



Functional capacity and mental state of patients undergoing cardiac surgery

Capacidade funcional e estado mental de pacientes submetidos à cirurgia cardíaca

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Abstract

Introduction: Cardiovascular diseases are a serious public health problem in Brazil. Myocardial revascularization surgery (MRS) as well as cardiac valve replacement and repair are procedures indicated to treat them. Thus, extracorporeal circulation (ECC) is still widely used in these surgeries, in which patients with long ECC times may have greater neurological deficits. Neurological damage resulting from MRS can have devastating consequences such as loss of independence and worsening of quality of life. **Objective:** To assess the effect of cardiac surgery on a patient's mental state and functional capacity in both the pre- and postoperative periods. **Methods:** We conducted a cross-sectional study with convenience sampling of subjects undergoing MRS and valve replacement. Participants were administered the Mini-Mental State Exam (MMSE) and the *Duke Activity Status Index* (DASI) in the pre- and postoperative periods, as well as before their hospital discharge. **Results:** This study assessed nine patients (eight males) aged 62.4 ± 6.3 years with a BMI of 29.5 ± 2.3 kg/m². There was a significant decrease in DASI scores and VO₂ from preoperative to postoperative status ($p = 0.003$ and $p = 0.003$, respectively). **Conclusion:** This study revealed a loss of cognitive and exercise capacity after cardiac surgery. A larger sample however is needed to consolidate these findings.

Keywords: Cardiovascular Diseases. Thoracic Surgery. Extracorporeal Circulation. Motor Activity. Cognition.

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Resumo

Introdução: As doenças cardiovasculares são um grave problema de saúde pública no Brasil, sendo as cirurgias de revascularização do miocárdio (CRM) e reparações ou trocas valvares, indicadas para tratamento destas doenças. Assim, a circulação extracorpórea (CEC) ainda é muito utilizada nestas cirurgias, onde pacientes com tempo elevado de CEC podem apresentar maiores déficits neurológicos. Os danos neurológicos decorrentes da CRM podem ter consequências devastadoras como perda de independência e piora na qualidade de vida. **Objetivo:** Avaliar o efeito da cirurgia cardíaca sobre o estado mental e capacidade funcional de pacientes cardiopatas nos períodos pré e pós-operatório. **Métodos:** Estudo transversal, com amostra de conveniência, onde os sujeitos foram submetidos à CRM e troca valvar. Foram aplicados os questionários Mini-Mental State Exam (MMSE) e o Duke Activity Status Index (DASI), no período pré-operatório e antes da alta hospitalar. **Resultados:** Foram avaliados nove pacientes (oito homens) com idade $62,4 \pm 6,3$ anos e IMC $29,5 \pm 2,3$ Kg/m². Observou-se uma queda significativa no DASI e no VO₂ no período pós em relação ao pré-operatório ($p = 0,003$ e $p = 0,003$, respectivamente). **Conclusão:** No presente estudo constatou-se uma perda da capacidade cognitiva e de exercício após a cirurgia cardíaca. No entanto, um aumento do tamanho amostral faz-se necessário para consolidação dos resultados.

Palavras-chave: Doenças Cardiovasculares. Cirurgia Torácica. Circulação Extracorpórea. Atividade Motora. Cognição.

Introduction

Cardiovascular diseases are a serious public health problem in Brazil. The main clinical manifestations result from atherosclerotic processes such as cerebrovascular disease, peripheral vascular disease, cardiac ischemia and coronary atherosclerotic disease or coronary artery disease (CAD) (1, 2). Smoking, high levels of low density lipoprotein (LDL), low levels of high density lipoprotein (HDL), diabetes mellitus, systemic arterial hypertension, family history, lifestyle, obesity, sedentary lifestyle and heavy alcohol intake are the main risk factors that contribute to the development of the disease (3 – 5).

Heart valve diseases may, however, be congenital, acquired during life or result from an infection. There are two categories of the disease, namely: stenosis and regurgitation or insufficiency. Severe aortic stenosis is the most common heart valve disease in older adults in western society. It is associated with reduced quality of life and increased mortality. Heart valves can be replaced by mechanical or biological prostheses (6 – 8).

Myocardial revascularization surgeries (MRS) as well as valve replacement or repair are considered to be major surgeries that require immediate postoperative intensive care. Extracorporeal circulation (ECC) is widely used in different types of cardiac surgery

and can produce a systemic inflammatory response, releasing substances that impair coagulation and immune response. Thus, patients with long ECC times are more likely to have greater neurological deficits (9, 10).

Neurological damage resulting from ECC can have devastating consequences such as loss of independence and worse quality of life. However, the most important factor associated with impairment of functional independence is duration of ICU stay and mechanical ventilation. These factors contribute to impairing the performance of daily activities such as personal hygiene and feeding after hospital discharge (11 – 13).

The functional autonomy required to perform activities of daily living may be reduced or lacking due to some types of chronic diseases, traumatic or surgical processes. The assessment of functional capacity is important in measuring the impact of disease on the patient's life and it is also a factor in diagnosis and prognosis, as well as a strong predictor of mortality (14).

Previous studies indicate that patients undergoing heart surgery have reduced functional capacity in the immediate postoperative period. Functional capacity, however, can be recovered 1-3 months after the procedure through a cardiac rehabilitation program (CRP) (15, 16).

Given the importance of cardiac surgery in correcting myocardial ischemia to relieve symptoms, improve quality of life and facilitate a return to daily life activities, this study aimed to assess the effect of cardiac surgery on the mental state and functional capacity of patients with heart disease.

Methods

We conducted a cross-sectional study with convenience sampling of subjects undergoing MRS and valve replacement in a regional teaching hospital between September and December, 2015.

This study included patients aged 18 years or older who had been admitted to the aforementioned hospital with a diagnosis of CAD or valvular heart disease, had undergone cardiac surgery, provided written informed consent, were clinically stable postoperatively and had participated in a CRP during hospital stay. Individuals who were not physically and/or mentally capable of completing the assessments were excluded from the study. This study complied with resolution CNS/MS 466/2012 regarding ethics in research with human beings and was approved by a Research Ethics Committee (protocol number 1.228.400).

First, we collected patients' identification data, clinical status information, surgical procedure data, information on intraoperative complications and length of ICU and hospital stay from their medical records and recorded on Surgical Monitoring Sheets. Next, the following questionnaires were administered to participants preoperatively and postoperatively before hospital discharge: the *Mini-Mental State Exam* (MMSE) and the *Duke Activity Status Index* (DASI).

The MMSE consists of 11 questions divided into 2 parts. Evaluate temporal orientation (5 points), spatial orientation (5 points), immediate memory (3 points), attention/concentration (5 points), delayed recall (3 points), naming (2 points), verbal repetition (1 point), verbal comprehension (3 points), writing (1 point), language (8 points) and reading a sentence (1 point), and constructional praxis (1 point). Scores range from 0 (cognitive impairment) to 30 (best cognitive capacity). Scores between 30 and 25 are considered normal. Scores below 25 are considered indicative of severe (< 10 points), moderate (10-17 points) or mild cognitive loss (18-24 points) (11, 17, 18).

Functional capacity was assessed with the Duke Activity Status Index (DASI). The DASI has been

especially used in patients with CAD, heart failure, myocardial ischemia and infarction. It consists of 12 items that assess activities of daily living such as personal care, ambulation, household tasks, sexual function, and recreational activities. Each item is weighed based on the known metabolic cost (MET) of each activity. The final score ranges from 0 to 58.2 points. The higher the score, the better the functional capacity. VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$) is estimated according to the following multiple regression equation: $VO_2 = 0.43 \times DASI + 9.6$. Both questionnaires were administered preoperatively and immediately before hospital discharge (14, 19).

Sample size was calculated based on a previous study by Morais et al. (18). It was calculated that a sample size of 9 would be sufficient to detect a three-point difference in the mean DASI score between the pre- and postoperative periods, with a standard deviation of 4 points, 80% power and a p-value less than 0.05.

All statistical analyses were conducted using SPSS (version 20.0). Normality was tested using Shapiro-Wilk's tests. The data are shown as mean \pm standard deviation. Pre- and postoperative variables were compared using paired Student's t test. The level of statistical significance was set at $p < 0.05$.

Results

This study assessed nine patients (eight males and one female) diagnosed with CAD or aortic stenosis. Table 1 describes the sample characteristics. Risk factors for cardiovascular diseases were present in all nine patients. Other comorbidities, such as chronic renal insufficiency, rheumatic fever, stroke, chronic atrial fibrillation and acute myocardial infarction (AMI), were found in seven patients.

Table 1 - Baseline characteristics of the study population

Variables	n = 9
Male gender, n (%)	8 (88.9)
Age (years)	62.4 \pm 6.3
Weight (kg)	88.4 \pm 10.8
Height (cm)	172.7 \pm 0.9
BMI (kg/m^2)	29.5 \pm 2.3
Normal weight, n (%)	1 (12.5)
Pre-obese, n (%)	5 (55.6)
Grade 1 obese, n (%)	3 (33.3)

(To be continued)

(Conclusion)

Table 1 - Baseline characteristics of the study population

Variables	n = 9
CAD, n (%)	7 (77.7)
Aortic stenosis, n (%)	2 (22.2)
SAH, n (%)	9 (100)
Smoking, n (%)	4 (44.4)
Dyslipidemia, n (%)	2 (22.2)

Note: BMI: Body Mass Index; CAD: Coronary artery disease; SAH: Systemic arterial hypertension.

The most often used surgical procedure was MRS. Only 2 patients underwent valve replacement. Table 2 depicts information about surgery and hospitalization. Blood products were used trans- and postoperatively by four patients who underwent MRS.

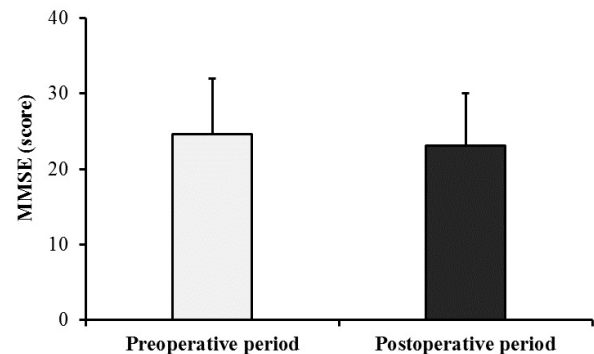
Table 2- Surgical procedure and hospitalization characteristics

Variables	n = 9
MRS, n (%)	7 (77.7)
Valve replacement, n (%)	2 (22.2)
ECC (min)	55.2 ± 27.2
Perfusion (min)	68.4 ± 29.7
Hospitalization (days)	12.6 ± 8.1
ICU hospitalization (days)	3.8 ± 2.8
Number of drains	1.8 ± 0.6
Blood products, n (%)	4 (44.4)
Transoperative complications, n (%)	4 (44.4)
Complications at ICU, n (%)	6 (66.6)

Note: MRS: Myocardial revascularization surgery; ECC: Extracorporeal circulation; ICU: Intensive care unit.

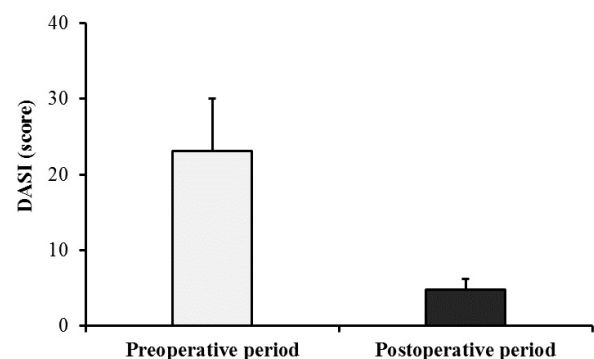
MMSE scores dropped from 24.46 ± 3.3 points in the preoperative period to 23.1 ± 4.5 points in the postoperative period (Figure 1). This reduction, however, was not statistically significant ($p = 0.461$). Five patients had normal scores (≥ 25 points) at baseline and another 5 patients had normal scores in the final assessment. The other patients had scores between 17 and 24 points. For patients who had normal scores in the final assessment, the mean ECC time was 45 minutes and the mean perfusion time was 59.4

minutes. Only 1 patient had normal MMSE scores at baseline, but MMSE scores compatible with moderate cognitive impairment in the final assessment.

**Figure 1** - Patients' pre- and postoperative Mini-Mental State Exam (MMSE) scores.

For patients who had normal MMSE scores at baseline and MMSE scores compatible with mild or moderate impairment in the final assessment, the mean ECC times was 73.5 minutes and the mean perfusion time was 86.5 minutes. None of the participants had dementia as a result of surgical procedure.

Patients' mean DASI scores also dropped from 23.1 ± 13.9 METs in the preoperative period to 4.8 ± 2.5 METs in the postoperative period (Figure 2), revealing a significant functional loss during hospitalization ($p = 0,003$).

**Figure 2** - Patients' pre- and postoperative Duke Activity Status Index (DASI) scores.

The mean estimated VO_2 decreased from $19.5 \pm 5.9 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ in the preoperative period to $11.6 \pm 2.1 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ in the postoperative period (Figure 3). Consequently, the sample also exhibited a significant decrease in exercise capacity ($p = 0.003$).

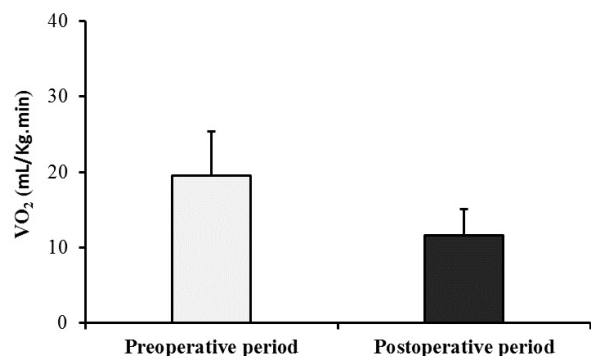


Figure 3 - Patients' pre- and postoperative oxygen uptake as estimated by the *Duke Activity Status Index*.

Discussion

This study found a significant reduction between pre- and postoperative DASI scores and VO_2 . Previous studies have shown that patients referred to undergo MRS are increasingly older and have other associated comorbidities. In line with this trend, the mean age of participants was 62 years and the underlying disease was associated with comorbidities in 77% of cases (17, 19 – 22).

Carrazedo et al. (11) assessed the cognitive performance of patients and found similar results. Most patients had worse cognitive function postoperatively. This is probably associated with previous AMI. In this study, 5 patients had previous AMI. No correlation, however, was found between this event and cognitive function.

Study participants undergoing valve replacement showed no cognitive deficits postoperatively. Nevertheless, studies on cognitive performance suggest this type of intervention is more detrimental to cognitive function than MRS, even in the case of replacement with biological prostheses (23, 24).

The correlation between ECC time and brain damage is well known and established in the literature. About 20-45% of patients develop a cognitive disorder after undergoing cardiac surgery. In this study, the mean ECC time was 55,2 minutes, which is considered normal (< 115 minutes) in this kind of surgical procedure. Thus, the reduction in cognitive capacity cannot be associated with ECC time (17, 25 – 27).

A literature review discussed the main factors involved in neurological injury following cardiac surgery and assessed the pharmacotherapy used to prevent it (28). This study indicates that ECC and

perfusion time is an intraoperative risk factor associated with the duration of the procedure.

In addition to assessing cardiac patients' cognitive impairment, it is also critical to assess their exercise capacity. It is known that the functional status of cardiac patients may be severely limited by reduced muscle mass and strength. A reduction in oxidative capacity and a significant decrease in blood flow affect the production of energy in the muscle. The Brazilian version of the DASI is a valid, reliable and easily administered instrument for self-assessing functional capacity in patients with cardiovascular diseases (2, 14, 29).

Orvin et al. (15) investigated changes in the cognitive performance and functional status of older adults undergoing MRS. Assessments were performed at baseline and at 1 month postoperatively using the *Medical Outcome Study Short Form -36* (MOS SF-36), the MMSE, the clock drawing test, the *Color Trails Test* (CTT), the *Cognistat evaluation*, the Barthel Index and the DASI. The study found positive functional performance and cognitive function results postoperatively. This agrees with this study, because patients were assessed in the initial (intra-hospital) phase of the CRP. We believe that administering the DASI at a more advanced phase of rehabilitation would result in better scores, especially in items related to household tasks and recreational tasks.

Gonçalves et al. (16) assessed quality of life of patients who participated in a CRP after MRS using the MOS SF-36 questionnaire at three time points: preoperatively, at 5 days and at 2 months postoperatively. There was a significant ($p < 0.001$) reduction in body function (41.9%) at discharge, with a recovery at 2 months postoperatively. These results corroborate the findings of this study, in which patients exhibited a 79.23% reduction in mean DASI scores postoperatively, evidencing significant functional loss before hospital discharge.

Morais et al. (20) assessed pain in the pre- and postoperative periods, both in the first surgery and reoperation. The study was conducted with cardiac patients undergoing cardiac surgery with ECC. Patients were assessed using the Functional Independence Measure (FIM) and the visual analogue scale (VAS) preoperatively and at 2, 3, 5 and 6 days postoperatively. There was a loss of functional performance from the preoperative period to days 2 and 3 postoperatively and a gain of functional performance from days 2 and 3 postoperatively to days 5 and 6 postoperatively ($p < 0.001$). These findings are in line with the results

obtained in this study, in which patients' functional capacity was lower in the postoperative period, compared with the preoperative period.

Koch et al. (30) investigated the pre- and postoperative functional status of patients undergoing MRS. Older patients and patients who had chronic obstructive pulmonary disease, AMI, stroke, diabetes, vascular disease, severe postoperative infection and had to be returned to the operating room had lower postoperative scores. This study found similar results. Seven patients who had comorbidities and advanced age obtained lower postoperative than preoperative functional scores.

One limitation of this study was the issue of how to deal with respondents' failure to answer MMSE questions due to their illiteracy. Owing to patients' short hospital stay, it was not possible to assess exercise capacity using other instruments such as the six-minute walk test (MWT). Moreover, their clinical status usually did not allow for performance of other exercise capacity tests.

Conclusion

This study demonstrated a loss of exercise capacity - but no cognitive changes - after cardiac valve replacement or myocardial revascularization surgery.

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