Original Article

Dose response relationship of incentive spirometer on lung compliance in post-coronary artery bypass grafting patients

Madiha Ashfaq, Furqan Ahmed Siddiqi, Muhammad Iqbal Tariq, Muhammad Saqeef, Hina Shafi, Sana Bashir

Department of Cardiology, Foundation University Institute of Rehabilitation Sciences, Riphah College of Rehabilitation Sciences, Islamabad, Pakistan

Objective: To assess the dose response relationship of incentive spirometer on lung compliance among post-coronary artery bypass grafting (CABG) patients.

Methodology: This Quasi Experimental study was conducted at Begum Akhtar Memorial Hospital, Bahria, Islamabad and included 45 patients. Non-probability purposive sampling technique was used. Via PEFR meter Peak Expiratory Flow was taken and with IS Forced Expiratory Volume in 1 minute and Forced Vital Capacity were measured. Incentive Spirometer was performed.

Results: Pre and post session PEFR, FEV1 and FVC of Groups A, B and C showed that p-values of Pre-Post 1st session, Pre-post 2nd session were not statistically significant.

Conclusion: Incentive Spirometer although can be clinically effective, but further studies are needed to quantify specific dosage of IS.

Keywords: Incentive spirometer, coronary artery bypass grafting (CABG), dose response relationship.

INTRODUCTION

The burden of coronary artery disease (CAD) remains high around the globe and continues to be the main cause of death, morbidity, and loss of quality of life.[1] CAD can be managed conservatively by changing lifestyle, doing regular exercises, quitting smoking, controlling blood pressure, diabetes and maintaining cholesterol levels.[2-4] As the disease increases,PCI and coronary artery bypass grafting (CABG)are used.[5,6] CABG procedure provides enhanced amount of oxygen and nutrients to cardiac muscles[7,8] and often performed in triple vessels CAD.[9,10]

After cardiac surgery, post-pulmonary complications (PPC) occur frequently. There are different ways utilized as a part of chest physical therapy, for example, BiPaP, breathing activities, diaphragmatic activities and Incentive spirometry (IS) to reduce PPCs. And out of these, IS has a wide role in preventing and reducing PPC such as pneumonia, atelectasis, pleural effusion, lung secretions and prolong hospital stay.[11] It is also used to prevent by taking deep breaths after thoracic and abdominal surgeries.[12]

Various studies support the effectiveness of IS after CABG surgeries.[13] Use of pre- and postoperative ISgreatly reduced the risk of PPC.[14] With IS, patient inhales though the mouth piece balls placed in the chamber and the level to which balls raise, indicates the inspiratory and expiratory capacities of patients.[15] Time of hospital stay was also reduced by muscle training via IS.[16] We found a major gap related to lack of proper guidelines for usage of IS hence, if an effective dosage is set, then it will greatly improve the lung compliance, which in turn, will increase quality of life of patients after CABG. So, there was a need to evaluate effectiveness of appropriate dosage of incentive spirometry among CABG patients.

METHODOLOGY

This Quasi Experimental Study of 6 months' duration with a sample size of total 45 patients with three groups (15 patients in each) was conducted in Begum Akhtar Memorial Hospital, Bahria, Islamabad. Non-probability purposive sampling technique was used. Both genders of age between 40 to 60 years, 1st post op day of CABG, ejection fraction more than 40% and hemodynamically stable patients were included in the study. Hemodynamically unstable or having serious bed-stricken medical condition patient's (e.g., Infection, DVT etc.), heart rate more than 150 beats per minute, impaired cognition with GCS below 3 and severe neurological deficits like stroke were excluded. Ethical approval from Institutional Review Board (IRB) was taken and all participants gave an informed consent.

After obtaining demographics of 45 patients, they were divided into 3 groups; A, B and C, according to systematic manner (on the basis of first contact patient in Group A, second in B and third in C and likewise it was repeated till the groups were filled with number of patients as 15 in each).

Via PEFR meter Peak Expiratory Flow was taken and with IS Forced Expiratory Volume in 1 minute and Forced Vital Capacity were measured. Incentive Spirometer was performed according to format given: Group A with IS Dose = 3 reps with 5 sec pauses; Group B with IS Dose = 15 reps continuously and Group C with IS Dose = 7 reps with 5 sec pauses, for twice (morning and evening) on 1st and 2nd Post-op days respectively.Pre and post sessions readings among all groups were compared.

Statistical Analysis: Data were analyzed on SPSS version 21. Comparison between the groups for all outcome variables (PEFR, ISL, FEV1 and FVC) was done by applying ANOVA. $p < 0.05$ was considered significant.

RESULTS

Out of 45 patients, 9 (60%) were males and 6 (40%) females in Group A, 11 (73.3%) were males and 4 (26.7%) females in group B, and 13 (86.7%) males and 2 (13.3%) females in group C. The mean age of Group A was 52.07 ± 7.97, group B was 59.67 ± 9.84 and group C was 54.40 ± 7.36. The mean weight of group A was 73.20 ± 15.68, Group B was 74.13 ± 9.11 and group C was 80.67 ± 15.351.

Table 1: PEFR Metre (Peak Expiratory Flow).

PEFR (Peak Expiratory Flow)	Group A (Mean ± SD)	Group B (Mean ± SD)	Group C (Mean ± SD)	p-Value
1st pre- session	1.26 ± 0.72	1.11 ± 0.43	1.53 ± 0.88	0.270
1st post-session	1.38 ± 0.71	1.49 ± 0.48	1.55 ± 0.79	0.791
2nd pre-session	1.35 ± 0.69	1.47 ± 0.61	1.37 ± 0.72	0.887
2nd post-session	1.47 ± 0.70	1.87 ± 0.67	1.46 ± 0.82	0.240

Table 2. Incentive spirometer level.

Incentive Spirometer Level	Group A Mean ± SD (n = 15)	Group B Mean ± SD (n = 15)	Group C Mean ± SD (n = 15)	p value
Pre 1st Session	260.00 ± 98.56	300.00 ± 141.42	266.67 ± 97.59	0.594
Post 1st Session	280.00 ± 120.71	396.67 ± 128.82	273.3333 ± 88.37	0.007
Pre 2nd Session	283.33 ± 109.65	400.00 ± 125.36	300.00 ± 113.39	0.018
Post 2nd Session	393.33 ± 116.29	580.00 ± 142.43	320.00 ± 137.32	0.000

Table 3: Incentive spirometer (Forced Expiratory Volume in 1 minute).

(IS) Forced Expiratory Volume in 1 Minute	Group A (Mean ± SD)	Group B (Mean ± SD)	Group C (Mean ± SD)	p- value
1st Pre-session	0.59 ± 0.37	1.24 ± 2.70	0.78 ± 0.50	0.520
1st Post-session	4.24 ± 13.49	0.82 ± 0.14	0.83 ± 0.42	0.392
2nd Pre-session	0.66 ± 0.37	0.77 ± 0.19	0.73 ± 0.43	0.694
2nd Post-session	0.79 ± 0.38	0.98 ± 0.12	0.80 ± 0.42	0.227

Table 4: Incentive Spirometer (Forced vital capacity).

Forced Vital Capacity	Group A Mean ± SD (n = 15)	Group B Mean ± SD (n = 15)	Group C Mean ± SD (n = 15)	p value
Pre 1st Session	0.62 ± 0.40	0.65 ± 0.38	0.88 ± 0.59	0.258
Post 1st Session	0.78 ± 0.40	0.86 ± 0.14	0.89 ± 0.47	0.660
Pre 2nd Session	0.68 ± 0.38	0.79 ± 0.19	0.78 ± 0.47	0.659
Post 2nd Session	0.80 ± 0.38	1.01 ± 0.08	0.85 ± 0.47	0.238

Comparison among the groups A, Group B and Group C was done by applying ANOVAs on pre-post 1st session and pre-post 2nd session of Peak Expiratory Flow, p values for both sessions (0.270, 0.791, 0.887 & 0.240), were statistically insignificant (Table 1). P-values (0.594, 0.007, 0.018 & 0.000) of both pre- post sessions of Incentive Spirometer Level among three groups were found to be statistically significant (Table 2). P-values (0.520, 0.392, 0.694 & 0.227) of Forced Expiratory Volume in 1 minute were also found to be statistically insignificant (Table 3). p-values (0.258, 0.660, 0.659 & 0.238) of Forced Vital Capacity among three groups for both pre-post sessions were also found to be statistically insignificant (Table 4).

DISCUSSION

Comparison between the groups A, B and C for PEFR, FEV1 and FVC, Pre- Post 1st session and Pre-post 2nd session were not statistically significant whereas ISL was found to be statistically significant. Flow-oriented devices enforce more work of breathing and increase muscular activity of the upper chest. Volume-oriented devices enforce less work of breathing and improve diaphragmatic activity the results of which directly coincide with the findings of our study that volume, level and flow have significant impact on both improvements in lung compliance and muscular activity.[17-19] Some studies showed no clear evidence establishing its benefit to prevent PPCs, which contradict with our study.[20]

A study showed that pulmonary functions (FVC, FEV1, PEFR) on 1st post-operative day when compared to preoperative period had a significant decrease in both flow and volume IS and our study is supported.[21] Ko et al found that although there is a small change produced using IS combined with various breathing exercises and coughing techniques in the prevention of PPCs yet they emphasized on a fact that this small improvement was thought to be worth the investment in terms of utilization of manpower resources, although the addition of conventional physiotherapy added significantly to staff time.[22] Our results coincides with their findings.

Another systemic review titled "Incentive spirometry in major surgeries" concluded that there was no evidence to support the use of IS in the management of surgical patients.[23] These findings are contrary to our study which emphasizes its significant role in clinical practice.Possibly IS treatment given more frequently may be more effective. Yet quantifiable dosage of IS perspectives need to be incorporated into future trials with larger sample size and multiple settings to build a stronger evidence base for IS dose-response relationship on lung compliance after CABG surgeries.

Dosage should be determined using reliable methods capable of collecting data on various IS parameters throughout the intervention period so that valid inferences can be made. Data collection methods should be standardized to enable comparisons between trials and reporting should be comprehensive to facilitate valid dosage interpretations.

CONCLUSION

Incentive Spirometer although can be clinically effective, further studies are needed to quantify specific dosage of IS.

Author Contributions:
Conception and design: Madiha Ashfaq.
Collection and assembly of data: Madiha Ashfaq.
Analysis and interpretation of data: Furqan Ahmed, Muhammad Iqbal Tariq.
Drafting of the article: Madiha Ashfaq, Hina Shafi, Sana Bashir.
Critical revision of article for important intellectual content: Muhammad Saqeef.
Statistical expertise: Furqan Ahmed, Muhammad Iqbal Tariq.
Final approval and guarantor of the article: Madiha.
Corresponding author email: Sana: drsana.bashir@fui.edu.pk
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