

# Relationship of postoperative walk test and lung function with the length of heart surgery hospital stay

*Relação do teste de caminhada pós-operatório e função pulmonar com o tempo de internação da cirurgia cardíaca*

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RBCCV 44205-1121

## Abstract

**Objective:** The lung function is identified as a predictor of time of hospital stay in heart surgery. Meanwhile six-minute walk test has been used to establish functional capacity of cardiac patients, however there are few studies that correlate it with the length of hospital stay. The aim of this study was to determine whether there is correlation of preoperative and postoperative lung function and the postoperative deambulation ability with postoperative hospital stay.

**Methods:** A prospective cohort with 18 patients was performed, being 8 males and 10 females, with age above 40 years (mean  $64.89 \pm 6.95$  years). Patients were admitted for coronary artery bypass graft surgery and/or valve replacement. To characterize the pulmonary function, patients had undergone spirometry in preoperative and at 5th postoperative day. In the latter period was also performed a test for 6 minutes walk (6MWT) to characterize the deambulation ability.

**Results:** There was not significant correlation of preoperative and postoperative lung function with length of postoperative hospital stay. Only the distance covered in 6MWT showed a significant negative correlation ( $\rho=-0.62$ ) with length postoperative hospital of stay. The distance in 6MWT obtained a significant positive correlation with forced vital capacity ( $r=0.59$ ) and first second of a maximal forced expiratory maneuver ( $r=0.52$ ).

**Conclusion:** These results suggest that patients with increased postoperative deambulation capacity have a shorter time of hospital stay and it also suggests that the distance in the 6MWT can better represent the functional capacity of these patients than lung function alone.

**Descriptors:** Respiratory function tests. Early ambulation. Length of stay. Cardiovascular surgical procedures.

## Resumo

**Objetivo:** A função pulmonar é apontada como preditora do tempo de hospitalização na cirurgia cardíaca. E o teste de caminhada de seis minutos (TC6') tem sido utilizado para caracterizar a capacidade funcional em pacientes cardiopatas, porém há poucos estudos que o correlacione com tempo de internação hospitalar. O objetivo desta pesquisa foi verificar se há correlação da função pulmonar pré e pós-operatória e da capacidade da deambulação pós-operatória com tempo de internação pós-operatória.

**Métodos:** Foi realizada uma coorte prospectiva com 18 pacientes, sendo 8 do gênero masculino e 10 do gênero feminino, com idade acima de 40 anos (média  $64,89 \pm 6,95$  anos), internados para a submissão de cirurgias de revascularização do miocárdio e/ou troca valvar. Para caracterizar a função pulmonar, os pacientes foram submetidos a uma espirometria no pré-operatório e ao 5°

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Article received on May 25<sup>th</sup>, 2009  
Article accepted on October 13<sup>th</sup>, 2009

dia pós-operatório. Neste último período também foi realizado um teste de caminhada de 6 minutos (TC6') para caracterizar a capacidade de deambulação.

**Resultado:** Não houve correlação significativa da função pulmonar pré e pós-operatória com o tempo de internação pós-operatória. Somente a distância percorrida no TC6' apresentou correlação negativa significativa ( $\rho=-0,62$ ) com o tempo de internação pós-operatória. A distância no TC6' obteve correlação positiva significativa com a capacidade vital forçada ( $r=0,59$ ) e volume expiratório forçado no 1° segundo ( $r=0,52$ ).

**Conclusão:** Esses resultados sugerem que os pacientes com maior capacidade de deambulação no pós-operatório apresentam menor tempo de internação e sugere-se também que a distância no TC6' pode representar melhor a capacidade funcional desses pacientes do que a função pulmonar isoladamente.

**Descritores:** Testes de função respiratória. Deambulação precoce. Tempo de internação. Procedimentos cirúrgicos cardiovasculares.

## INTRODUCTION

The American Heart Association (AHA) estimates that there are 80,700,000 American adults with one or more types of cardiovascular disease, representing a ratio of one American with no cardiovascular impairment in three healthy ones [1]. The institution also reports that each year 6,989,000 cardiac surgeries are performed in the United States of America (USA), and in 2005 were approximately 469,000 coronary artery bypass grafting in 261,000 patients, with a mortality rate around 2.1% [1]. In Brazil, according to the DATASUS [2], 10,652 coronary artery bypass grafting and/or valve replacement surgeries were performed during the period January to June 2008, with a cost of R\$ 91,837,917.24, with average value of each hospital of R\$ 8,621.66 and the national mortality rate was of 7.93% during that period. With this epidemiological presentation, it is observed the high cost that the cardiac surgery has in the attention of high complexity issue in health.

Cardiac surgery causes in the patient a series of clinical and functional complications, among them, the postoperative complications (PPC) are the most common, with incidence ranging from 6% to 88%, and directly contributes to increased morbidity and mortality, duration of hospital stay, use of resources and time to return to productive life [3-6]. This is due to changes induced by cardiac surgery on pulmonary and cardiac mechanics when using general anesthesia, median sternotomy, thoracic manipulation and cardiopulmonary bypass (CPB), causing depression of cardiorespiratory function and postoperative pain [6,7]. These dysfunctions affect the breathing pattern, reducing lung volume and capacity, contributing to the appearance of atelectasis and changes in the ventilation/perfusion relationship [7,8].

This presentation reduces the cardiorespiratory capacity, which is also negatively influenced by physical postoperative inactivity, due to longer bed rest, which also produces loss of muscle strength and deconditioning,

which is a risk factor for pulmonary complications and thromboembolism [8-10]. However, this immobility results not only from the patient's medical condition when admitted to hospital, which already dictates a greater need for rest than usual, but also traditional perioperative cares, which also involve the prescription of bed rest [10, 11].

The positioning of the patient to rest in the dorsal decubitus position causes a reduction in volume and lung capacity and increased work of breathing and heartbeat. This is because the positioning promotes the accumulation of central blood volume that promotes the formation of congestion, edema and decreased lung compliance, as well as reduced cardiac output by 30%, which can lead to orthostatic intolerance [8-10].

Thus, there is a need to evaluate the patient from the preoperative and follow the behavior of variables during his hospital stay. In this analysis a proper pulmonary and functional evaluation of patients should be included related to the type of surgical procedure to be performed [11]. And all these evaluations could be better assessed when correlated with an objective parameter of quantification of the patients's deambulation ability.

In light of the foregoing, the aim of this study was to evaluate pre- and postoperative lung function and the postoperative deambulation ability; this latter considered by the distance of the six-minute walk test (6-MWT) in patients undergoing CABG and/or valve replacement, to assess the influence of both variables at the time of hospital stay.

## METHODS

It was performed a prospective cohort study that assessed pulmonary function and the distance walked at 6MWT of patients undergoing coronary artery bypass grafting and/or valve replacement through a median sternotomy in both genders (male and female), aged above 40 years treated at the Cardiology Institute of the Distrito

Federal (IC-DF), from March to August of 2007 and 2008. Patients were informed about the procedures to be performed and signed a written informed consent to participate in this study, in compliance with Resolution 196/96 of the National Health Council. This study was approved by the Research Ethics Committee of IC-DF, under number 012/2007.

During the period from March to August 2007 and 2008, 145 patients were admitted to perform CABG procedure and/or valve replacement in the IC-DF. For this study, 101 patients were excluded, and of these, 34 patients were below the age of inclusion, eight patients with other associated surgical procedure, 19 patients who had not medical release to perform the tests, four patients with secondary motor impairment and 36 patients who did not signed a written informed consent.

Among the 44 patients studied, 26 patients were excluded and 11 dropouts, three deaths, a sequel due to encephalic stroke perioperatively and 11 patients had not medical release to perform the tests in the postoperative period. Thus, the sample consisted of 18 patients.

Pulmonary function was characterized by spirometry, using the portable spirometer manufactured by Micro Medical model Microlab 3500 (Rochester, England). Forced vital capacity maneuver was performed following the technical procedures, criteria for acceptability and reproducibility, as recommended by the American Thoracic Society [12]. The technique was performed until we obtained the values of at least three maneuvers without air leak detected by the device and it chose the curve with the best performance. The variables of the test to be used in the study are the Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second ( $FEV_1$ ) Tiffenau index ( $FEV_1/FVC$ ) and Peak Expiratory Flow (PEF). We measured the absolute values, expressed in BTPS conditions, and calculated the percentage related to predicted for gender, height and age, following table described by Pereira et al. [13] already saved in the device.

To characterize the deambulation ability, the patient also underwent the 6-MWT at the fifth postoperative day. When released, before and after the 6-MWT were collected at rest blood pressure, respiratory rate, heart rate, oxygen saturation and data of fatigue or dyspnea by means of the Borg's scale of subjective perception. The patient was guided to walk as fast as possible without running, as recommended by the American Thoracic Society [12] in a course of 30 meters, marked every 3 meters, with the turning point marked by a cone. After completing the six minutes, the patient immediately stopped and sat in a chair where he left off. It was measured the total distance walked by the patient and again all variables at the time of stopping, with repetition of the after two minutes and again after five minutes. After half an hour, it was performed again the

patient's spirometry. And, when the patient was discharged from hospital, it was recorded the length of hospital stay in the postoperative period.

The statistical management of data was performed using the SPSS software, version 13.0 for Windows and Excel spreadsheet. The Shapiro-Wilk test showed that all variables presented normal distribution, except the length of postoperative hospital stay. Thus, we used the paired t test to compare lung function before and after surgery and the Spearman correlation ( $\rho$ ) for the correlation of lung function and 6-MWT distance with the time of admission. For correlation between the 6-MWT distance, with age, with the left ventricular ejection fraction (LVEF) and pulmonary function after surgery, it was used Pearson's correlation test. It was considered as level of statistical significance ( $P$ ) a value equal or less than 0.05.

## RESULTS

The final sample consisted of 18 patients: eight (44.44%) were female and 10 (55.56%) were male, mean age of  $64.89 \pm 6.95$  years (50-78 years) and the mean LVEF of  $63.44 \pm 8.42\%$  (47-79%). The median length of postoperative hospital stay was 7 days and the average of  $7.22 \pm 3.02$  days (5-18 days).

The results from spirometric values collected preoperatively and on the fifth postoperative day are described in Table 1. It can be observed a significant reduction of all values except the Tiffenau values.

The average distance in 6-MWT was  $375.78 \pm 50.66$  meters, and the maximum walked in the sample was of 457 meters and minimum of 270 meters.

Table 1. Values of pre- and postoperative pulmonary function (n=18)

Variables <sup>o</sup>	Preoperative*	5th PO *	P
$FEV_1$ (%)	$87.33 \pm 20.80$	$56.78 \pm 18.03$	<0.0001 <sup>**</sup>
FVC (%)	$84.33 \pm 20.03$	$56.11 \pm 16.05$	<0.0001 <sup>**</sup>
Tiffenau (%)	$102.50 \pm 11.46$	$99.06 \pm 12.00$	0.1570
PEF (%)	$69.28 \pm 22.63$	$49.33 \pm 20.61$	0.0010 <sup>**</sup>

\*Values expressed in mean  $\pm$  Standard Deviation; Percent predicted values; <sup>\*\*</sup> $P < 0.05$ . PO = Postoperative;  $FEV_1$  = Forced Expiratory Volume in 1 second; FVC = Forced Vital Capacity; PEF = Peak Expiratory Flow

There was no significant correlation between preoperative pulmonary function variables and length of preoperative hospital stay ( $FEV_1$ :  $P = 0.7790$  and  $\rho = -0.07$ , FVC:  $P = 0.944$  and  $\rho = 0.02$ ; PEF:  $P = 0.8190$  and  $\rho = 0.06$ ; Tiffenau:  $P = 0.323$  and  $\rho = -0.25$ ). Similarly, there was no significant correlation between pulmonary function

and length of postoperative hospital stay ( $FEV_1$ :  $P = 0.119$  and  $\rho = -0.38$ , FVC:  $P = 0.1650$  and  $\rho = -0.34$ ; PEF:  $P = 0.2590$  and  $\rho = -0.28$ ; Tiffenau:  $P = 0.489$  and  $\rho = -0.17$ ).

The distance walked in 6-MWT in the fifth postoperative day had significant negative correlation with the length of postoperative hospital stay, with  $P = 0.0058$  and  $\rho = -0.62$  (Figure 1). There was no significant correlation of the 6-MWT distance between the age ( $P = 0.4680$  and  $r = -0.18$ ) and LVEF ( $P = 0.8070$  and  $r = -0.06$ ).

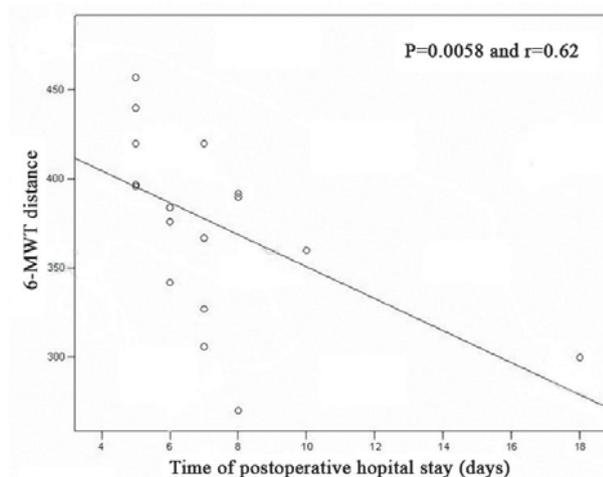


Fig. 1 - Correlation of 6-minutes Walk Test distance (6-MWT) with the time of postoperative hospital stay ( $n=18$ )

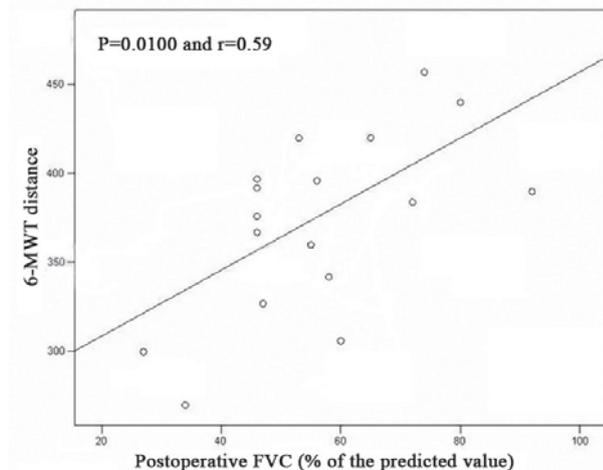


Fig. 2 - Correlation of 6-minutes Walk Test distance (6-MWT) with postoperative forced vital capacity (FVC) ( $n=18$ )

The distance of the 6-MWT had significant positive correlation with FVC ( $P = 0.0100$  and  $r = 0.59$ ) and  $FEV_1$  ( $P = 0.0270$  and  $r = 0.52$ ) postoperatively, which can be seen in Figure 2 and 3, respectively. There was no correlation with PEF ( $P = 0.1370$  and  $r = 0.37$ ) and Tiffenau ( $P = 0.7070$  and  $r = 0.10$ ) postoperatively.

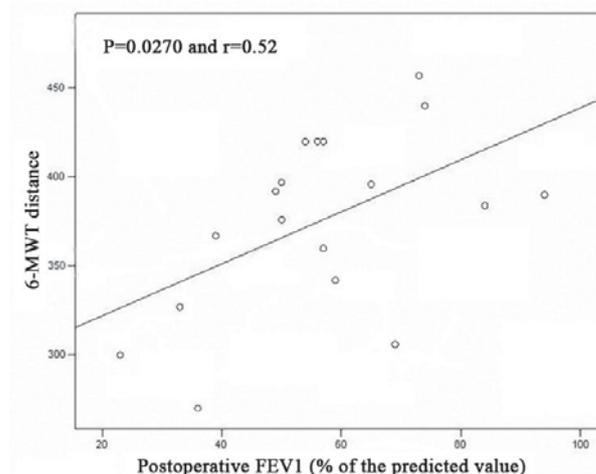


Fig. 3 - Correlation of 6-minutes Walk Test distance (6-MWT) with postoperative forced expiratory volume in 1 second ( $FEV_1$ ) ( $n=18$ )

## DISCUSSION

In this study, we could observe reduction of volumes and lung capacity after coronary artery bypass grafting and/or valve replacement, in addition to significant negative correlation only of the deambulation ability on the fifth postoperative day with the length of postoperative hospital stay of these patients.

The behavior of the significant reduction in volume and lung capacity after heart surgery in this study occurred as described in other studies performed in this population [4-8]. It is suggested that the reduction in forced vital capacity (FVC) and forced expiratory volume in one second ( $FEV_1$ ) occurs by increased respiratory work and shallow breathing, due to pain and decreased chest expansion secondary to median sternotomy and thoracic manipulation, resulting in restrictive respiratory dysfunction in the postoperative period [14-17].

The impact of pulmonary function in the time of hospital stay has been studied by some authors, such as Leguisamo et al. [18], who assessed the effectiveness of a physiotherapy program of breathing patterns in

preoperative of CABG in 86 patients with a control group and observed a significant reduction in the length of hospital stay in the intervention group, of which the mean length of hospital stay was  $14.65 \pm 6.61$  days in the control group and  $11.77 \pm 6.26$  days in the intervention group. However, in this study, the hospital stay did not correlate significantly with pulmonary function preoperatively. Hulzebos et al. [5] found a reduction in the incidence of pulmonary complications and length of hospital stay in 140 patients who had undergone an inspiratory muscle training compared with 139 patients in the control group, both in the preoperative period of CABG. These results differ from this study, which can be explained by the small number of our sample, but also by the fact that this reduction of days may have occurred by more patient's cooperation in the postoperative period, who was better guided and understood the importance of physiotherapy treatment, since there was no statistical difference in lung function between the two groups.

It is also suggested that preoperative lung function may not be a predictor of length of hospital stay due to the enormous influence of factors inherent to the CABG and/or valve replacement procedures in determining the degree of functional impairment postoperatively. This is influenced by the median sternotomy, which promotes a respiratory muscle inefficiency; by the intensity of the chest manipulation, which stimulates the pleural effusion and diaphragmatic dysfunction; by the duration of cardiopulmonary bypass (CPB), which promotes an inflammatory response that can lead to pulmonary surfactant inactivation and collapse in some areas; by the time of general anesthesia, which causes respiratory depression and consequent reduction in functional residual capacity, thereby favoring the onset of atelectasis; by the positioning of the drain, as in the subxiphoid region there is better preservation of pulmonary function and less subjective pain than in the intercostal region; and also due to the fact that it deals with an associated procedure, because some authors observed a more pronounced pulmonary shunt in patients undergoing valve replacement, compared to those who underwent CABG alone [19,20].

With all these factors influencing the deterioration of lung function, it becomes, in the postoperative period, one of the main purposes of treatment and reference for clinical follow-up and rehabilitation. The latter occurs because the reduction in FVC and  $FEV_1$  weakens the coughing and the movement of secretions, which can lead to early closure and obstruction of small airways that predispose to microateletasias and hence reduction in oxygenation [18]. This early closure may also be influenced by the FVC, because it maintains lung volume close to the closing volume, leading some alveolar segments to become permanently closed, further increasing arterial hypoxemia

[19]. And with this pulmonary condition there is predisposition to a longer intervention on the patient to increase the level of arterial saturation, improve ability to cough and reducing areas of atelectasis, which can increase the length of hospital stay.

In this study, the distance of the 6-MWT, presented mean of  $375.78 \pm 50.66$  meters walked on the fifth postoperative day, a number slightly higher than that found by Macchi et al. [21], which was  $335 \pm 120$  meters in 111 patients with  $7.8 \pm 2.7$  days after surgery. Compared with the study of Fiorina et al. [22], who obtained  $299 \pm 87$  meters in 348 patients on the fourth postoperative day, the mean of this study was lower, but these authors have shown that female patients presented a lower distance, as well as patients with diabetes and valve replacement surgery, which can influence the analysis of comparison with this study. This occurs because the distribution of types of heart surgery and gender in both samples may be different for comparison, as the difference in days of collection and small sample size. It can be observed a study with sample and collection similar to Fiorina et al. [22], which is from Opasich et al. [23], who observed the average distance in 6-MWT at the fourth postoperative day of  $296 \pm 111$  meters.

The early ambulation in heart surgery has been correlated with reduction of morbidity and pulmonary complications, which can consequently reduce the length of hospital stay [20,22]. Moreover, Macchi et al. [21] reported that the implement of a quick recovery after the surgical procedure allows a range of motion around the fifth day, which allows an earlier transfer of the patient to rehabilitation services. This demonstrates that the measure of deambulation ability of the patient is used by some professionals as the purpose of treatment, since this parameter represents better the individual's functional capacity [14,20,21]. Thus, one can justify, in our study, the significant negative correlation of the 6-MWT distance walked by the patient with the time of hospital stay, because it suggests that the patient who presents more deambulation ability has a functional capacity more suitable for hospital discharge, reflecting better the functionality than the lung function alone. The significant correlation of FVC and  $FEV_1$  with the 6-MWT also suggests that deambulation ability may better reflect overall functional capacity and can be justified by the fact that greater deambulation capacity is associated with higher stimulation of ventilation, increased pulmonary perfusion and detachment of secretions and oxygenation improvement [24].

This study has some limitations, such as small sample size that may influence the statistical analysis, as well as the possibility of analysis by separating groups according to age of patients and the surgical procedure associated.

## CONCLUSION

In conclusion, pre- and postoperative pulmonary function may not be predictive of length of hospital stay, but the distance walked in 6-MWT at the fifth postoperative day shows a negative correlation with length of hospital stay, suggesting that the 6-MWT distance may represent better functional capacity of these patients. Thus, we suggest further studies on the correlation of postoperative functional capacity with the time of hospital stay, by means of observational studies with larger samples, as well as, interventions studies to investigate the impact of a program of early deambulation on the time of hospital stay in the postoperative period of heart surgery.

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