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Evaluation of peripheral muscle strength of patients undergoing elective cardiac surgery: a longitudinal study

Avaliação da força muscular periférica de pacientes submetidos à cirurgia cardíaca eletiva: estudo longitudinal

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Abstract

Introduction: Peripheral muscle strength has been little explored in the literature in the context of cardiac rehabilitation.

Objective: To evaluate the peripheral muscle strength of patients undergoing elective cardiac surgery.

Methods: This was a longitudinal observational study. The peripheral muscle strength was measured using isometric dynamometry lower limb (knee extensors and flexors) at three different times: preoperatively (M1), the day of discharge (M2) and hospital discharge (M3). Participants received physiotherapy pre and postoperatively during the days of hospitalization during the morning and afternoon.

Results: Twenty-two patients were evaluated. The values of peripheral muscle strength of knee extensors preoperative found were about 50% lower than those predicted for the healthy population. When comparing muscle strength prior (M1), with the remaining evaluation, found himself in a fall of 29% for the movement of knee extension and 25% for knee flexion in M2 and a decrease of 10% movement for knee extension and 13% for knee flexion in M3 when comparing with M1.

Conclusion: The values of peripheral muscle strength prior of the study patients were lower than predicted for the healthy population of the same age. After the surgical event this reduction is even more remarkable, being reestablished until the time of discharge, to values close to baseline.

Descriptors: Muscle Strength. Muscle Strength Dynamometer. Heart Diseases.

Resumo

Introdução: A força muscular periférica tem sido pouco explorada na literatura atual no contexto da reabilitação cardiovascular.

Objetivo: Avaliar a força muscular periférica de pacientes submetidos à cirurgia cardíaca eletiva.

Métodos: Trata-se de um estudo observacional e longitudinal. A força muscular periférica foi mensurada por meio de dinamometria isométrica de MMII (extensores e flexores de joelho) em três momentos distintos: pré-operatório (M1), dia da alta da unidade de terapia intensiva (M2) e dia da alta hospitalar (M3). Os participantes receberam atendimento fisioterapêutico pré e

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Abbreviations, acronyms & symbols

CABG	Coronary Artery Bypass Grafting
FBHC	Fundação de Beneficência Hospital de Cirurgia
PMS	Peripheral muscle force

pós-operatório durante os dias do internamento, nos períodos matutino e vespertino.

Resultados: Foram avaliados 22 pacientes. Os valores de força muscular periférica de extensores de joelho pré-operatórios encontrados foram cerca de 50% menores do que os preditos para a população saudável. Ao comparar a força muscular prévia

(M1), com os demais momentos de avaliação, encontrou-se em M2 queda de 29% para o movimento de extensão do joelho e 25% para o movimento de flexão de joelho e queda de 10% para o movimento de extensão do joelho e 13% para o movimento de flexão de joelho em M3 ao comparar com M1.

Conclusão: Os valores de força muscular periférica prévia dos pacientes do estudo foram menores do que o predito para a população saudável com a mesma faixa etária. Após o evento cirúrgico, essa redução é ainda mais notável, sendo reestabelecida até o momento da alta hospitalar a valores próximos ao basal.

Descritores: Força Muscular. Dinamômetro de Força Muscular. Cardiopatias.

INTRODUCTION

Cardiovascular diseases are responsible for high rates of morbidity and mortality in Brazil and in the world^[1]. For treatment of many of these cardiac conditions, surgery is the main resource^[2]. Although very safe, heart surgery is a procedure considered large and is accompanied by the need for general anesthesia, cardiopulmonary bypass, mechanical ventilation and relative restriction to bed rest^[3].

The heart disease patients showed loss of functional capacity resulting from decreased oxidative capacity of skeletal muscle and reduced muscle perfusion, such loss being aggravated in case of hospitalization for bed rest, impacting loss of peripheral muscle function^[4]. Peripheral muscle strength (PMS) can be considered as a predictor of overall muscular strength, and is associated with functional and nutritional presentation^[4]. The PMS is of great interest to cardiac rehabilitation, but it has been little explored in the current literature^[5].

The aim of this study was to assess peripheral muscle strength in patients undergoing elective heart surgery.

METHODS

Study design

This is a pilot, observational, longitudinal study performed at the Fundação de Beneficência Hospital de Cirurgia (FBHC) in the city of Aracaju - SE. The patients' assessments were performed at three time points: preoperatively (a day before surgery) (M1), on the 1st day after ICU discharge (M2) and the day of discharge (M3), in the form of lower limb isometrics.

All study participants received physiotherapy (physical and respiratory therapy), in the pre- and postoperative periods, twice a day for every day of hospitalization in the morning and afternoon. The treatment protocol included: breathing exercises (ventilatory), lung re-expansion maneuvers, bronchial hygiene, postural drainage, exercises to prevent

deep vein thrombosis, deambulation, walking up and down stairs, active-assisted and active kinesiotherapy of upper and lower limbs, and muscle stretching. The rehabilitation protocol followed the guidelines of the Brazilian Consensus on Cardiovascular Rehabilitation^[6].

Study Population

Patients were recruited from a tertiary hospital of Cardiology between September and November 2012. Patients undergoing elective cardiac surgery (both genders and aged between 18 and 80 years) were eligible for this study. Inclusion criteria were: absence of neurocognitive decline or dementia that could influence the process of communication, absence of musculoskeletal disorder and previous pulmonary diseases (chronic obstructive pulmonary disease), presence of hemodynamic instability (Mean Arterial Pressure >60 mmHg), dyspnea with oxygen saturation less than 90%. The patient, who refused to sign the Written Informed Consent and those who had the time of stay in the ICU more than 7 days were excluded from the study.

This research protocol was approved by the Research Ethics Committee of our institution (CAAE nº 01521012.2.0000.0058). All patients signed a written informed consent prior to participation in this research.

Data collected from medical records

Clinical history, diagnosis, vital signs, type of surgery, total days of hospital and ICU stay, time of cardiopulmonary bypass and mechanical ventilation time were collected, as well as the patient's characteristics involved in the study (Table 1).

Assessment of peripheral muscle strength

The PMS was assessed at three different time points: preoperatively (day before surgery) (M1), on the 1st day after ICU discharge (M2) and the day of discharge (M3), in the form of isometrics for extension and flexion of the right and left knees. The instrument used in this assessment was the portable digital dynamometer, IMPAC®, IP-90DI model with

scale in kgf, associated with an anatomical adapter for better coupling of the lower end segment^[7].

In the assessment of knee isometric strength was observed muscle performance in flexion and extension, bilaterally. The procedure followed in the following standardization: the patient remained seated, hips at 90° of flexion and abduction at shoulder width. Patients performed the movements required under verbal command of the evaluator, exerting a continuous isometric force for 5 seconds. Three independent measurements and with one-minute interval between them for each movement and collection of averaging of such measurements were performed. The digital dynamometer remained leaning against a flat surface in order to maintain the stability of the instrument under the pressure exerted by the subject at the time of isometrics. Patients were instructed not to perform the Valsalva maneuver. The analgesic therapy in the study patients was standardized.

Statistical analysis

Data are presented as mean and standard deviation. The data presented normal behavior (Shapiro Wilk test) and for the analysis of PMS at different times, we used one-way ANOVA test and Bonferroni post-test with 95% confidence interval. We consider the level of less than 5% ($P < 0.05$) significance. For statistical analysis we used SPSS (Chicago IL, USA) version 13.0.

RESULTS

In this study, 31 patients were listed for surgery of which 22 met the inclusion criteria. Nine patients were excluded and 22 were assessed until the end of the study (Figure 1, Table 1).

Concerning body composition of the sample, BMI (Body Mass Index) had values classified as normal weight (37.5% men, 64.29% women), overweight (50% men, 14.29% women) and obesity grade 1 (12.5% men, 21.42% women). All subjects were considered physically inactive with respect to the level of physical activity after submission to the specific questionnaire.

The preoperative values of peripheral muscle strength for knee extension found in study patients (3.5 ± 8.94) were nearly 50% lower than predicted for the healthy population with the same mean age (18.2 ± 2.3)^[8].

There was a 29% reduction in the PMS for the movement of knee flexion in the interval between assessments of M1 (7.06 ± 2.8), CI=(3.30, 14.50) and M2 (5.29 ± 1.9) CI (2.55, 10.67) ($P = 0.056$). Comparing M1 and M3 (6.35 ± 2.4), CI=(3.05, 12.82) there is still a deficit of PMS of 10% for movement of knee flexion ($P = 0.99$).

For movement of knee extension, there was also a 25% reduction of M1 (8.94 ± 3.5), CI=(5.10, 20.45) for M2 (6.34 ± 2.24), CI=(2.34, 11.92) ($P = 0.016$) and further reduction of 13% when comparing M1 with M3 (7.74 ± 3), CI=(3.91, 17.19) ($P = 0.057$) (Figure 2).

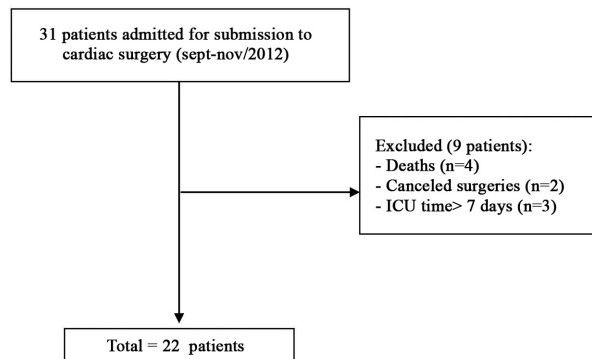


Fig. 1 - Flow of patients in the study.

Table 1. Characteristics of the study patients.

Variables	Number of patients (%), number of surgeries (%), Time (min, hours, days)
Total of patients	22
Age (years)	50.4±5
Type of surgery	n(%)
CABG	8 (36.4%)
Valve replacement	7 (31.8%)
Valvuloplasty	2 (9.9%)
CABG + valve replacement or repair	2 (9.9%)
IAC repair	1 (4.54%)
Aneurysmectomy	1 (4.54%)
Myxoma resection	1 (4.54%)
CPB time (minutes)	94.1±14.8
MV time (hours)	12.1±1.2
Length of hospital stay (days)	
Total	10.1±0.8
ICU	2.9±0.3

CABG=coronary artery bypass grafting, IAC=interatrial septal defect, CPB= cardiopulmonary bypass, MV=mechanical ventilation, ICU=intensive care unit

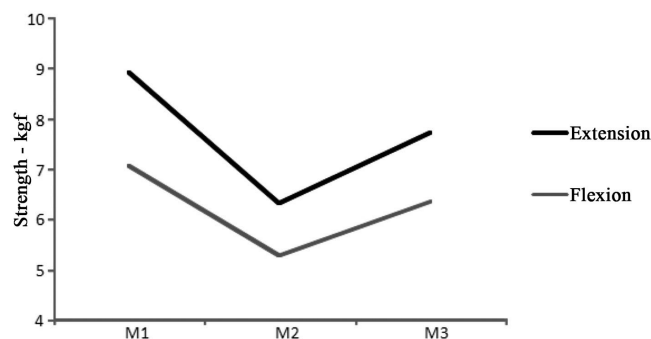


Fig. 2 - Peripheral muscle strength. Peripheral muscle strength in patients undergoing cardiac surgery. M1 (preoperative assessment), M2 (assessment on the day of discharge from ICU), M3 (assessment on the day of hospital discharge). The data were assessed using the one-way ANOVA test and Bonferroni post-test.

DISCUSSION

The main finding of our study was the reduction in muscle strength of the lower limbs of patients undergoing elective cardiac surgery procedure.

Some studies have reported that postoperative complications of cardiac surgery may contribute to the increased staying time of intensive care unit^[3], especially respiratory and metabolic complications^[9]. Nevertheless, decrease in postoperative functionality of these patients has been reported^[10].

Among the postoperative respiratory complications, one aggravating factor is the loss of respiratory muscle strength^[11], but so far, it is unknown whether such loss is also reproduced in peripheral muscle strength.

Peripheral muscle force (PMS) can be regarded as a predictor of overall muscular strength, and is associated with functional and nutritional presentation of the patient^[12,13]. Nevertheless, the PMS has been little explored in the literature, especially in the context of complications from surgery, the reason why the study was proposed.

Diffuse neuromuscular abnormalities have been reported in 50% of patients admitted to the ICU after staying on mechanical ventilation, with the primary clinical sign the physical deconditioning and muscle weakness^[14].

Immobility in bed following surgical procedures, the use of cardiopulmonary bypass (CPB) and mechanical ventilation, the pain caused by sternotomy and saphenectomy, the presence of drains and venous access, peripheral edema, among other factors, are conditions that limit mobility in bed and consequently the functionality^[6].

It is known that the functionality of cardiac patients can be severely limited by the reduction of muscle mass and strength, decreased oxidative capacity and a significant deficit in blood flow affecting the energy intake to the muscle^[6].

In the present study, after ten days, on average, CABG patients were discharged from hospital (M3) and currently has detected an increase in the PMS values compared to the values listed in M2, demonstrating loss of only 10% when compared with M1.

Even with the limitation of the study, taking into consideration the design and duration of patient follow-up, it is not possible to identify the causes of incomplete restoration of PMS in patients postoperatively, but it is noteworthy that the patients had a good recovery of strength muscle, which was demonstrated by the absence of significant differences when comparing the previous values with the day of discharge.

However, it is clear that the moment of greatest restriction on the bed (due to the drains, access and pain) is closely linked to the largest deficit in muscle strength (M2), emphasizing the need for early inclusion of this patient in cardiac rehabilitation protocols with supervised physical exercise.

Limitations of the study

The fact that this was a pilot study limits the interpretation of some data. Even in the absence of a gold standard for assessment of peripheral muscle strength, dynamometry is an effective, practical and reproducible method has demonstrated in the literature^[15].

CONCLUSION

Patients undergoing cardiac surgical procedures may present reduction in peripheral muscle strength in the immediate postoperative period, with a tendency to gain strength in subsequent days until the day of discharge.

Potential conflict of interest

There was no potential relevant conflict of interest.

Authors' roles & responsibilities

KMSS	Data collection
MLCN	Editing
VOC	Guidance, supervision
VJSF	scientific writing and supervision
WMSJ	training and supervision of staff
AAAF	Data Collection
TCFC	Evaluation of patients
LAPC	Coordination and guidance

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