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Article *in* Reviews on Recent Clinical Trials · July 2019

DOI: 10.2174/1574887114666190710165951

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Reviews on Recent Clinical Trials, 2019, *14*, 1-5

CLINICAL TRIAL STUDY

What is the Role of Preoperative Breathing Exercises in Reducing Postoperative Atelectasis after CABG?

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ARTICLEHISTORY

Received: April 22, 2019
Revised: June 02, 2019
Accepted: June 11, 2019

DOI:
10.2174/1574887114666190710165951

Abstract: ***Background*:** Atelectasis and hypoxemia are frequently reported after coronary artery bypass graft surgery (CABG). Some studies confirm the benefits of breathing exercises on pulmonary complications, but the efficacy of preoperative breathing exercises in patients undergoing CABG is controversial. In this study, the effect of preoperative breathing exercises on the incidence of atelectasis and hypoxemia in patients candidate for CABG was examined.

Method*:** In a single-blinded randomized clinical trial, 100 patients who were undergoing coronary artery bypass graft surgery were randomly allocated into two groups of experimental and control, each consisted of 50 patients. Before the operation, experimental group patients were enrolled in a protocol including deep breathing, cough and incentive spirometer. ***In the control group, hospital routine physiotherapy was implemented. All the patients received the hospital routine physiotherapy once a day for 2 to 3 minutes in the first four days postoperatively. Arterial blood gases and atelectasis were compared between groups.

***Results*:** There was no significant difference between groups in terms of atelectasis and hypoxemia *($p_{Value}>0.05$)*.

***Conclusion*:** Preoperative breathing exercise does not reduce pulmonary complications in patients undergoing CABG.

Keywords: Atelectasis, breathing exercise, coronary artery bypass graft, hypoxemia.

1. INTRODUCTION

About one million Coronary artery bypass graft (CABG) surgeries are annually performed in the world [1]. The risk of developing pulmonary complications is very high in patients undergoing coronary artery bypass graft surgery [2, 3]. Respiratory complications are the most common postoperative complications, playing an important role in morbidity and mortality, and increased hospital stay and associated costs [4]. In spite of significant advances in cardiopulmonary bypass, pre and post-operative care, and anesthesia protocols [5-7], no meaningful relationship has still been observed between progression in technology and reduction in pulmonary complication rate [8].

Postoperative breathing exercises are among the interventions frequently performed to diminish pulmonary complication in CABG patients. Many studies have been conducted on the influence of breathing exercises. However, findings of these studies are substantially different from each other, so as they can even be located at two ends of a spectrum. Some studies have questioned the effectiveness of breathing exercises [3, 9, 10], while other investigations have confirmed the efficacy of these practices [11-16]. It has been recommended to conduct more researches to access adequate evidence regarding the effectiveness of breathing exercises and selecting appropriate strategies for the management of post-operation patients [3, 17, 18].

According to our knowledge, only a few studies have assessed the effect of preoperative breathing exercises on patients' physical performance and respiratory complications following CABG surgery, in which contradictory results have been obtained [18, 19]. Studies that examine the pure effect of the preoperative breathing exercise are limited, because in most of the studies, the breathing exercises are done during the pre and postoperative period simultaneously [18, 20]. Therefore, the present study has been implemented to assess the effect of preoperative breathing exercises on the incidence of atelectasis in patients candidate for CABG.

2. MATERIALS & METHODS

2.1. Patients

In a single-blinded randomly allocated parallel-group study (IRCT201404096778N5) that was performed during

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February to December 2014 in a university hospital, 104 patients who were undergoing CABG were randomly assigned into groups of experimental and control, each contained of 52 patients. Patients who were waiting for surgery at least three days were invited to participate in the study. Those who had neuromuscular or cognitive disorders, emergency surgery, history of CABG surgery, respiratory diseases prior to the operation (pneumonia, chronic obstructive pulmonary disease, atelectasis, pleural effusion, and asthma), inability to perform planned breathing exercises, severe renal dysfunction, and history of unstable angina in the last two days were not included in the study. During the study period, patients requiring mechanical ventilation more than 24 hours and reoperation due to probable complications, refusal to continue participation in each of the study steps, and those with postoperative cognitive and neurological complications as well as severe hemodynamic dysfunctions were excluded from the study. For alpha=0.05 (1-tailed) and power of 0.85, and according to atelectasis ratio presented in Brage study, 17.3 and 36.3 percent for the experimental and the control group respectively [21], the required sample size for this study was calculated to be 47 patients in each group, and regarding 10 percent additional samples as sample loss, 52 subjects were determined as the required sample in each group. The Ethics committee of a medical sciences university approved the study protocol. Before the operation at the time of admission, the researcher explained the study objectives to the participants and obtained the informed consent.

The sequence of randomization was produced using Excel 2007 (Microsoft, Redmond, WA, USA) with a 1:1 allocation, using random block sizes of 2 and 4 by an investigator with no clinical involvement in the trial. The series details were unknown to the coordinator or investigators. After obtaining the consent from the patient, research nurse telephoned a number which was independent of the recruitment process for allocation consignment.

2.2. Study Groups and Planned Breathing Exercises

All the patients received the hospital routine physiotherapy once a day for 2 to 3 minutes in the first four days postoperatively. Patients in the experimental group were first trained in the effects of CABG surgery on respiratory function and derived pulmonary complications, and then planned breathing exercises instruction was given to them on the admission day. The researcher attempted to ensure the exercise proper implementation by evaluating the experimental-group participants. The exercises were performed in the preoperative phase under the researcher's supervision.

Planned breathing exercises included three parts; first patients took 10 deep breaths using the incentive spirometer in every waking hour. After a deep inspiration in sitting position, patients kept holding their breath for 2 to 3 seconds, and coughed while exhaling in 5 breaths, and exhaled slowly in other deep breaths by incentive spirometer. Patients coughed 5 consecutive times in every awakening hour and rested for 30 seconds following each cough. Then, the patients wanted to perform 30 deep breaths once per hour in waking hours (in daytime), included three sets of 10 deep breaths with a 30- to 60-s pause between each set.

2.3. Measurements

In the present study, atelectasis in chest x-ray, arterial blood gases, and SpO_2 were compared between groups. Arterial blood gases were measured before anesthesia induction, as well as the first three days after the surgery. SpO_2 was also assessed before and on the fourth day after the operation using pulse oximetry. Chest x-rays were evaluated on the first, second and third postoperative days by an anesthesiologist unaware of the study groups.

The SPSS version 16 software was used for analyzing the data. The one way ANOVA, independent t test and chi-square statistical tests were used for interpreting the data. Statistical significance was considered as P value less than 0.05.

3. RESULTS

From February to December 2014, 104 patients were candidates for coronary artery bypass graft surgery, from whom four patients were excluded from the study for different reasons (one for hemodynamic impairment and death, one participant for prolonged mechanical ventilation, and two cases for re-operation due to bleeding). A total of 100 patients (67 males and 33 females) were enrolled as experimental (n=50) and control (n=50) group for final analysis. The two groups were not significantly different in terms of baseline variables (Table **1**). In addition, none of the experimental patients' experienced a complication during breathing exercises.

3.1. Atelectasis

Chest x-rays evaluation on first, second and third postoperative days showed that the incidence of atelectasis is the same in experimental and control groups. Findings also revealed that 10 patients (20%) in each group exhibited signs of atelectasis on their chest x-ray.

3.2. Arterial Blood Gases and Pulse Oximetry

The results illustrated that SaO_2 and PaO_2 were similar before and first to third days after the surgery between the two groups. PaO_2/FiO_2 ratio was also compared between the two groups and showed similar values before and first to third days after the surgery for both of the study groups. Also, there was no difference between groups in the SpO_2 that was measured on the fourth postoperative day (Table **2**).

4. DISCUSSION

The results of the present study demonstrated that planned breathing exercises including deep breathing, incentive spirometry, and effective coughing does not reduce atelectasis and arterial blood gases disorders, compared to the hospital routine treatment. Incidence of atelectasis was 20 percent in patients performing breathing exercises in the present study, which is similar to the Brage observation reported 17% incidence of atelectasis [21]. Some studies have indicated lower [9, 22], and some others have noted the higher incidence of atelectasis; so as Westerdahl *et al*. have mentioned that almost all the patients undergoing CABG surgery

Table 1. Demographic, pre and postoperative data (mean ± sd).

Variable	Experimental Group	Control Group	P Value
Age (yr)	62.20 ± 9.8	60.62 ± 10.43	0.43
BMI (kg/m2)	25.63 ± 3.77	25.54 ± 3.92	0.91
Male/Female	34/16	33/17	0.83
Number of distal anastamoses	3.2 ± 0.75	3.14 ± 0.90	0.99
Cardiopulmonary bypass time (min)	70.43 ± 15.12	73.04 ± 18.21	0.45
Post-operative ventilation time (min)	10.50 ± 4.50	11.56 ± 4.36	0.23
Number of smokers	15	19	0.68
Number of addicts	8	14	0.22
Ejection fraction (%)	52.18 ± 9.54	52.97 ± 8.52	0.66
Diabetic/no diabetic	9/41	7/42	0.61
HTN/no HTN	20/30	12/37	0.09

BMI: Body mass index; CABG: Coronary artery bypass graft; HTN: hypertension

Table 2. Arterial blood gasses analysis.

	Baseline		P	POD 1		P	POD 3		P
	Experimental	Control		Experimental	Control		Experimental	Control	
Pao_2	67.71 ± 8.88	66.45 ± 7.37	0.46	88.36 ± 20.27	87.71 ± 18.33	0.87	69.89 ± 11.29	69.23 ± 13.24	0.80
SaO_2	93.38 ± 5.47	92.33 ± 6.51	0.40	96.04 ± 1.51	95.54 ± 2.64	0.26	93.55 ± 5.05	93.87 ± 2.59	0.70
$PaCo_2$	33.20 ± 2.39	33.21 ± 1.65	0.98	34.85 ± 3.66	36.71 ± 3.66	0.01	33.67 ± 3.94	34.73 ± 3.67	0.18
PaO_2/FiO_2	324.2 ± 39.5	319 ± 23.6	0.43	175.4 ± 37.6	177.6 ± 33.4	0.70	251.4 ± 81.2	250.2 ± 71.1	0.91

POD: Post Operation Day; PaO_2: Partial arterial Pressure Oxygen; $PaCo_2$: Partial Arterial Pressure of Co_2; SaO_2: Saturation of Arterial Oxygen; FiO_2: Friction of Inspired Oxygen.

have signs of atelectasis [12], and have announced symptoms incidence in 77% of patients [23]. These discrepancies can be owing to numerous definitions for pulmonary complications, various approaches for the measurement of these complications, the difference in demographic characteristics, history of chronic disease in the study populations, and applying different therapeutic techniques in different centers. The results of this study have not shown the prevalence of atelectasis high, but the prevalence (10 in each group) is significant and requires better preventive measures. Compared with other researches [22], cardiopulmonary bypass time was high in this study which can augment pulmonary complication rate. In studies with higher CPB time, the pulmonary complication rate was observed [12].

Preoperative breathing exercises do not reduce the atelectasis in the experimental group compared to the control. Some studies report a better outcome with preoperative breathing exercises. Results had been previously obtained in 2003, and 2005 by Westerdahl and colleagues and in 2009 by Brage *et al* and 2015 by Shakouri *et al*. [11, 12, 18, 21] is in contrast with the present study. A systematic review that is done by Pasquina and Walder doesn't report improvement with breathing exercises [3].

With regard to oxygenation, the study results revealed that SaO_2 and PaO_2 were not different between groups. Furthermore, PaO_2/FiO_2 ratio was compared between the two groups, and on the first postoperative day, significant decline in this ratio was found. On the second day after the surgery, the ratio showed relative improvement in both experimental and control groups. But, on the third day, the ratio was not different between experimental and control groups. In Brage study in 2009 and Westerdahl's in 2003, oxygenation improvement has been reported in patients performing breathing exercises [11, 21]; nevertheless, no difference was found in Westerdahl study, in 2005 [12].

Although hypoxemia is a clinically important alteration after CABG surgery. Hypoxemia is not merely considered as a diagnosis and is usually as a part of other clinical changes such as atelectasis and pneumonia [4]. Therefore, it can be concluded that interventions with a positive impact on pulmonary complications can lead to an improvement in pulmonary function and oxygenation.

Computed tomography scan is better to be applied for the assessment of atelectasis. It has not been performed for the study patients, since it is not routinely done after CABG sur-

gery, and the present survey has been implemented in a standard treatment condition. Moreover, if atelectasis ratio is diagnostically lower, the reduction will be considered in both experimental and control patients, so it cannot cause the difference between the two groups.

Not having a control group without the intervention was among other limitations of the study. It should be noted that despite the interventional effect of usual breathing exercises, it was not ethically feasible not to provide regular breathing exercises to the control group patients. Besides, having a real control group is to some extent impossible, since if a control-group patient develops hypoxemia symptoms, he/she may be encouraged to perform breathing exercises based on the previous routine treatment. According to the available sources of information, there was only one survey with a non-intervention control group among the studies conducted, which could be due to not performing respiratory physiotherapy as that center routine before the study [22].

Moreover, it is better to conduct the study with a larger sample size. It may be if these exercises were done more days before surgery, the positive effect would observe.

CONCLUSION

Results of the present study indicate that performing breathing exercises before the surgery doesn't improve the oxygenation in comparison with those receiving hospital routine treatments. Atelectasis ratio was also the same in both experimental and control groups. Therefore, respiratory physiotherapy is not recommended to be performed as a routine program for all CABG candidate patients before the operation.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

This study was conducted as a thesis for the degree of master of sciences in critical care nursing. The study was supported by the Deputy of research of the Baqiyatallah University of medical sciences.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors kindly thank the managers and staff of the Shiraz Kowsar hospital especially staff of intensive care unit and cardiology wards.

REFERENCES

[1] Keenan TD, Abu-Omar Y, Taggart DP. Bypassing the pump: changing practices in coronary artery surgery. Chest 2005; 128(1): 363-9. [http://dx.doi.org/10.1378/chest.128.1.363] [PMID: 16002958]

[2] Haeffener MP, Ferreira GM, Barreto SSM, Arena R, Dall'Ago P. Prophylactic respiratory physiotherapy after cardiac surgery: systematic review. BMJ (Clinical research ed) 2008; 327(7428): 1379.

[3] Pasquina P, Tramèr MR, Walder B. Prophylactic respiratory physiotherapy after cardiac surgery: systematic review. BMJ 2003; 327(7428): 1379. [http://dx.doi.org/10.1136/bmj.327.7428.1379] [PMID: 14670881]

[4] Wynne R, Botti M. Postoperative pulmonary dysfunction in adults after cardiac surgery with cardiopulmonary bypass: clinical significance and implications for practice. Am J Crit Care 2004; 13(5): 384-93. [PMID: 15470854]

[5] Myles PS, McIlroy D, Eds. Fast-track cardiac anesthesia: choice of anesthetic agents and techniques. SAGE Publications 2005.

[6] Staton GW, Williams WH, Mahoney EM, *et al.* Pulmonary outcomes of off-pump *vs.* on-pump coronary artery bypass surgery in a randomized trial. Chest 2005; 127(3): 892-901. [http://dx.doi.org/10.1378/chest.127.3.892] [PMID: 15764773]

[7] Goksin I, Baltalarli A, Sacar M, *et al.* Preservation of pleural integrity in patients undergoing coronary artery bypass grafting: effect on postoperative bleeding and respiratory function. Acta Cardiol 2006; 61(1): 89-94. [http://dx.doi.org/10.2143/AC.61.1.2005145] [PMID: 16485738]

[8] Ng CSH, Wan S, Yim APC, Arifi AA. Pulmonary dysfunction after cardiac surgery. Chest 2002; 121(4): 1269-77. [http://dx.doi.org/10.1378/chest.121.4.1269] [PMID: 11948063]

[9] Brasher PA, McClelland KH, Denehy L, Story I, Yang W. Does removal of deep breathing exercises from a physiotherapy program including pre-operative education and early mobilisation after cardiac surgery alter patient outcomes? Aust J Physiother 2003; 49(3): 165-73. [http://dx.doi.org/10.1016/S0004-9514(14)60236-1] [PMID: 12952516]

[10] Pasquina P, Tramèr MR, Granier JM, Walder B. Respiratory physiotherapy to prevent pulmonary complications after abdominal surgery: a systematic review. Chest 2006; 130(6): 1887-99. [http://dx.doi.org/10.1378/chest.130.6.1887] [PMID: 17167013]

[11] Westerdahl E, Lindmark B, Eriksson T, Hedenstierna G, Tenling A. The immediate effects of deep breathing exercises on atelectasis and oxygenation after cardiac surgery. Scand Cardiovasc J 2003; 37(6): 363-7. [http://dx.doi.org/10.1080/14017430310014984] [PMID: 14668188]

[12] Westerdahl E, Lindmark B, Eriksson T, Friberg O, Hedenstierna G, Tenling A. Deep-breathing exercises reduce atelectasis and improve pulmonary function after coronary artery bypass surgery. Chest 2005; 128(5): 3482-8. [http://dx.doi.org/10.1378/chest.128.5.3482] [PMID: 16304303]

[13] Westerdahl E, Lindmark B, Almgren SO, Tenling A. Chest physiotherapy after coronary artery bypass graft surgery--a comparison of three different deep breathing techniques. J Rehabil Med 2001; 33(2): 79-84. [http://dx.doi.org/10.1080/165019701750098920] [PMID: 11474953]

[14] Herdy AH, Marcchi PLB, Vila A, *et al.* Pre- and postoperative cardiopulmonary rehabilitation in hospitalized patients undergoing coronary artery bypass surgery: a randomized controlled trial. Am J Phys Med Rehabil 2008; 87(9): 714-9. [http://dx.doi.org/10.1097/PHM.0b013e3181839152] [PMID: 18716482]

[15] Hulzebos EHJ, Helders PJM, Favié NJ, De Bie RA, Brutel de la Riviere A, Van Meeteren NLU. Preoperative intensive inspiratory muscle training to prevent postoperative pulmonary complications in high-risk patients undergoing CABG surgery: a randomized clinical trial. JAMA 2006; 296(15): 1851-7. [http://dx.doi.org/10.1001/jama.296.15.1851] [PMID: 17047215]

[16] Moradian ST, Najafloo M, Mahmoudi H, Ghiasi MS. Early mobilization reduces the atelectasis and pleural effusion in patients undergoing coronary artery bypass graft surgery: A randomized clinical trial. Journal of vascular nursing : official publication of the Society for Peripheral Vascular Nursing 2017; 35(3): 141-5. [http://dx.doi.org/10.1016/j.jvn.2017.02.001]

[17] Westerdahl E, Möller M. Physiotherapy-supervised mobilization and exercise following cardiac surgery: a national questionnaire survey in Sweden. J Cardiothorac Surg 2010; 5(1): 67. [http://dx.doi.org/10.1186/1749-8090-5-67] [PMID: 20738852]

[18] Shakouri SK, Salekzamani Y, Taghizadieh A, *et al.* Effect of respiratory rehabilitation before open cardiac surgery on respiratory function: a randomized clinical trial. J Cardiovasc Thorac Res 2015; 7(1): 13-7. [http://dx.doi.org/10.15171/jcvtr.2014.03] [PMID: 25859310]

[19] Arthur HM, Daniels C, McKelvie R, Hirsh J, Rush B. Effect of a preoperative intervention on preoperative and postoperative outcomes in low-risk patients awaiting elective coronary artery bypass graft surgery. A randomized, controlled trial. Ann Intern Med 2000; 133(4): 253-62. [http://dx.doi.org/10.7326/0003-4819-133-4-200008150-00007] [PMID: 10929164]

[20] Savci S, Degirmenci B, Saglam M, *et al.* Short-term effects of inspiratory muscle training in coronary artery bypass graft surgery: a randomized controlled trial. Scand Cardiovasc J 2011; 45(5): 286-93. [http://dx.doi.org/10.3109/14017431.2011.595820] [PMID: 21793631]

[21] Yánez-Brage I, Pita-Fernández S, Juffé-Stein A, Martínez-González U, Pértega-Díaz S, Mauleón-García A. Respiratory physiotherapy and incidence of pulmonary complications in off-pump coronary artery bypass graft surgery: an observational follow-up study. BMC Pulm Med 2009; 9(1): 36. [http://dx.doi.org/10.1186/1471-2466-9-36] [PMID: 19638209]

[22] Stiller K, Montarello J, Wallace M, *et al.* Efficacy of breathing and coughing exercises in the prevention of pulmonary complications after coronary artery surgery. Chest 1994; 105(3): 741-7. [http://dx.doi.org/10.1378/chest.105.3.741] [PMID: 8131535]

[23] Dull JL, Dull WL. Are maximal inspiratory breathing exercises or incentive spirometry better than early mobilization after cardiopulmonary bypass? Phys Ther 1983; 63(5): 655-9. [http://dx.doi.org/10.1093/ptj/63.5.655] [PMID: 6844410]