Journal of Clinical and Experimental Research in Cardiology
Volume 4 | Issue 1
ISSN: 2394-6504

Research Article Open Access

# Impact of Myocardial Revascularization on the Range of Joint Motion of the Superior and Inferior Members

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**Citation:** De Lima ASF, Rios MBT, Silva Bispo RDS, Lisboa Cordeiro AL, Borges DL, et al. (2018) Impact of Myocardial Revascularization on the Range of Joint Motion of the Superior and Inferior Members. J Clin Exp Res Cardiol 4(1): 105

## Abstract

**Introduction:** The surgical procedure for myocardial revascularization (MRI) may compromise chest stability, compliance and range of motion (ROM) of the shoulder joint due to sternotomy and knee joint due to saphenectomy.

**Objective:** To evaluate the impact of myocardial revascularization surgery on upper and lower limb ROM

**Methodology:** This is a prospective cohort study, performed with a group of patients submitted to cardiac surgery. In the preoperative period the ROM was evaluated through a goniometer, for flexion, horizontal abduction and vertical abduction of the right and left shoulder, as well as evaluation of the flexo-extension movement of the right knee. On the day of discharge from the Intensive Care Unit, the patients were reassessed.

**Results:** Twenty patients were evaluated during the time of the study. The majority were men 14 (70%), with a mean age of 60 ± 10 years. Regarding ROM, it was verified that all the movements presented a significant reduction in the postoperative period. The right shoulder flexion (75 ± 11ºvs66 ± 8º, p = 0, p <0.01), right shoulder abduction (155 ± 17º vs127 ± 22º, p < (P = 0.02), right vertical abduction (142 ± 24º vs117 ± 22º, p <0.01), left vertical abduction (142 ± 24º vs121 ± 22º, p = 0), left horizontal abduction (79 ± 9º vs70 ± 5º, p=0,02), Knee flexion (100 ± 14º vs75 ± 19º, p <0.01) and knee extension (94 ± 13º vs79 ± 15º, p <0.01).

**Conclusion:** It can be concluded that the surgery promote reduction of the range of joint motion in this sample of patients submitted to myocardial revascularization.

**Keywords:** Range of Articular Movement; Physical Therapy; Thoracic Surgery

## Introduction

One of the major causes of mortality in Brazil is cardiovascular diseases, which affect almost 30% of the population. According to Rocha Coronary Artery Disease (CAD) is one of the major causes of morbidity in the world, especially in developed countries, due to the population's longer life expectancy, daily habits and lifestyle adopted by these individuals, targeting the population aged 60 and over [1].

CAD can be managed with the use of medications or corrective treatment such as the surgical procedure [2] affirm that cardiac surgeries are highly complex techniques performed throughout the world, with myocardial revascularization being the most common [3].

Although the surgical intervention increases the life expectancy of patients, there is a possibility of clinical complications such as infections, suture dehiscence, paresthesia, distal edema, lymphangitis, among others. These factors increase morbidity and mortality and cause great discomfort to these individuals [4].

ROM can be compromised by sternotomy and safectomy. For Titolo *et al.* [5] it is a procedure used in cardiac surgeries, being a technique that interferes with thoracic stability and compliance. According to Baraúna *et al.* the degrees of freedom of the shoulder joint, flexion and extension are performed in the sagittal plane, summing together a total of 220° to 240°, and the flexion has the highest degree of freedom, reaching from 170° to 180° in the anatomical position [6].

The absence of the stimulation in the postoperative period may lead to muscle shortening with a consequent decrease in ROM. Freeman *et al.* verified that the application of activated or passive exercises are effective in reducing the joint complications associated with immobilism.

Even with physiotherapeutic intervention for prevention and / or treatment of possible muscular shortenings, it is noted, in clinical practice, that there is a decrease in ROM, especially in the upper and lower limbs due to sternotomy and saphenectomy, respectively.

In the literature there is a difficulty in finding articles that quantify this reduction, so the objective of the study was to evaluate the impact of myocardial revasculatization surgery with sternotomy and saphenectomy on ROM of the upper and lower limbs.

## Material and Methods

This is a prospective cohort study, conducted with a group of patients submitted to cardiac surgery at the Instituto Nobre de Cardiologia (INCARDIO) in Feira de Santana - BA, from October 2016 to May 2017. This study was approved by the Committee of Ethics in Research of the Faculty Nobre of Feira de Santana, Bahia, with the opinion number 1,784,226.

As inclusion criteria, both genders, aged between 40 and 70 years, were used in the postoperative period of myocardial revascularization surgery via sternotomy and with saphenectomy. These age values were used by the age group seen in the hospital. As exclusion criteria, patients with mechanical ventilation time greater than 12 hours, length of stay in the Intensive Care Unit (ICU) over four days, physical or functional limitation prior to surgery, emergency surgery and difficulty understanding or performing the assessment of range of motion

At the preoperative time, all were evaluated in relation to the range of motion (ROM) for right and left shoulder flexion, right and left horizontal abduction, right and left vertical abduction, and right knee flexion and extension. This evaluation was performed through goniometry, using the goniometer Estadiometer and Anthropometric Ruler - Trident (Carci ® - Brazil).

For evaluation of the shoulder flexion, the patient was sitting and with the arm attached. The axis was placed in the acromium, the bar being fixed towards the ground and the movable bar accompanying the flexion movement of the shoulder, lateral to the humerus, in the direction of the lateral epicondyle, upwards. Already for vertical abduction, the axis was located in the acromion and measured approximately two fingers below it towards the spine of the scapula. The bar fixes toward the ground posteriorly and the movable bar following the abduction movement, in the dorsal region. Horizontal abduction with the patient seated, the axis was placed on the acromion. The bar is fixed towards the humerus anteriorly (forward) and the movable bar parallel to the humerus follows the movement of moving the arm away from the median line (outwards). The knee was evaluated with the patient also sitting with the goniometer aligned to the major trochanter of the femur, lateral side of the knee joint and the movable bar directed to the lateral malleolus of the ankle accompanying the flexion-extension movement [8].

After the surgical procedure, all patients were referred to the ICU, where they were managed according to the routine of the unit, without applying any specific intervention of the research. These interventions consisted of active bed-free kinesiotherapy, transfer from sitting to sitting with lower limbs supported, shifting from sitting to orthostasis, training in standing gait, seating in the armchair and subsequent walking in the unit. The order and possibility in relation to the ducts depended on the patient's physical capacity, level of consciousness and medical release, since the patient could be using vasoactive drugs. On the second postoperative day ROM was re-evaluated for pre and postoperative comparison, and it should be noted that these evaluations were performed by examiners blind to the protocol.

Statistical Package for the Social Sciences version 20.0 was used to analyze the data. To evaluate the normality of the sample, the Kolmogorov-Smirnov test was used. Data were expressed as mean and standard deviation. For comparison of the pre and post surgery ROM the Paired Student T Test was used and considered as statistically significant if $p < 0.05$

## Results

During the study period, 30 patients underwent myocardial revascularization. Of these, 10 were excluded due to: hemodynamic instability [5] stay longer than 4 days in the ICU [2] failure to sign a consent form [3].

Therefore, 20 patients were evaluated, and 14 (70%) were male, with a mean age of 60 ± 10 years. The most prevalent comorbidity was systemic arterial hypertension with 14 (70%). The other clinical and surgical characteristics are shown in (Table 1).

| Variable | Mean ± standard deviation | n (%) |
|---|---|---|
| **Genre**<br>Male<br>Female | | <br>14 (70%)<br>6 (30%) |
| **Age (years)** | 60 ± 10 | |
| **IMC (kg/m²)** | 24 ± 4 | |
| Comorbidities<br>Systemic Arterial Hypertension<br>Diabetes Mellitus<br>Dyslipidemia<br>Smoking | | <br>14 (70%)<br>8 (40%)<br>4 (20%)<br>2 (10%)<br>2 (10%) |
| **VM time (hours)** | 8 ± 1 | |
| **CEC time (minutes)** | 75 ± 17 | |

**BMI - Body Mass Index; VM - Mechanical Ventilation; CEC - Extracorporeal Circulation.**

Table 1: **Baseline data of patients undergoing myocardial revascularization.**

When analyzing the joint range of motion, it was verified that only in the horizontal abduction of the right shoulder there was no statistically significant reduction (p = 0.08). The other joints presented a significant decrease as shown in (Table 2).

| Movement | Pré | Post | p[a] |
|---|---|---|---|
| **Right Shoulder Flexion** | 159±17 | 129±20 | <0,01 |
| **Left shoulder flexion** | 155±21 | 127±22 | <0,01 |
| **Right Horizontal Abduction** | 75±11 | 66±8 | 0,08 |
| **Left Horizontal Abduction** | 79±9 | 70±5 | 0,02 |
| **Vertical Right Adduction** | 142±24 | 117±22 | <0,01 |
| **Adução Vertical Esquerda** | 142±24 | 121±22 | 0,01 |
| **Knee Flexion** | 100±14 | 75±19 | <0,01 |
| **Knee Extension** | 94±13 | 79±15 | <0,01 |

[a] Paired Student T Test. Values expressed in degrees.

**Table 2:** Behavior of joint range of motion before and after myocardial revascularization.

## Discussion

After analyzing the results, it was verified that myocardial revascularization surgery generates a significant reduction in the range of joint movement of the shoulders and right knee.

Physical therapy in the postoperative period of surgical procedures with sternotomy or thoracotomy aims at pulmonary reexpansion and mucociliary clearance [9]. In addition, attention should be paid to postural corrections, associated with the presence of the thoracic drain [10] and limitations of ROM, possibly related to the thoracic approach.

During the review of the literature on the subject it was found in several articles5,6 that after cardiac surgery there may be a reduction in ROM, but such reduction was not quantified in any study. Median longitudinal sternotomy is the most commonly used approach to cardiac surgeries due to exposure to the region. However, this approach may significantly alter pulmonary function and consequent instability of the upper thorax [11].

Kendall *et al.* [9] reported that ROM alteration and muscle strength reduction related to surgical procedures may be associated with limitation of daily life activities and increased need for analgesia. In this scenario, the physiotherapeutic intervention through measures that minimize postoperative pain, such as electroanalgesia, is extremely valid [12].

In their study, Westerdahl *et al.* demonstrated that there is a reduction of ROM after cardiac surgery and, in addition, they concluded that the physiotherapeutic intervention from the first postoperative day had little impact on the improvement of this amplitude [13]. A negative point of this study is that the authors do not report numerically this worsening of ROM and the type of surgery that was performed.

Many patients after surgery are afraid to move their shoulders due to pain and fear, so this restriction can lead to joint capsule changes leading to ROM worsening. In such situations, physiotherapy should be applied early in an attempt to prevent such adverse effects [14]. Olsén *et al.* did not find a difference in ROM for shoulder flexion and abduction in patients submitted to thoracotomy for stabilization of rib fractures [15]. Our hypothesis is that one of the reasons for this difference between the results

of the Olsen study for the present study is related to patients' fear of performing upper limb movement due to dehiscence of the sutures.

An alternative to reduce the impact of heart surgery on range of motion is the robotic procedure. Woo demonstrated that robotic surgery promotes better results in relation to ROM when compared to the traditional open approach [16]. However, apparently, this technique only reduces the impact on the upper limbs without causing effects on lower limbs.

This study has some limitations such as: 1) lack of sample calculation; 2) the non-follow-up of these patients until hospital discharge in order to verify if there is a tendency to return the ROM to preoperative values.

## Conclusion

The present study shows that there is a reduction of ROM in patients undergoing coronary artery bypass grafting, active movements of shoulder flexion, vertical abduction, horizontal abduction, and flexion / extension of the right knee.

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