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Research Article

EFFECT OF RESPIRATORY REHABILITATIONIN AND CORRELATIONS OF THE SIX-MINUTES' WALK TEST AND SPIROMETRY AFTER OPEN HEART SURGERY

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ABSTRACT

Respiratory complications after open heart surgeries are common problems which can be life-threatening and cause death if not properly managed. The aim of this study was to evaluate the role of pulmonary rehabilitation before and after surgery for reducing the risk of pulmonary complications after surgery also Correlations of the Six-minute Walk Test and Respiratory following open heart surgery. In a randomized clinical trial, 60 patients undergoing heart surgery were divided into two groups randomly (Group A and B). In group A, physiotherapy before and after chest physiotherapy surgery was performed, but on patients in group B, only chest physiotherapy after surgery were done. Effects of preoperative pulmonary rehabilitation were compared between two groups, using Spirometry and 6MWT. Thirty Nine of males (65%) and 21 females (35%) with a mean age of 8.10 ± 9.56 were analyzed. The mean difference in predicted forced vital capacity (FVC) (CI95%: 1.3 to 8.7) and Predicted Peak Flow indices (PEF) (CI95%: 1.9 to 9.4) of spirometery indicator was significant. Also, Evaluation of 6MWT showed that mean difference in walking distant (CI 95%; 8.8 to 21.0) and mean SPO2 (CI 95%;.59 to 1.67) in group A was more than group B. Pulmonary rehabilitation program before surgery is recommended to reduce complications of heart surgery. Further evaluations are necessary in relation to the sensitivity and specificity of 6MWT parameters alone in the evaluation of respiratory performance.

Keywords: *Thoracic Surgery, Movement Techniques, Breathing Exercises, Randomized Clinical Trial, 6 MWT, Spirometry*

INTRODUCTION

Cardiac surgery is associated with pulmonary complications (PC) incidence, defined any pulmonary abnormality that occurs during the postoperative period which creates detectable syndrome that is clinically important and affects the clinical course (Tenling *et al.*, 1998). The global average prevalence of PC following Coronary Arterial Bypass (CAB) surgery was estimated between 2-4 % (Wynne and Botti, 2004). The most common complications was reported, atelectasis (27 -95%), pleural effusion (16.6-88%) and phrenic nerve paralysis (30-75%) (Aida *et al.*, 2004). Possibility of PC resulting the CABG in Iran not accessible but the event of PC following the public surgery has been reported 50 % (Brasher, 2003; Rajaei and Dabbagh, 2012). PC following cardiac surgery leads to chief socio– economic burden such as prolonging hospitalization, ICU admission, the huge cost of treatment, loss of the work days and even death. Some thoracic physiotherapy techniques are used in order to Respiratory Function

improvement in oxygenation and decline in respiratory complications incidence after Coronary Artery Bypass Grafting (CABG) (Herdy *et al.*, 2008). Despite the common use of respiratory exercises in patients after CABG in different countries, there is still insufficient scientific evidence for their efficacy (Miller *et al.*, 2008). Furthermore, how to assess respiratory function is unclear. Spirometry is invaluable as a screening test of general respiratory health in the same way that blood pressure provides important information about general cardiovascular health and as well as national guidelines, advise spirometry as the gold standard for accurate and repeatable measurement of lung function. The 6MWT can be easily performed, and associated parameters during 6MWT could provide important indicators for treatment interpretation (Takigawa, 2007).

The objective of this study was survey of pre & post-operative respiratory rehabilitation in patients undergoing open cardiac surgery based spirometry and 6 MWT in addition correlation between spirometry and 6 MWT (Takigawa, 2007).

MATERIALS AND METHODS

Design

The patients were asked to take part in the study after they received full explanations about the aim of the study, random allocation to study groups and reassurance about the absence of any side effects. The study protocol was approved by the local Ethics Committee (with a code of 2272/4/5) and was registered in the International Center for Clinical Trials with a code of IRCT138904294422N1. The patients were randomly assigned to the intervention (Group1) and control (Group 2) groups. Collection of samples took approximately 12 months. The reliability of the study was evaluated and confirmed by a physiotherapist and an evaluator who had been trained by the researcher. The equipment used for the physiotherapy and evaluation of the respiratory function was standard and was used under the direct supervision of the principal investigator in the present study.

The patients in group A underwent physiotherapy 15 days before the surgical operation, with an emphasis on strengthening inspiratory muscles, and thoracic cavity physiotherapy was carried out based on the surgical ward routines. However, patients in group B received only post-operative physiotherapy based on surgical ward routines.

Participants

Sixty seven patients were candidates for open cardiac surgery using the mid-sternotomy technique in Tabriz Cardiac Educational/Treatment Center and had similar conditions in relation to the administration of medicines. A total of 60 CABG patients were included in the present randomized clinical trial in a period of 12 months (2011-2012). The exclusion criteria consisted of a history of any chronic respiratory condition, emergency surgery, cardiac insufficiency (EF<40%), valvular disorders, a history of connective tissue conditions, chronic renal insufficiency and a history of musculoskeletal conditions.

Intervention

Pre-operative physiotherapy techniques for group A consisted of the following:

1. Breathing exercises consisting of 10 deep breathing attempts, diaphragmatic breathing and pursing of the lips;
2. Instruction of flow-IS-based incentive spirometer (Respiflow™ FS) and effective coughing;
3. Instruction of neck and shoulder mobilization exercises with an emphasis on thoracic extension and rotation;
4. Instruction of muscular tension exercises;
5. Instruction of exercises to strengthen muscles responsible to move the shoulders forwards and backwards.

Post-operative exercises and physiotherapy procedures in groups A and B were carried out as follows:

1. Techniques to cleanse the lungs including mobilization, manual techniques, use of the active cycle of breathing techniques and use of IS;

2. Auxiliary active movements of the extremities;
3. Active movement of the extremities;
4. Breathing exercises and expansion of the lobes of the lungs.

In group A during the two-week period before the surgical operation, 15 sessions were held, consisting of exercises and auxiliary activities for extension and rotation of thoracic vertebrae, breathing exercises, exercises to expand lung lobes, instruction of IS equipment, extension exercise for thoracic cavity muscles and muscles with a role in breathing (aerobic exercises) for 25 minutes at a constant low speed for all the patients. The patients once again underwent physiotherapy for the respiratory system. However, patients in group B, received physiotherapy only after surgery.

RESULTS

Evaluation of respiratory function was carried out by trained physiotherapists, using 2 Spirometry parameters and 6MWT, in group A, spirometry and 6MWT were carried out 15 days before surgery and immediately after discharge from the ICU. In group B, too, spirometry and 6MWT were carried out before surgery and immediately after discharge from the ICU, and the parameters were compared.

Spirometry parameters included forced expiratory volume in 1 second (predicted FEV1), predicted forced vital capacity (FVC) and peak expiratory flow (PEF). Spirometry was carried out in group A (intervention) once before rehabilitation programs and once after discharge from the ICU. But in group B once 15 days before CABG and once immediately after discharge from the ICU.

6MWT parameters consisted of heart rate, the distance walked, maximum oxyhemoglobin saturation (Max SPO_2), minimum oxyhemoglobin saturation (Min SPO_2) and mean oxyhemoglobin saturation (Mean SPO_2).

6MWT was carried out in all the patients in three 2-minute stages as follows:

1. The initial stage: two minutes of rest on a chair;
2. The second stage: walking for 2 minutes on a smooth surface;
3. The third stage: recovery at chair rest.

6MWT was carried out on each patient with the patient wearing comfortable shoes and comfortable hospital clothes without any extra loads in hands during the second stage. The patients chose the walking pace voluntarily and felt at ease at that pace.

6MWT was carried out in the intervention group (A) once before rehabilitation programs and once immediately after discharge from the ICU; the test was carried out in the control group (B) once before CABG operation and once immediately after discharge from the ICU.

In a pilot study on 10 patients, once the reliability of the observer and once the reliability of the equipment were evaluated. Kappa coefficient was used to estimate the reliability of the study, which was estimated to be more than 90% in both evaluations.

Data Analysis

Student's t-test analyses and multiple linear regression were used to compare the study variables at a confidence interval of 95%, using SPSS 18.

Flow of Participants through the Trial

Sixty seven patients with candidates for open cardiac surgery using the mid-sternotomy technique were screened for eligibility between October 2011 to November 2012.In the present clinical trial, Sixty patients were randomly assigned to groups A (n=30) and B (n=30). Seven patients were excluded from the study for various reasons, including arthritis, dissatisfaction and lack of access. The groups A and B had similar baseline demographic characteristicsanddifferencebetweenthemwasnotstatisticallysignificant (Age: P-value=.096; Sex: P-value=.97; Smoking: P-value=.51; Diabetes Mellitus: P-value=.51; BMI (Body Mass Index): P-value=.29, Duration of Operation: P-value=.82 (Table 1).

Table 1: Baseline variables of patients who completed the study

Variables	Groups		
	Expression (n=30)	Control(n=30)	P-Value
Age; Years, mean (SD)	54.4(10.8)	59.3(10.45)	.096
Gender; Female, frequency (%)	11(36.7)	10(33.3)	.97
Smoking; Yes, frequency (%)	9(30)	10(33.3)	.51
Diabetes mellitus; Yes, frequency (%)	11(36.7)	8(26.6)	.29
Body Mass index (BMI); mean (SD)	26.8(4.7)	27.7(4.9)	.46
Duration of operation, Hours; mean (SD)	2.6(.23)	2.8(.36)	.82

Compliance with Trial Method

All candidate CBAG patients received Pre-operative physiotherapy which they had been randomly allocated. All data were collected and analyzed as intended.

Effect of Intervention

After data normality was confirmed, making it possible to use parametric tests, In order to neutralize the effect of each patient's initial status in relation to respiratory function, Spirometry and 6MWT parameters were measured in both groups before rehabilitation and surgery. The two groups were evaluated and compared in relation to differences in each parameter before and after rehabilitation in each patient. Analysis was based T-student. (Table2).Evaluation of Spirometry parameters by mean difference analysis showed significant changes in predicated FVC (CI 95%: 1.3 to 8.7)and PEF (CI 95%: 1.98 to 9.4) in the group A compared to the group B (Table2).

Table 2: Mean (SD) for all outcomes for each group, mean (SD) difference within groups, and comparison (95%CI) between groups

Groups						**Difference within groups**		**Difference between interventions**
Outcome		**preoperative**		**Post operative**		**Post minus pre-operative**		**Post minus pre-operative**
		Expression (n=30)	**Control (n=30)**	**Expression (n=30)**	**Control (n=30)**	**Expression (n=30)**	**Control (n=30)**	**Expression- Control**
spirometry indicators	FEV1	81.7 (13.1)	79.1 (13.4)	80.03 (12.4)	73.8 (13.05)	-1.4 (2.2)	-5.3 (10.9)	3.9 (-.46 to 7.9)
	FVC	85.8 (9.7)	81.1 (10.6)	84.5 (8.96)	74.7 (12.8)	-1.37 (2.4)	-6.4 (9.8)	5.03* (1.3to8.7)
	PEF	68.3 (16)	74.0 (15.9)	68.5 (14.3)	68.7 (16.5)	.2 (7.2)	-5.5 (7.2)	5.7 * (1.979 to 9.4)
6MWT	HR	107.7 (12.5)	110.0 (14.5)	98.1 (7.96)	101.2 (9.68)	-9.6 (7.3)	-8.8 (9.54)	-.8 -5.2 to 3.6)
	walking distance	110.9 (20.6)	104.5 (22.5)	97.7 (16.39)	76.27 (20.49)	-13.3 (9.86)	-28.23 (13.48)	14.93* (8.8 to 21.0)
	max spo2	96.1 (1.5)	97.1 (.9)	96.4 (5.34)	97.07 (1.4)	.3 (4.87)	-.03 (0.99)	.33 (-1.49 to 2.1)
	min spo2	91.4 (1.9)	91.2 (1.9)	92.07 (1.96)	91.2 (1.4)	.67 (1.20)	.00 (2.06)	.67 (-1.48 to.26)
	mean spo2	94.0 (1.3)	94.3 (1.2)	94.93 (1.198)	94.1 (1.23)	.93 (.85)	-.2 (1.18)	1.13* (.59 1.67)

Evaluation of 6MWT showed, mean difference in walking distant (CI 95%; 8.8 to 21.0) and mean SPO2 (CI 95%; .59 1.67) in group A was more than group B significantly, but mean difference of maxSPO2 and min SPO2 in two groups (A and B) were not significant (CI95%: -1.49 to 2.1 and -1.48 to.26 respectively).

The Pearson correlation coefficients were calculated to examine the correlation between the6MWT parameters and spirometry parameters in A group (intervention).

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Table 3 shows that the HR was correlated with FEV1(r =-.4, p<.002) and FVC(r=-.56,p<0.0001) walking distance was correlated with FVC (r =.3, p=.019) and peak flow(r=.57,p<.0001),min spO2 was significantly correlated with FEV1(r=-546,p<0001 and peak flow (r =.44, p<.0001) and mean spO2 was correlated with FEV1 (.57, p<.0001), FVC(r=-.51,p<.0001) and weakly with peak flow(r=.28, p=.028).The three spirometry parameters;FEV1, FVC, and peak flow were included in the multiple linear regressions with the 6MWD parameters.FVC was significant determinants of the HR (P<.001, β=-.69). Peak flow determinants of the walking distance (p<.0001, β=.86).FEV1 determinants of the min spO2 (P=.009, β=-0.1) and FEV1 weakly with mean spO2.

Table 3: Correlation distribution between spirometry and 6 MWT parameters among patients after CABG

		HR	Walking distance	Max spO2	MinspO2	Mean spO2
FEV1	Pearson Correlation	-.401**	.207	.128	-.536**	.571**
	Sig. (2-tailed)	.002	.112	.331	.000	.000
FVC	Pearson Correlation	-.558**	.303*	.130	.440**	.513**
	Sig. (2-tailed)	.000	.019	.323	.000	.000
Peak Flow	Pearson Correlation	-.147	.568**	.038	.217	.284*
	Sig. (2-tailed)	.263	.000	.772	.096	.028

Table 4: Multiple regression of spirometrey parameters for the six-minute walk distance (6MW)

6MWT	HR		Distance		Max spO2		MinspO2		MeanspO2	
	B	sig	β	sig	β	sig	β	sig	β	sig
FEV1	-.044	.808	.235	.360	-.031	.726	-.101	.009	.060	.016
FVC	-.693	.001	.345	.210	.038	.692	.017	.671	.026	.313
Peak Flow	.079	.552	.856	.000	-.009	.893	.003	.902	.010	.574

Discussion

In the present study, FVC and PEF mean differences were significant; however, as expected, the difference in the means was higher in group A compared to the group B, which is consistent with the results of a study by Tanriover(10)

Evaluation of respiratory performance based on 6MWT parameters showed a greater difference in the means of SPO_2 and distant walked in the group A compared to the group 2, revealing a discrepancy between the results of this study and a study by Savci *et al.*, (11). This discrepancy between the results of these two studies shows the need for further studies in this respect.

The HR showed inverse correlations with FVC in multiple linear regressions, which suggested patients with greater restrictive constraints more heart rate during the Walking test. Also patients with less walking distance had greater restrictive constraints. Minimum and mean SpO2 also showed correlations with FEV1, which suggested that patients with greater restrictive constraints had less min and mean spO2. these results, had consistency with Chen in Taiwan among COPD patients (2012).

Conclusion

The results of this study, based on the evaluation of parameters of respiratory performance, showed that pre-operative respiratory physiotherapy can have a positive effect on the improvement and quality of respiratory performance of patients undergoing open cardiac surgery. Further evaluations are necessary in relation to the sensitivity and specificity of 6mwt parameters alone in the evaluation of respiratory performance.

Ethics approval: The local Ethics Committee of Tabriz University of Medical Sciences (with a code of 2272/4/5) approved this study. All participants gave written informed consent before data collection began.

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