ضغط الأوعية الدموية لحالات عمليات القلب المفتوح

يهدف البحث إلى دراسة مقارنه بين تأثير استخدام طريقتين من طـرق العـلاج الطبيعـي (القيـاس الرئـوي الحـافز والتسـهيلات العصبية العضلية) على نسبة ضغط الأوكسجين فى الدم الشرياني لدى المرض ذو عمليات القلب المفتوح .
طوع في هذه الدراسة عشرون مريضا ممن أجرى لهم جراحه القلب المفتوح لاستبدال الصمام المترالى وقد تراوحت أعمـارهم من ٢٥ – ٣٠ سنه وقد تم استخدام طريقتي المقياس الرئوي الحافز والتسهيلات العصبية العضلية .
وقد تم أخذ عينه دم شرياني قبل كل طريقه وبعدها مباشرة وبعد نصف ساعة ثم بعد ساعتين من العلاج كما تم أيضا اسـتخدام الطرق والوسائل الإحصائية اللازمة لتحديد مدى الدلالات المعنوية للتغييرات الناتجه.
أوضحت نتائج البحث ارتفاع ذو دلاله إحصاعيه في نسبة ضغط الأوكسجين في الـدم الشـرياني بعـد اسـتخدام المقيـاس الرئـوي الحافز فقط لذا ينصح باستخدام هذه الطريقة مع مرضى جراحات القلب المفتوح لتحسين تلك الحالات