

ORIGINAL MANUSCRIPT

Physiological Changes from Walking and Time of Stay after Heart Surgery

André Luiz Lisboa Cordeiro¹, Nassany Marilyn Amorim¹, Pedro Henrique Andrade¹, Mateus Souza Esquivel², André Raimundo Guimarães³, Thiago Araújo de Melo⁴, Murillo Frazão⁵, Giulliano Gardenghi⁶

¹Instituto Nobre de Cardiologia – Setor de Fisioterapia – Feira de Santana, BA – Brazil

²Grupo de Pesquisa em Fisioterapia Cardiovascular – Salvador, BA – Brazil

³Instituto Nobre de Cardiologia – Setor de Cirurgia Cardíaca – Feira de Santana, BA – Brazil

⁴Universidade Salvador – Hospital Aliança – Unidade de Terapia Intensiva – Salvador, BA – Brazil

⁵Centro Médico Pulmonar Diagnóstico – João Pessoa, PB – Brazil

⁶Hospital Encore – Aparecida de Goiânia, GO – Brazil

Abstract

Background: In the past decades, physical therapy has been outstanding in the management of patients undergoing heart surgery and walking is a type of exercise well tolerated by patients.

Objectives: To evaluate the physiological changes from walking and the correlation with hospital stay after heart surgery (HS).

Methods: Cross-sectional quantitative observational clinical trial has been conducted. Thirty 30 patients were selected. The following hemodynamic variables have been evaluated: heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and double product (DP); as well as the following respiratory variables: respiratory rate (RR), peripheral oxygen saturation (PO₂S), one minute before walking and immediately after the end of the walk.

Results: The following rates were increased: SBP 112.0±11.9 mmHg to 118.2±19.1 mmHg (p=0.06); end HR 94.1±17.6 bpm to 81.7±14.6 bpm (p=0.00); DP 9166.0±2041.6 to 11230.7±3441.3 (p=0.00); and DBP 74.0±18.7 mmHg to 77.3±11.7 mmHg (p=0.27). RR increased from 19.4±4.4 ipm to 24.0±4.4 ipm (p=0.00); and PO₂S 95.3±2.4% to 94.9±3.2% (p=0.53). There was also a significant correlation between the variation of HR, DP and SBP after exercise.

Conclusions: Walking generated hemodynamic effects over HR, DP, and changes in RR. HR, DP and SBP after heart surgery had a direct relationship with the length of hospital stay.

Keywords: Walking; Thoracic surgery; Physiotherapy

Introduction

Cardiovascular diseases are one of the leading causes of morbidity and mortality in the world. Heart surgeries are widely used to treat patients and improve their prognosis¹.

Complications after surgery often result from associated diseases or pre-operative factors such as age, sex, left ventricular dysfunction, type of surgery, intra-aortic

balloon, congestive heart failure, recent myocardial infarction, kidney failure, associated surgeries, reoperations and obesity². Intraoperative factors such as time of cardiopulmonary bypass, surgical manipulation and number of pleural drains may also interfere with pulmonary function³.

Due to hemodynamic instability that often happens in the immediate postoperative period, the patient may need vasoactive drugs (VAD) in the Intensive Care Unit

Corresponding author: André Luiz Lisboa Cordeiro

Av. Maria Quitéria, 2116 – Kalilândia – 44001-008 – Feira de Santana, BA – Brazil

E-mail: andrelisboacordeiro@gmail.com

DOI: 10.5935/2359-4802.20150068

Manuscript received on October 19, 2015; approved on October 30, 2015; revised on November 03, 2015.

(ICU) as long as required^{4,5}. The controls of vital data such as blood glucose and monitoring are performed each hour, which can also bring discomfort to the patient⁶.

Postoperative strategies must also be conducted to reduce pulmonary complications after heart surgery, including: deep ventilation exercises, incentive spirometry, continuous positive airway pressure, mobilization in bed, coughing techniques and pain management, as well the practice of aerobic exercises⁷.

Walking assisted by a physiotherapist is an inexpensive option well tolerated by patients with heart disease. It allows the patient to determine the speed and the time for pauses for rest and reduces the chances of motor and respiratory complications⁸.

A number of physiological effects occurs during and after walking, such as change in heart rate, respiratory rate, blood pressure, among other physiological variables⁹.

Physical therapy has been considered a key component in the rehabilitation of patients who have undergone cardiovascular surgery in order to improve cardiovascular fitness and prevent thromboembolic events and analgesic postures, offering greater physical independence and security for hospital discharge and subsequent recovery of daily life activities¹⁰.

This study aims to evaluate the physiological changes of walking in patients after heart surgery.

Methods

Cross-sectional quantitative observational clinical trial has been conducted, following the criteria established by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)¹¹, with patients undergoing heart surgery at Unidade de Internamento do Instituto Nobre de Cardiologia/Santa Casa de Misericórdia, em Feira de Santana, BA, from October 2014 to May 2015.

The design of this study has been approved by the Research Ethics Committee of Faculdade Nobre under no. 796580. All patients or their custodians signed the Informed Consent Form.

Patients older than 18 of both sexes, who have undergone heart surgery (coronary artery bypass grafting, aortic valve and/or mitral valve replacement and atrial septal defect repair) have been included in this study. All patients were without vasoactive drugs (VAD) and

maintaining hemodynamic stability by evaluating the mean blood pressure (MBP).

We excluded patients who had hemodynamic instability (MBP <65 mmHg), agitation during maneuvers, resistance of movements, decrease in oxygen saturation (<90%), lung disease history, complex arrhythmias, neurological and/or motor deficits and musculoskeletal limitations that prevented the performance of the protocol.

Walking protocol

Patients were evaluated on two occasions on the third day after the surgery. On the first occasion, the patient was transferred from bed to a chair in a corridor of 30 meters and kept in this position for at least 20 minutes to rest. Subsequently, the patient was asked to walk down that corridor to complete 100 meters. The intensity was selected by the patient, but the researchers would say encouraging words, such as “come on”, “walk as fast as you can” or “walk faster, it is nearly over”. After walking, the patient was sent to the same pre-test chair and the physiological variables were evaluated again.

Hemodynamic measurements: heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) and double product (DP), and respiratory variables: respiratory rate (RR) and peripheral oxygen saturation (PO₂S) were performed one minutes prior to the protocol and in the first minute after the end of the walk.

To check the clinical signs, patients were monitored before and after the test with electrocardiographic tracing (ECG), HR, SBP, DBP, MBP, HR and PO₂S with multiparameter monitor Dixtal DX 2010 (Dixtal Biomédica Ind. Com. Ltda, Manaus, Brazil). The variable double product (DP) was obtained by multiplying SBP by HR (DP=SBP×HR).

Besides this, patients were followed up until hospital discharge day to check the correlation between physiological change and length of stay in the unit.

Statistical analysis

Data normality was confirmed using the Kolmogorov-Smirnov test. Categorical variables were expressed as

ABBREVIATIONS AND ACRONYMS

- *HS* – heart surgery
- *DP* – double product
- *VAD* – vasoactive drugs
- *HR* – heart rate
- *RR* – respiratory rate
- *DBP* – diastolic blood pressure
- *MBP* – mean blood pressure
- *SBP* – systolic blood pressure
- *PO₂S* – peripheral oxygen saturation

absolute numbers and in proportions and continuous variables were expressed as mean±standard deviation. To compare the moments before and after walking, we used the Student's t test for paired samples. Differences between categorical variables were compared using the chi-square test. The correlation between data was tested by the Spearman correlation. Data were analyzed using the Statistical Package for Social Sciences (SPSS 17.0), adopting the significance level of $p < 0.05$.

Results

The study included 30 patients (56.6% men) with mean age of 52.5 ± 16.9 years. Table 1 shows the baseline characteristics the patients included in the study.

Table 2 describes the acute hemodynamic behavior of patients regarding the application of the walking protocol. Analyzing the SBP, $p = 0.06$, DBP $p = 0.27$, HR=0.00 and SD $p = 0.00$ were found; therefore, the variables HR and DP were the ones that showed statistically significant changes.

Table 3 shows the respiratory variation of walking. RR presented statistical significance ($p = 0.00$) by comparing the pre- (19.4 ± 4.4 ipm) with post-walking (24.0 ± 4.4 ppm); despite clinical change, PO_2S did not present any statistical significance ($p = 0.53$): $95.3 \pm 2.4\%$ to $94.9 \pm 3.2\%$.

Table 1
Baseline characteristics of the patients studied

Characteristics	Values
Age (years) mean±SD	52.5 ± 16.9
Sex n (%)	
Male	17 (56.6)
Female	13 (43.4)
Type of surgery n (%)	
Coronary artery bypass grafting	14 (46.6)
Mitral valve replacement	11 (36.6)
Mitral and aortic valve replacement	2 (6.8)
Aortic valve replacement	3 (10.0)
Cardiopulmonary bypass time n (%)	
Up to 50 minutes	7 (23.3)
51 - 100 minutes	20 (66.7)
> 100 minutes	3 (10.0)
Mechanical ventilation time n (%)	
Up to 6 hours	14 (46.6)
> 6 hours	16 (53.4)

During the walking protocol, there were no adverse events such as desaturation, chest pain, sweating, syncope, and psychomotor agitation.

Table 2
Hemodynamic parameters at rest and after the walk

Parameters		Mean±SD	p value
SBP (mmHg)	Rest	112.0 ± 11.9	0.06
	After walking	118.2 ± 19.1	
DBP (mmHg)	Rest	74.0 ± 18.7	0.27
	After walking	77.3 ± 11.7	
HR (bpm)	Rest	81.7 ± 14.6	0.00
	After walking	94.1 ± 17.6	
Double product (mmHg x bpm)	Rest	9166.0 ± 2041.6	0.00
	After walking	11230.7 ± 3441.3	

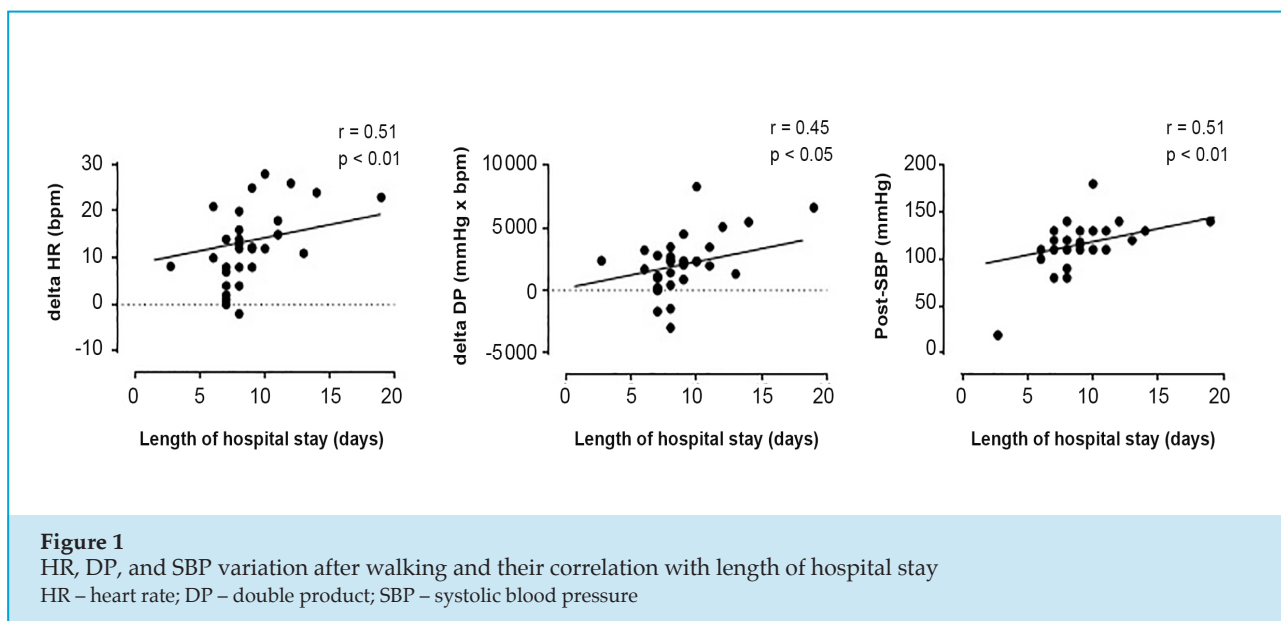
SBP – systolic blood pressure; DBP – diastolic blood pressure; HR – heart rate; DP – double product

Table 3 Respiratory parameters at rest and after the walk			
Parameters		Mean±SD	p value
RR (ipm)	Rest	19.4 ± 4.4	0.00
	After walking	24.0 ± 4.4	
PO2S (%)	Rest	95.3 ± 2.4	0.53
	After walking	94.9 ± 3.2	

RR – respiratory rate; PO2S – peripheral oxygen saturation; DP – double product

Figure 1 shows the variation in post-walking HR, DP and SBP and their correlation with length of hospital stay. All variables presented statistical significance with moderate

correlation: post HR ($p < 0.01$; $r = 0.51$), DP ($p < 0.05$; $r = 0.45$) and SBP ($p < 0.01$; $r = 0.51$). The correlations showed an increase in the variables analyzed during the hospital stay.



Discussion

In this study, walking promoted as an immediate response a significant increase in HR, DP and RR. No changes were found in SBP, DBP and PO₂S.

Exercises bring several benefits to the cardiovascular system, particularly improvement in endothelial function, increased HR variability, reduced myocardial oxygen demand for relative exertion loads, development of collateral circulation and interference in inflammatory factors¹²⁻¹⁵.

Regarding aerobic training in cardiac patients, some studies have shown reduction in HR at rest, systolic blood pressure and decreased maximal oxygen consumption (maximal VO₂), also promoting an increase in basal metabolic rate and systolic volume at rest¹⁶.

Ricardo et al.¹⁷ conducted a systematic review of the role of cardiac rehabilitation with emphasis on exercise in relation to mortality, quality of life and modifiable risk factors, showing that most of the literature describes an immediate increase in systolic

blood pressure during exercise but, over time, the tendency is autonomic regulation and decrease in SBP¹⁷.

In the study by Zafiropoulos et al.¹⁸ hemodynamic change occurred in 15 patients intubated after abdominal surgery, from the supine to standing position and during walking. At rest, there was a 12.0% average increase in HR and 15.0% in SBP after both activities¹⁸.

Bailey et al.¹⁹ assessed 103 patients with 762 walking activities. During this intervention, the authors observed no episodes of decrease in peripheral oxygen saturation and significant increases in systolic blood pressure that could lead to instability during these activities¹⁹.

Another strategy used in patients after heart surgery is cycle ergometer. In a national study, one group performed exercises with a cycle ergometer in 39 patients, observing a small increase in HR (<5%) and perceived exertion by the patient after exercise compared to rest²⁰.

One group from the state of Bahia evaluated the use of cycle ergometer on the third and fourth day after cardiac surgery, showing that there is no significant change in hemodynamic variables. Only the respiratory variable RR presented statistical variation²¹.

Study on cardiovascular abnormalities in 32 individuals after coronary artery bypass grafting, in which walking was started on the second postoperative day, reported that this activity increased HR by 15% and SBP by 5%. The authors, in their conclusion, report that inappropriate prescription of exercise for patients in the postoperative period of heart surgery may slow down or jeopardize their recovery²².

Cacau et al.²³ conducted a study including virtual reality in the postoperative period of heart surgery. They found that this approach increased the walking time in the six-minute test, noting that early walking is related to reduced morbidity and pulmonary complications, which can reduce the length of hospital stay²³.

This study showed that walking after heart surgery does not bring any harm to homeostasis. Soares et al.²⁴, in a longitudinal retrospective study, found that patients who are taken off bed early tend to have lower mortality rates

and are also able to restore functional limitations earlier due to functional improvement of the cardiovascular and respiratory system²⁴.

This study evaluated the physiological variables on the third postoperative day. This evaluation could have been started before, but there is still a cultural bias on early mobilization in patients after heart surgery. This act is confirmed by a national study that reported that 82.0% of patients underwent at least one motor physical therapy session during the length of stay in a clinical ICU, but this activity usually had low complexity, being held in bed²⁵.

Ghashghaei et al.²⁶, in a randomized controlled study, showed that an exercise program based on aerobic training for two months can increase rest and maximal hemodynamic responses, such as SBP, DBP and HR²⁶. On the other hand, another study showed that training translates into reduction in SBP and DBP. It did not report any relationship between weekly training frequency, one per session, or intensity of physical training with the magnitude of blood pressure reduction²⁷.

Tsai et al.²⁸ conducted research to assess the effects of cardiac rehabilitation in the recovery of heart rate for 1 minute after peak exercise in patients who underwent coronary artery bypass grafting. They concluded that there was a significant decrease in heart rate at rest ($p < 0.001$ cardiac rehabilitation; control $p = 0.05$) and improved recovery of heart rate for 1 minute (cardiac rehabilitation $p < 0.001$; control $p = 0.001$) compared with baseline measurements²⁸.

This study revealed an increase in DP, which occurred by an increase in HR as there was no significant increase in SBP. A similar result was found in the study of Freitas et al.²⁹ that evaluated the hemodynamics in patients using passive cycle ergometer²⁹. DP may reach levels similar to those seen in dynamic resistance exercises performed at high intensity and a relatively small number of repetitions^{30,31}.

Some limitations were found in this study: 1) small number of patients; 2) lack of sample size calculation; 3) lack of pre-establishment of intensity while walking; 4) failure to evaluate exertion variables such as the Borg scale; 5) failure to carry out a survey of patients using beta-blockers and/or bronchodilators.

Conclusions

Patients walking after heart surgery have presented acute hemodynamic effects on HR and DP and changes in RR. Furthermore, it was observed that the variation in HR, DP and SBP post-exercise is directly correlated with increased length of hospital stay.

Potential Conflicts of Interest

This study has no relevant conflicts of interest.

Sources of Funding

This study had no external funding sources.

Academic Association

This study is not associated with any graduate programs.

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