Pre-operative Pulmonary Training Program in Coronary Artery Bypass Graft Surgery Patients at Siriraj Hospital

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ABSTRACT

Objective: To compare the incidence of pulmonary complications in coronary artery bypass graft surgery patients who underwent a pre-operative pulmonary training program to those who did not.

Methods: The patients with coronary artery disease who underwent elective coronary artery bypass graft (CABG) surgery at Siriraj Hospital from January to December 2007 were included in this study and were divided into two groups depending on whether they received a pre-operative pulmonary training program. The primary clinical variable was the presence or absence of pulmonary complications. The comparison of the pre-operative pulmonary training and non- pre-operative pulmonary training group was performed by the Chi-square test for the qualitative data and the Independent sample t-test for the quantitative data.

Results: A total of 627 patients were divided into two groups, the pre-operative pulmonary training group (G1) and non-pre-operative pulmonary training group (G2). Comparison between the two groups showed, pulmonary complications were significantly more frequent in G2 than in G1 (7.4% and 3.1%). The difference in incidence of pneumonia was also statistically significant (6.6% and 0.8% in G2 and G1), respectively. The odds ratio for total pneumonia of G2 was 9.3, 95% CI [2.1, 57.3] and for total pulmonary complication of G2 was 2.6, 95% CI [1.1, 6.3]. G2 also had a longer length of stay than G1 (11.0 ± 10.3 and 15.3 ± 12.2 days), respectively.

Conclusion: A pre-operative pulmonary training program can prevent post-operative pulmonary complications and reduce the length of hospital stay in patients who underwent coronary artery bypass surgery.

Keywords: Incidence, post-operative pulmonary complication, pre-operative pulmonary training program, coronary artery bypass graft, pneumonia

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Coronary artery disease is one of the primary causes of death in the world,[1] including Thailand.[2] From the Thai Health Profile 2005-2007, the admission rate per 100,000 populations has risen from 56.5 in 1985 to 618.5 in 2006.[3-4] Although CABG should give satisfactory results, post-operative pulmonary complications can occur[4,5-6] and are the most common causes of morbidity and mortality.[7] Its incidence has a wide range of 6% to 76%.[7]

A pre-operative pulmonary training program is widely used to prevent pulmonary complications after surgery.[8-9] However, its benefits may be controversial. The study of Yanez-Brage[6] in 2009 reported that pre-operative respiratory physiotherapy such as use of an incentive spirometry and breathing exercise could reduce pulmonary complications in coronary artery bypass graft surgery. Hulzebos in 2006[11] supported that pre-operative inspiratory muscle training in high risk patients awaiting elective coronary artery bypass graft surgery could prevent post-operative pulmonary complications. Arthur in 2000[12] also supported that pre-operative intervention could reduce post-operative pulmonary complications in low risk patients awaiting elective coronary artery bypass graft surgery. On the contrary, the study of Weiner in 1998[13] reported that prophylactic inspiratory muscle training in patients undergoing coronary artery bypass graft could not prevent pulmonary complication and Stiller in 1994[14] also reported that breathing and coughing exercises could not prevent pulmonary complications after coronary artery bypass graft surgery. In

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Thailand, there are various preoperative pulmonary training programs such as deep breathing exercise, diaphragmatic breathing exercise, use of incentive spirometry, forced expiratory technique, cough training and inspiratory muscle training which are adopted depending on physicians in each hospital. However there is no study about the effectiveness of those programs on pulmonary outcomes.

The aim of this study is to compare the incidence of post-operative pulmonary complications in patients who underwent a pre-operative pulmonary training program to those who did not in elective coronary artery bypass graft surgery patients.

MATERIALS AND METHODS

The patients with coronary artery disease who underwent elective coronary artery bypass graft surgery at Siriraj Hospital in Thailand from January to December 2007 were included in this study. The exclusion criterium was any patient who died during the perioperative period. Six hundred and twenty seven patients were divided into two groups depending on whether they received a pre-operative pulmonary training program. Each patient in a pre-operative pulmonary training group received a pre-operative training program from a physical therapist including an incentive spirometry and deep breathing exercise 10 times every hour when awake, cough training and early mobilization during the pre-operative period, and he or she also received the post-operative physical therapy. The primary clinical variable was the presence or absence of pulmonary complications such as pneumonia, atelectasis, pleural effusion, pneumothorax and respiratory failure which are diagnosed in the inpatient record. The secondary variable was the length of hospital stay which was calculated from the day of surgery until the day of discharge.

The sample size was calculated. The confident level is 95% and the post-operative pulmonary complication from previous studies was 20%.[6,11] The minimal number was 246 patients for each group.

The comparison of the pre-operative and non-pre-operative pulmonary training groups was performed by the Chi-square test for the qualitative data and the Independent sample t-test for the quantitative data. The statistical significance was set at 5% ($p<0.05$). This study was approved by Siriraj Hospital's Ethics Committee (Si 238/2009).

RESULTS

Six hundreds and twenty seven patients were admitted for elective CABG surgery from January to December 2007. There were 430 males (68.6%) and 197 females (31.4%), with ages ranging from 57.2 to 76.7 years old. They were divided into two groups, the pre-operative pulmonary training group [G1, 264 patients (42.1%)] and non-pre-operative pulmonary training group [G2, 363 patients (57.9%)].

The two groups were similar in age, sex and comorbidities such as hypertension, diabetes mellitus, chronic renal failure, peripheral vascular disease, obesity, asthma and chronic obstructive pulmonary disease which indicated no statistically significant difference between the two groups. Dyslipidemia was the only characteristic that G2 had patients more than G1 (Table 1). The incidence of total pulmonary complications in both groups was 5.58% and the most frequent pulmonary complication was pneumonia. The most frequent pulmonary complication in G1 was pleural effusion while the most complication in G2 was pneumonia (Table 2).

Comparison between the two groups indicated that total pulmonary complications were significantly more frequent in G2 than in G1 (7.4% and 3.1%). The difference in the incidence of pneumonia was also statistically significant (6.6% and 0.8% in G2 and G1), respectively (Table 2). In the comparison of G2 to G1, the odds ratio for total pneumonia was 9.3, 95% CI [2.1, 57.3] and for total pulmonary complication was 2.6, 95% CI [1.1, 6.3]. However, the distribution of patients with other pulmonary complications such as pleural effusion, atelectasis, pneumothorax and respiratory failure showed no statistically significant difference (Table 2).

One patient (0.4%) in G1 and nine patients (2.5%) in G2 died ($p = 0.05$). The cause of death in G1 was pneumonia whereas the causes of death in G2 were pneumonia (2 patients), hyperkalemia (2 patients), cardiogenic shock (2 patients), myocardial failure (1 patient), intracerebral hemorrhage (1 patient) and infective endocarditis (1 patient). The patients in G2 had a longer length of stay in hospital than G1 [11.0 ± 10.3 and 15.3 ± 12.2 days, respectively ($p <0.001$)].

DISCUSSION

The authors divided the patients into two groups

TABLE 1. Demographic data of pre-operative pulmonary training group (G1) and non-pre-operative pulmonary training group (G2).

Demographic data	Pre-operative pulmonary training group (G1) (n=264)	Non-pre-operative pulmonary training group (G2) (n=363)	p-value
Age (year)	67.2±9.5	66.8±9.6	0.39
Gender	Case (%)	Case (%)	
Female	84 (31.8)	113 (31.1)	0.92
Male	180 (68.2)	250 (68.9)	
Diabetes mellitus	121 (45.8)	175 (48.2)	0.61
Hypertension	211 (79.9)	276 (70)	0.29
Dyslipidemia	53 (20)	184 (50)	<0.001*
Chronic renal failure	17 (6.4)	36 (9.9)	0.17
Peripheral arterial disease	2 (0.8)	10 (2.8)	0.13
Obesity	1 (0.4)	0 (0)	0.42
Asthma	3 (1.1)	2 (0.6)	0.56
COPD	4 (1.5)	7 (1.9)	0.76

* $p < 0.05$: statistical significant

TABLE 2. Post-operative pulmonary complications of pre-operative pulmonary training group (G1) and non-pre-operative pulmonary training group (G2).

Post-operative pulmonary complications	Pre-operative pulmonary training group (G1) (n=264) Case (%)	Non-pre-operative pulmonary training group (G2) (n=363) Case (%)	p-value
Atelectasis	0 (0)	0 (0)	0.39
Pneumonia	2 (0.8)	24 (6.6)	<0.001*
Isolated pneumonia	2 (0.8)	18 (5)	0.01
Pneumonia and pleural effusion	0 (0)	3 (0.8)	0.27
Pneumonia and respiratory failure	0 (0)	3 (0.8)	0.27
Pleural effusion	5 (1.9)	6 (1.6)	1.0
Pneumothorax	1 (0.4)	0 (0)	0.42
Total	8 (3.1)	27 (7.4)	0.03*

* $p < 0.05$: statistical significant

which were the pre-operative pulmonary training group (G1) and the non-pre-operative pulmonary training group (G2) and defined the pre-operative pulmonary training group as the patients who underwent the pre-operative pulmonary training program that consisted of deep breathing exercises, incentive spirometry training, cough training and early mobilization.

To compare the differences between the two groups, the authors used statistical significance among several variables. Regarding the baseline characteristics such as age, sex and comorbidities, there was no significant difference between the two groups except dyslipidemia. The patients in G1 had dyslipidemia more often than those in G2. However, this condition was not related to pulmonary complications.

In this study, the total post-operative pulmonary complications were significantly lower in the group that received the pre-operative pulmonary training program as in the study of Hulzebos in 2006[11] and Arthur in 2000.[12] In addition, the incidence of pneumonia was also significantly reduced in the pre-operative pulmonary training group. The reasons might be that the pre-operative pulmonary training program could prevent the deterioration of lung capacity and weakness of the inspiratory muscle.

The two frequent pulmonary complications in both groups were pneumonia and pleural effusion, which were similar to the other studies.[15] However, it was surprising that atelectasis was not the most common complication which was different from the other studies in post-cardiac surgery patients.[6,16] The reason might be explained from the invalidity of diagnostic criteria or under diagnosis. Regarding the other pulmonary complications such as pleural effusion, pneumothorax and respiratory failure, there was no significant difference between the two groups.

The cause of death in G1 was pneumonia and the causes of death in G2 were various causes such as pneumonia, hyperkalemia and cardiogenic shock. Comparison between the two groups indicated that totally dead patients were significantly more frequent in G2 than in G1 (2.5% and 0.4%). However, the number of deaths from pneumonia was not significantly different between the two groups (0.55% in G2 and 0.4% in G1).

The length of hospital stay was significantly lower in the group that received the pre-operative pulmonary training program. There are studies in the literature in which the use of a pre-operative pulmonary training program showed a reduction in ICU time and hospital stay.[7,8,17]

A limitation of this study was that it was a retrospective study, so controlling variables might be affected. Moreover, the number of sessions of pre-operative pulmonary training program was limited because it was not possible to admit patients much earlier due to the increased length of hospital stay and costs. For the next study, a plan for a prospective study and a preoperative outpatient pulmonary training program should be prepared and implemented.

CONCLUSION

A pre-operative pulmonary training program can reduce the risk of post-operative pulmonary complications, especially pneumonia and also reduce the length of hospital stay.

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