

## Gravitational stress in postoperative heart surgery

### Estresse gravitacional no pós-operatório de cirurgia cardíaca

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**RESUMO | INTRODUÇÃO:** após a cirurgia cardíaca, a mobilização precoce busca o ganho funcional e um melhor condicionamento para as próximas fases da reabilitação cardiovascular, tendo o estresse gravitacional(EG) um importante papel para o retorno destas atividades, através da integridade dos mecanismos compensatórios cardiovasculares. **OBJETIVO:** verificar o comportamento de variáveis circulatórias e respiratórias durante o EG no pós-operatório de cirurgia cardíaca. **MATERIAIS E MÉTODOS:** estudo quasi-experimental, transversal e analítico, composto por 83 indivíduos adultos clinicamente estáveis, submetidos a cirurgia de revascularização do miocárdio ou abordagem valvar. Excluídos aqueles com dificuldade de compreensão das atividades realizadas, além de comprometimento motor e/ou neurológico que impossibilitassem a realização do EG, de forma adaptada. Foram coletados os dados circulatórios e respiratórios no 1º minuto para cada etapa através do monitor multiparamétrico *Gemedical Systems*®. **RESULTADOS:** as frequências cardíaca e respiratória apresentaram um aumento com significância estatística ( $p \leq 0,01$ ), quando analisado seus valores de variação de decúbito dorsal para sedestação e decúbito dorsal para ortostase. **CONCLUSÃO:** as variáveis hemodinâmicas e respiratórias se comportam de acordo com a resposta fisiológica durante o EG, sugerindo que esse procedimento é seguro no ambiente da terapia intensiva, mesmo se tratando de um pós-operatório de alta complexidade.

**PALAVRAS-CHAVE:** Cirurgia cardíaca. Estresse gravitacional. Mobilização precoce.

**ABSTRACT | INTRODUCTION:** after cardiac surgery, early mobilization seeks functional gain and better conditioning for the next phases of cardiac rehabilitation, with gravitational stress (GS) playing an important role in the return of these activities through the integrity of cardiovascular compensatory mechanisms. **OBJECTIVE:** to verify the behavior of circulatory and respiratory variables during (GS) in the postoperative period of cardiac surgery. **MATERIALS AND METHODS:** experimental cross-sectional analytical study, consisted of 83 clinically stable adults undergoing coronary artery bypass or valve surgery approach. Excluded those with difficulty understanding the activities performed, in addition to motor and / or neurological impairment that made it impossible to perform GS, an adapted form. Circulatory and respiratory data were collected in the 1st minute for each stage using the multi-parameter monitor *Gemedical Systems*®. **RESULTS:** the heart and respiratory rates showed an increase was statistically significant ( $p \leq 0.01$ ) when analyzed their dorsal range of values for sedestation and supine to standing position. **CONCLUSION:** hemodynamic and respiratory variables behave in accordance with the physiological response during GS, suggesting that this procedure is safe within the intensive care setting, even if a treating postoperative high complexity.

**KEYWORDS:** Cardiac surgery. Gravitational stress. Early mobilization.

## Introduction

Cardiac surgeries are intended for patients with serious heart defects due to limit conditions, ie, functional impairment of the heart, or severe difficulties in performing activities of daily living<sup>1-3</sup>.

There was a depression of autonomic cardiac modulation with a suppression of vagal regulation and increase of sympathetic cardiac activity during the six postoperative days, with a progressive return between 30 and 60 days after surgery<sup>4-6</sup>. The prolonged immobility after a cardiac surgery can lead to deleterious repercussions on the cardiovascular system. Individuals with ischemic heart disease who remain for long periods without being influenced by gravity tend to develop postural hypotension or syncope prior to ambulation<sup>7-9</sup>. Orthostatic intolerance in this period has been attributed to dysfunction of baroreceptor reflexes, which play a fundamental role in short-term cardiovascular control, promoting adaptation to orthostatic changes<sup>10,11</sup>.

Hemodynamic parameters should be carefully monitored in the immediate postoperative period, because the immobility leads to a decrease in circulating blood volume, orthostatic hypotension and thromboembolic pathologies<sup>12,13</sup>. Current studies report the importance of early mobilization in patients admitted to intensive care units (ITU). The start of mobilization should be between 12 and 24 hours after admission, but they emphasize that the exercises performed in the dorsal decubitus do not present an effective impact to our body, which is adapted for orthostatism<sup>11,13</sup>.

The stimulus to gravitational stress (GS) underlying orthostatism is of extreme importance in hospitalized patients' rehabilitation process. This fact has already assured by the guideline of the European Respiratory Society and European Society of Intensive Care Medicine, which indicates GS as soon as possible, due to the benefits to patients in their systemic repercussions<sup>14</sup>.

GS promotes adjustments in the autonomic modulation of heart function (HF) as well as hemodynamic adaptations in these patients without any clinical complications or any sign and / or symptom of effort

intolerance<sup>15,16</sup>. However, studies have reported that the execution of out-of-bed activities in patients 24 hours of postoperative should be monitored because of reduced myocardial function<sup>17</sup>.

GS can be very important in the hospital setting due to cardiovascular and respiratory response to functional stimuli. Besides, it guides phase I cardiac rehabilitation. Based on the physiological benefits of postural changes, this study aimed to verify the conduct of circulatory and respiratory variables during the gravitational stress in the postoperative period of cardiac surgery. This study was approved by the Ethics Committee on Research in Human Subjects through the number CAAE: 55241616.6.0000.5520.

## Material and methods

This is an experimental, cross-sectional, and analytical study performed at the Cardiovascular Intensive Care Unit (UCV) of a philanthropic hospital in Salvador, Bahia, Brazil, which is a reference in Cardiology. The data collection was carried out in the period of May to December 2016, under the responsibility of a team of researchers previously trained for all stages of the study.

Individuals hospitalized at the Cardiovascular Unit (CVU) undergoing elective coronary artery bypass grafting (CABG) and valve approach, aged 18 years or older, of both sexes, with hemodynamic stability and without complaints of precordial pain, respiratory distress, or any other symptom which placed the participant at imminent risk during the execution of gravitational stress, were included in the study. Individuals, who presented difficulties in understanding the activities, altered level of consciousness and motor and / or neurological impairment, which impeded the performance of GS in the bed for the transfer of dorsal decubitus to sedestation and orthostasis, were excluded from the study.

Sociodemographic, clinical and surgical data were collected through an electronic medical record and transferred to the collection form of the research, which was elaborated specifically for this study. The data not found in the collection form were inquired to the individuals or their companions.

All patients performed physiotherapy, following the protocol of the Institution, which consists of performing respiratory exercises and active kinesiotherapy in upper and lower limbs outstanding, at a frequency of twice daily, during ten minutes each session. There was a progression of physical activity to perform transfers of dorsal decubitus for sedestation in bed with lower limbs outstanding, orthostasis and functional gait readjustment. The standard protocol for post-operative drugs involved the use of an antibiotic (cefuroxime), analgesia with morphine and dipyrone, antiemetic (bromopride) and gastric mucosal protector (ranitidine). An antiplatelet agent was inserted seven hours after the surgery in the Intensive Care Unit (ICU); and the medications previously used by the patient are usually reinserted before leaving the ICU, such as beta-blockers. Vasoactive drugs and vasodilators were administered depending on the hemodynamic status of the patient.

Participants were instructed to perform the steps of gravitational stress in the second day postoperative, after removal of the mediastinal drain and medical release, following an adapted protocol<sup>1,2</sup> due to the height of the patients' bed heads that could not be in zero degree.

The data were collected with patient in dorsal decubitus and head elevation from 30 to 45 degrees, through multiparametric monitor (GEMEDICAL SYSTEMS - model B40), systolic arterial depression (SBP), diastolic blood pressure (DBP) and heart rate (HR), as well as respiratory data of peripheral oxygen saturation (SpO<sub>2</sub>). The respiratory rate (RR) was measured by directly counting by the researcher, in order to confront the value displayed on the monitor, to generate greater reliability in the data found. After this procedure, the individual was moved in bed from dorsal decubitus to sedestation with lower limbs outstanding, and the variables were recorded. After sitting for three minutes, the orthostasis was performed aside from the bed, with a new record of these data. HR and SpO<sub>2</sub> were monitored continuously, but the values of all the variables collected for analysis in the present study were related to the first minute after the patient assumed the new position.

The sample power of this study was obtained through the WinPepi calculator (publichealth.jpupub.com/book/gerstman/winpepi.cfm). The Pairs command was selected with a sample number of 83 people, considering the variable heart rate, where the standard deviation was used in the first moment of measurement, 12.89 bpm (dorsal decubitus), and in the second measurement point, 14.69 bpm (sedestation), to detect a difference of 5.5bpm, with a correlation coefficient of 0.85, and a significance level of 5%, resulting in a power of 100%.

The Statistical Package for Social Sciences (SPSS), version 14.0 for Windows, was used for the elaboration of database, descriptive and inferential analysis. The normality of variables was verified through descriptive statistical analysis and Kolmogorov-Smirnov test. However, the descriptive analysis was prevalent. The time of extracorporeal circulation, mechanical ventilation and ICUs presented a non-normal distribution, being represented as the median and interquartile range, while the others presented as symmetrical, with significant mean and standard deviation. The paired T Student test was used for the analysis between the dorsal decubitus and the sedestation, and between the dorsal decubitus and orthostasis to compare the circulatory and respiratory variables. The level of significance was 5%.

## Results

The population was composed of 108 individuals of the control group. Ten patients were excluded due to lack of data collection, eight did not stand before leaving the UCI; two presented somnolence and two left the study, resulting in a total of 83 participants. Table 1 presents the main clinical and demographic characteristics of this population. The mean age was  $59 \pm 13$  years, where 59% underwent myocardial revascularization surgery, with a predominance of males (55.4%). Among the associated risk factors, the most present were hypertension (66.3%), and diabetes (30.1%).

**Table 1.** Clinical and surgical characteristics of 83 individuals in the postoperative period of cardiac surgery submitted to gravitational stress. Salvador, BA, 2018

Variable	Mean ± SD
Age (years)	59.08 ± 13.17
Body mass index (kg/m <sup>2</sup> )	26.23 ± 4.33
Ejection fraction (%)	62.26 ± 12.87
	<b>Median (IQ)</b>
Extracorporeal circulation time (minutes)	95 (65 – 120)
Mechanical ventilation time (hours)	5.08 (3.33 – 9)
Length of stay in intensive care (days)	2 (2 – 3)
<b>Gender</b>	<b>n (%)</b>
Male	46 (55.4)
Female	37 (44.6)
<b>Surgery</b>	
Revascularization of myocardium	49 (59)
Valvar Surgery	34 (41)
<b>Comorbidities</b>	
Hypertension	55 (66.3)
Diabetes	25 (30.1)
Dyslipidemia	18 (21.7)
Tabagism	9 (10.8)
Congestive heart failure	8 (9.6)
Obesity	1 (1.2)

SD = standard deviation; IQ = interquartil interval.

The hemodynamic and respiratory variables remained within the normal range expected at the three moments in which they were evaluated (Table 2). The values of HR and RR presented an increase with statistical significance when analyzed their values of variation from dorsal decubitus to sedestation, and dorsal decubitus to orthostasis.

**Table 2.** Conduction of hemodynamic and respiratory variables during the gravitational stress of individuals in the postoperative period of cardiac surgery. Salvador, BA, 2018

Position	Dorsal Decubitus	Sedestation	p (1)	Orthostase	p (2)
Systolic blood pressure	127.5±19.9	126.5±22.8	(p=0.67)	131±26.8	(p =0.10)
Diastolic blood pressure	67±11	67.1±11.9	(p=0.87)	69.5±12.5	(p=0.05)
Meand blood pressure	89.4±13.8	89.8±13.9	(p=0.91)	92±15.9	(p=0.11)
Cardiac frequency	85.8±12.7	91.3±14.6	<b>(p=0.00)†</b>	92.7±15.5	<b>(p=0.00)†</b>
Respiratory frequency	18.3±4.7	20.3±4.4	<b>(p=0.002)†</b>	19.9±5.1	<b>(p=0.08)†</b>
Peripheral saturation of O <sub>2</sub>	94.8±2.5	94.7±2.6	(p=0.78)	94.9±2.6	(p=0.50)

O<sub>2</sub>=Oxygen; T-student test for paired samples; p (1) = analysis between the moment of dorsal decubitus for orthostasis; p (2) = analysis between the moment of dorsal decubitus and sedestation. † p < 0.01.

## Discussion

The results showed that the gravitational stress in the postoperative period of cardiac surgery leads to changes in circulatory and respiratory variables, demonstrated by the increase in HR, which occurs in two moments: sedestation and orthostasis. This event is already certified in the literature<sup>8,10,12,18</sup>. RF also responds with an increase at the same moments, but the conduct of this variable is not often expressed in previous scientific studies<sup>3,12,13</sup>.

The HR proceeding demonstrates an adequate physiological response to gravitational stress at moments from dorsal decubitus (DD) to sedestation and posterior orthostasis. The cardiovascular system, when submitted to the gravitational challenge, reduces venous return and ventricular filling in response to changes in circulatory volume, which is exacerbated due to adjustments of the afferent and central regulatory mechanisms. The baroreflex mechanism activates the central components in the regulation of the cardiovascular system, causing an increase in the sympathetic tone of the heart and the peripheral vasculature, which elevates the HR. As a result, heart rate and peripheral vascular resistance enhance from 10% to 30% of baseline value<sup>19-23</sup>.

RF presents a statistically significant increase in the values considering the sitting and orthostasis changes, starting from the dorsal decubitus, however, it does not represent an impact in the clinical of these individuals<sup>24</sup>. The increase in RF is expected since there is an increase in oxygen consumption by metabolic expenditure, inherent to the proposed activity, which influences directly this marker<sup>18,20</sup>.

The literature presents some scientific studies with similar clinical aspects of our study<sup>12,25-27</sup>. A recent study with a population of prehypertensive patients shows the increase in HR in sedestation and orthostasis<sup>27</sup>, which corroborates our findings regarding HR. Another study with post-revascularization elderly people presented similar findings, with an increase in HR from dorsal decubitus to sedestation<sup>13</sup>. Almeida and colleagues (2014)<sup>13</sup> referred the increase in RF from dorsal decubitus

position to sedestation, but the values in this study exceeded the normality parameters, indicating reflex tachypnea, which is justified as a result of sedestation posture and exercises performed.

The changes of systolic blood pressure (SBP) and diastolic blood pressure (DBP) to gravitational stress reflect a little variability, represented by reduction and maintenance of their values respectively, but without statistical significance, remaining within the prehypertension range, according to the 7th Brazilian Arterial Hypertension Guideline<sup>28</sup>. The reflex response of blood pressure (BP) to gravitational stress is reduced due to reduced venous return. However, defense mechanisms to GS act by avoiding the fluctuation of BP to values below normal levels, with emphasis on the baroreceptor mechanism and peripheral pumping<sup>10,11,29</sup>. The literature corroborates these findings<sup>12,13</sup>, and highlights the possible positive response to physiotherapeutic treatment due to the reduced risk of postural hypotension. This procedure presents a great clinical value for this population since it maintains the active postural reflexes in the peripheral circulatory adjustment to postural changes imposed by GS<sup>26</sup>.

The sample of this study was obtained by convenience and only from a one hospital unit. So, the postoperative conductions may differ from other centers with the same population conducted in our study. Furthermore, the medications used by the patients, as well as their dosages, were not taken into account in our analysis, which may interfere with the hemodynamic response to gravitational stress.

## Conclusion

Despite the procedure submitted to these patients is of high complexity, the conduct of circulatory and respiratory variables during gravitational stress in this study presented an expected physiological response to these postural alterations, suggesting that this procedure is safe in this population.



## Author contributions

Lordello GGG participated in the design of the study, data collection, search and statistical analysis of data, results' interpretation and article writing. Serra JMM participated in collection and interpretation of data, and article writing. Rosier GL participated in the design, data collection, and statistical analysis of the research data, interpretation of the results and article writing. Viana PADC and Correia LC participated in the design and delineation of the scientific article.

## Conflicts of interest

There are no financial, legal or political conflict of interest involving the authors, the institutions affiliated and no other individual or institutions (government, non-government, business and/or private institutions), including but not limited to grants and funding, advisory board, study design, manuscript preparation, statistical analysis, or any other who participated in this study.

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