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ORIGINAL ARTICLE

Impact of Coronary Artery Bypass Grafting on Muscle Mass Reduction on the 7th Postoperative Day

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Abstract

Background: Ischemic heart failure is a chronic and degenerative disease with high morbidity and mortality in the world. Coronary artery bypass grafting is indicated as elective treatment and may cause a catabolic state that depletes energy reserves. Data on body composition evaluation in the postoperative period of major cardiac surgery are limited.

Objective: To evaluate the influence of elective coronary artery bypass grafting on body composition on the seventh postoperative day of patients with ischemic heart failure.

Methods: A cross-sectional study was carried out in which eighteen volunteers with New York Heart Association Class II and III heart failure underwent coronary artery bypass grafting. The energy and protein reserves of the participants were evaluated by anthropometry in the preoperative and on the seventh postoperative day. Paired t-Test or Mann-Whitney test was used if applicable. A significance level was considered at p value < 0.05.

Results: A significant loss of muscle mass was observed through the reduction of arm muscle circumference after surgery (4.2%, p 0.007). Major surgery causes hypermetabolic state and systemic inflammatory stimulus, due to the release of hormones and cytokines that may justify the observed loss of muscle mass.

Conclusion: Coronary artery bypass grafting had an impact on muscle mass reduction seven days after surgery in patients with ischemic heart failure. (Int J Cardiovasc Sci. 2019; [online].ahead print, PP.0-0)

Keywords: Heart Failure/physiopathology; Heart Failure/mortality; Coronary,Artery Bypass Grafting; Body Composition; Postoperative Period.

Introduction

Heart failure (HF) is a chronic and degenerative disease with high morbidity and mortality in the world. Coronary artery bypass grafting (CABG) is indicated as an elective treatment and, may cause a catabolic state that depletes energy reserves.[1]

Data from the preoperative body composition assessment, using the anthropometric method and clinical outcomes after myocardial revascularization are limited. Therefore, we aimed to demonstrate the influence of elective CABG on body composition in the postoperative period of patients with ischemic heart failure.[2]

Methods

This study is part of a clinical trial that assessed the association between CABG and cardiac reverse remodeling. This cross-sectional study was approved by the Research Ethics Committee of the University Hospital of *Universidade Federal Fluminense*. It was registered in the Brazilian Registry of Clinical Trials (RBR-7376mq).

Patients with ischemic HF New York Heart Association (NYHA) Class II and III,[2] of both genders, undergoing elective CABG were recruited from National Institute of Cardiology / RJ. The inclusion criteria were: clinical and hemodynamic stability and absence of protein or caloric

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restriction in the preoperative period. Participants who showed NYHA class worsening,[2] or had hemodynamic decompensation, renal failure, sepsis or myocardial infarction were excluded. All participants started preoperative fasting 12 hours before the surgery. Oral feeding with a liquid diet in small amounts was offered 24 hours after the surgery and was maintained until 48 hours postoperatively. It consisted of meatless vegetable soup, fruit juice and teas. Participants were recruited using convenience sampling.

The participants' energy and protein reserves were evaluated by anthropometry performed by the same trained evaluator in the preoperative period and on the seventh postoperative day. Height (m) and weight (kg) were measured in a portable stadiometer and electronic balance, respectively with participants dressed in lightweight clothes. Body mass index (BMI) was calculated as the ratio between weight and squared height (kg / m²). Normal weight was considered when BMI was between 22 - 27 kg / m²) and overweight as BMI > 27- < 30 kg/m².

Waist circumference (WC; cm) was measured with an inextensible metric tape, at midpoint between the lowest rib and the iliac crest after exhalation. The mean of the two measurements was considered in the analysis: high risk of metabolic complications was associated with obesity when WC > 102 cm.

In order to evaluate arm muscle circumference (AMC; cm), the arm circumference (AC; cm) was measured at arm midpoint between the acromion and the olecranon with the arm flexed, using a tape measure. Then, the triceps skinfold thickness (TST; mm) was measured in the same place using an adipose compass (Cescorf, Brazil). AMC was calculated based on the AC and TST using the formula: AMC = AC - (3.14 × TST). The AMC reference range for age 70–79 years was P_{50} = 27.2 cm. Adequacy percentage was calculated considering P_{50} value: normal weight > 90%.

The fat reserves were evaluated through TST and body fat percentage (BF%). TST reference range for age 70-79 years at P_{50} = 12.4 mm. Adequacy percentage was calculated considering P_{50} value: normal weight: 90 – 110%; obesity > 110%.

BF% was calculated based on the sum of the four folds: TST, bicipital (mm), suprailiac (mm) and subscapular (mm) folds. The bicipital fold was measured towards the longitudinal axis of the arm, on its anterior face, at the point of greatest apparent circumference of the biceps. The suprailiac fold was obtained in the medial axillary line at midpoint between the iliac crest and the last costal arch. The subscapular fold was measured one centimeter below the inferior angle of the scapula. Adequacy percentage of normal range for men is 15-18%; risk of diseases associated with obesity: ≥ 25%). The mean of two measurements was considered in the analysis. Serum albumin (g/dL) was also evaluated: normal range > 3.5 g/dL; medium risk: 2.8 – 3.4 g/dL.

Statistical analysis

Data were analyzed using the software SPSS, version 10 (SPSS Inc.), PASW version 18 (IBM) and Microsoft Excel. Data normality was verified by the Shapiro–Wilks test. Paired t Test was used to compare the pre- and postoperative periods when the variables had normal distribution. When the normality criterion was not met, the Mann-Whitney test was used. A significance level was considered at p value < 0.05.

Results

From July 2016 to August 2017, thirty-seven patients (94.6% males) were recruited and followed.

Nineteen (51%) patients were excluded: seven (18.9%) patients had NYHA class worsening, seven had hemodynamic decompensation, two (5.4%) had kidney disease, one (2.7%) had acute myocardial infarction, one (2.7%) had sepsis and one (2.7%) died.

Eighteen patients completed the study. Table 1[3-5] summarizes clinical and demographic characteristics of the study population.

The risk factors and comorbidities for ischemic heart disease were observed. The values found for body composition and plasma albumin in the preoperative period and on the 7th postoperative day are shown in table 2. BMI, AMC and albumin had values reduced by 4.2%, 25% and 1.8%, respectively.

Discussion

Preoperative nutritional risk assessment is well established and aims to minimize postoperative morbidity and mortality,[6] as well as targeting caloric and nitrogen support for healing and preventing excessive loss of lean body mass.[7]

Studies that evaluated the postoperative body composition of patients after major cardiac surgeries

Table 1 - Baseline characteristics

	n (%)
Age[a] (years)	69.3 ± 5
Male gender	18 (100)
Sedentary lifestyle	18 (100)
Alcohol consumption	2 (11.1)
Smoking	11 (61.1)
NYHA class	
II	14 (77.8)
III	4 (22.2)
Comorbidities	
Hypertension[b]	16 (88.8)
Type 2 diabetes[c]	8 (44.4)
Dyslipidemia[d]	9 (50.0)
Previous myocardial infarction	9 (50.0)
Drugs used	
Antidiabetic drugs	8 (44.4)
Lipid-lowering drugs	16 (88.8)
Antihypertensive drugs	16 (88.8)
Diuretics	14 (77.8)
Beta-blockers	9 (50.0)
Vasodilators	15 (83.3)

[a] Mean ± standard deviation. [b] On therapy. or resting blood pressure > 139/90 mmHg.[3] [c] On therapy. or fasting blood sugar > 126 mg/dL.[4] [d] Total cholesterol ≥ 239 mg/dL and triglycerides ≥ 150 mg/dL.[5]

Table 2 - Anthropometric and biochemical evaluation in the preoperative and postoperative periods of coronary artery bypass grafting

Parameters	Preoperative	Postoperative	p-value
BMI (kg/m²)[a]	28.4 ± 3.0 (overweight)	27.9 ± 2.9 (normal weight)	0.106*
AMC (cm)[a]	28.0 ± 2.2 102.9% (normal weight)	26.8 ± 2.1 98.5% (normal weight)	0.007*
TS (mm)[a]	15.6 ± 4.2 125.8% (obesity)	15.7 ± 5.3 126.6% (obesity)	0.973*
WC (cm)[b]	102.0 [99.33-104.3]	102.4 [99.4-105.8]	0.412**
BF (%)[b]	34.23 [30.8-36.8] (↑ risk)	34.0 [31.7-36.5] (↑ risk)	0.6514**
Albumin (g/dL)[a]	4.0 ± 1.0 (↓ risk)	3.0 ± 0.8 (medium risk)	< 0.00*

*[a] Mean ± standard deviation; b Median and interquartile range. *Paired t test. **Mann-Whitney test. BMI: body mass index; AMC: arm muscle circumference; TS: triceps skinfold; WC: waist circumference; BF: (%) body fat percentage; Serum albumin.*

are scarce. We have evidenced the impact of elective CABG on skeletal muscle mass reduction through anthropometry on the seventh postoperative day in patients with ischemic HF. This is a simple, low-cost method of assessing body composition.

Major surgeries, such as CABG, cause a hypermetabolic state and systemic inflammatory stimulus, due to the release of hormones and cytokines[3] that may justify the loss of muscle mass observed in this study. Iida et al.,[1] suggested surgical stress, extracorporeal circulation, and perioperative hypothermia as causes of muscle mass loss.

The muscle proteolysis after CABG in HF patients has been reported in studies that used biochemical parameters as an evaluation method. Iida et al.,[1] have identified protein hypercatabolism through serum IL-6, cortisol, insulin-like growth factor (IGF)-1, growth hormone, branched-chain amino acid, and aromatic amino acid levels and evaluated muscle proteolysis through the urinary ratio between 3-methylhistidine and creatinine.[3] They verified that muscle proteolysis was accelerated 24 hours postoperatively and suggested that interventions to preserve skeletal muscle mass should be carried out up to 48 hours after surgery. These findings suggested that muscle protein degradation was due to the metabolic response to surgical stress.

The inflammatory stimulus provoked by surgery also justifies the significant reduction in albumin levels observed in this study. It is known that albumin is a visceral protein that has its concentrations reduced at the expense of increased expression of inflammatory proteins, such as C-reactive protein. Despite being a biochemical marker widely used to assess nutritional risk, there are limitations for its use in inflammatory processes.[3] Thus, the use of serum albumin as an indicator of visceral protein reserve should be carefully evaluated in the presence of an inflammatory process.

We also observed BMI reduction due to weight loss, but without statistical significance. Similar results were found by Dimaria-Ghalili.[8] He reported that BMI reduction was due to the continuous inflammatory response related to surgical stress.

Although the study has limitations because it did not quantify the energetic and protein content of the liquid diet offered 24 hours postoperatively, this diet certainly did not reach the energy and protein requirements, despite the early reintroduction of the oral feeding, as recommended by Evans et al.[7]

Based on these preliminary results, an additional study can be proposed with the aim of improving the composition of the liquid diet offered 24 hours postoperatively in order to minimize muscle mass loss. The metabolic response to trauma is more intense on the first and second postoperative days, is proportional to the type of surgery[9] and justifies a higher protein requirement at this moment.

Conclusion

Elective coronary artery bypass grafting had an effect on muscle mass reduction on the seventh postoperative day. The impact of muscle mass reduction after cardiac surgery justifies additional studies.

Study limitations

The study had a small number of participants.

Author contributions

Conception and design of the research: Costa BO, Maciel G, Huguenin AB, Silva G, Guimarães SMS, Cruz WMS, Colanfranceschi AS, Boaventura GT. Acquisition of data: Costa BO, Maciel G, Huguenin AB, Silva G, Guimarães SMS, Cruz WMS, Colanfranceschi AS, Boaventura GT. Analysis and interpretation of the data: Costa BO, Silva G, Guimarães SMS, Cruz WMS. Statistical analysis: Costa BO, Guimarães SMS, Cruz WMS. Obtaining financing: Costa BO, Guimarães SMS, Cruz WMS, Colanfranceschi AS, Boaventura GT. Writing of the manuscript: Costa BO, Guimarães SMS, Cruz WMS. Critical revision of the manuscript for intellectual content: Costa BO, Maciel G, Huguenin AB, Silva G, Guimarães SMS, Cruz WMS, Colanfranceschi AS, Boaventura GT.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This paper is part of the clinical trial (Doctoral thesis) of Sheila Moreira da Silva Guimarães from *Universidade Federal Fluminense*.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the for Medical Research of *Faculdade de Medicina/ Hospital Universitário Antônio Pedro*. under the protocol number CAAE: 37659314.4.0000.5243. It was registered in the Brazilian Registry of Clinical Trials (RBR-7376mq). All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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