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ORIGINAL MANUSCRIPT

Mechanical Ventilation Time and Peripheral Muscle Strength in Post-Heart Surgery

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Abstract

Background: In recent years, there has been an increasing number of heart surgeries (HS). These are accompanied by complex processes that lead to complications. Invasive mechanical ventilation (IMV) can cause severe reduction in respiratory and peripheral muscle strength. Protocols of early weaning and mobilization are currently found, aimed at reducing IMV time.
Objective: To correlate IMV time on peripheral muscle strength in patients undergoing heart surgery.
Methods: Prospective cross-sectional study involving patients from the Intensive Care Unit (ICU) of a reference cardiology hospital in the city of Feira de Santana, BA, Brazil, from April 2014 to August 2015. The patients were evaluated preoperatively regarding their peripheral muscle strength through the Medical Research Council (MRC) scale. IMV time during surgery was noted down. After 12 hours of surgery, peripheral muscle strength was re-evaluated using the MRC scale.
Results: The study included 69 patients (56.5% men) with mean age of 52.5±16.9 years. Significant differences were found between invasive ventilatory assistance time (7.3±2.6 hours) and reduction in final peripheral muscle strength (47.5±3.8) through the MRC scale, with p=0.0001. Initial and final MRC (59.8±0.5 vs. 47.5±3.8; p=0.21) and cardiopulmonary bypass (CPB) time and final MRC (65.1±20.1 minutes vs. 47.5±3.8; p=0.74) were also correlated.
Conclusion: It was found that longer IMV time caused a reduction in peripheral muscle strength in patients undergoing heart surgery.

Keywords: Respiration, artificial; Weaning; Physical therapy specialty; Thoracic surgery

Introduction

Heart surgeries are major procedures that, although considered safe, are accompanied by complex processes such as general anesthesia, cardiopulmonary bypass, mechanical ventilation and immobility in bed[1,2] which, depending on the exposure time, may represent greater morbidity and mortality in patients.

In addition to these factors, cardiac patients have loss of functional capacity, resulting from decreased oxidative capacity of the skeletal muscle and reduced muscle perfusion. Added to this, the time that the patient remains on mechanical ventilation can contribute to immobility in bed, with a determining effect on the strength and peripheral muscle function, as patients on mechanical ventilation (MV) are more difficult to mobilize and are often sedated with vasoactive drugs that restrict mobilization.[3]

While inactivity of patients under IMV compromise the musculoskeletal system, such musculoskeletal system

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ABBREVIATIONS AND ACRONYMS

- *CPB – cardiopulmonary bypass*
- *FiO_2 – fraction of inspired oxygen*
- *HS – heart surgery*
- *ICU – Intensive Care Unit*
- *IMV – invasive mechanical ventilation*
- *MRC – Medical Research Council*
- *MV – mechanical ventilation*
- *PEEP – positive end-expiratory pressure*
- *SpO_2 – peripheral oxygen saturation*

disorders are likely to increase the duration of MV in these patients.[4,5] This is a good reason for studies on the loss of peripheral muscle strength, little discussed in scientific papers, especially in heart surgeries. The purpose of this study is to correlate IMV time on peripheral muscle strength in patients undergoing heart surgery.

Methods

Cross-sectional study conducted with patients from the Intensive Care Unit (ICU) of a major private cardiology hospital in the city of Feira de Santana, BA, Brazil, from April 2014 to August 2015.

This study has been approved by the Research Ethics Committee of Faculdade Nobre under no. 796580. All participants signed an Informed Consent Form according to Resolution CNS 466/12.

The study included patients > 18, of both sexes, who had undergone coronary artery bypass grafting, aortic valve and/or mitral valve replacement and atrial septal defect repair. The following patients were excluded: patients with hemodynamic instability, preventing the development of weaning, prior heart surgery, history of lung disease confirmed by spirometry, difficulty to understand or limitation to apply the Medical Research Council (MRC) muscle strength scale.[6]

The evaluations were performed at two different times: pre-operative and post-extubation. Preoperative period was used to collect anthropometric data, clinical history of patients, type of surgery to be performed and initial peripheral muscle strength through MRC. After extubation, mechanical ventilation time and recalculation of MRC were collected.

MRC evaluates six muscle groups bilaterally: shoulder abductors, elbow flexors, wrist extensors, hip flexors, knee extensors and ankle flexors. Using this scale, the strength degree of each muscle group is evaluated, assigning values ranging from 0 (complete paralysis) to 5 (normal muscle strength). The strength degree is evaluated by voluntary execution of these six specific movements, which may range from 0 to 60. The MRC evaluation was carried out by a "blind" evaluator at two moments.

After preoperative evaluation, the patients underwent heart surgery. Median sternotomy and cardiopulmonary bypass were conducted. After the surgical procedure, patients were directed to the Intensive Care Unit (ICU) and connected to a mechanical ventilator with the following parameters: current volume at 6 mL/kg, respiratory rate to maintain arterial carbon dioxide pressure ($PaCO_2$) between 35-45 mmHg, positive end-expiratory pressure (PEEP) 5 to 8 cmH_20 and the smallest fraction of inspired oxygen (FiO_2) possible in order to maintain peripheral oxygen saturation (SpO_2) above 95%, as recommended by the Brazilian consensus on mechanical ventilation.[7]

For the evolution of ventilatory weaning, it was necessary for the patient to present hemodynamic stability without or with minimal flow of vasoactive drugs, absence of acid-base disorder in gas analysis, drain bleeding ≤5 mL/kg/h, satisfactory urine output, temperature above 36º and adequate level of consciousness, Glasgow coma scale score above 10. This evaluation and the decision of extubation time were performed by the medical team on duty (doctor, nurse and physiotherapist), without the influence of researchers.

After extubation, the researchers took note of the time the patient remained on ventilatory support and, 12 hours after that, peripheral muscle strength was re-evaluated using the MRC scale.

The data were processed and analyzed using the program GraphPadInstat (GraphPad Inc., San Diego, USA, Release 3.06, 2003). The data were subject to normality criteria (Kolmogorov-Smirnov test). Continuous variables were expressed as mean±standard deviation. To evaluate pre and post-surgery values, Student's paired t test and the Spearman correlation coefficient were used. Bilateral p values were calculated and the significance level was 5%.

Results

During the period evaluated, there were 80 hospitalizations, but 11 patients were excluded from the

study: 6 due to hemodynamic instability, 3 due to confirmed pneumonitis and 2 for not accepting to sign the consent form.

The study included 69 patients (56.5% men) with mean age of 52.5±16.9 years. The general characteristics of the patients is presented in Table 1. Coronary artery bypass grafting was the most prevalent (71.0%). Mean CPB time was 65.1±20.1 minutes, while the IMV time was 7.3±2.6 hours.

Mean initial MRC was 59.8±0.52 while post-surgery value was 47.5±3.89; p=0.2166. There was significant negative correlation between invasive ventilatory assistance and final peripheral muscle strength (r=-0.85; p=0.0001). Final muscle strength had no association with initial strength and CPB time (Table 2). Figure 1 shows the correlation between MV time and final muscle strength.

Table 1
Characteristics of the population studied

Variables	
Sex n (%)	
Male	39 (56.5)
Female	30 (43.4)
Age (years) mean±SD	55.9 ± 14.2
Type of surgery n (%)	
Coronary artery bypass grafting	49 (71.0)
Valve surgery	18 (26.0)
ASD repair	2 (3.0)
CPB time (minutes) mean±SD	65.1 ± 20.1
MV time (hours) mean±SD	7.3 ± 2.6

ASD – atrial septal defect; CPB – cardiopulmonary bypass; MV – mechanical ventilation; SD – standard deviation

Table 2
Correlation between final peripheral muscle strength assessed by MRC and the variables: MV time, initial muscle strength and duration CPB

Variables	Final peripheral muscle strength (MRC)	
	r *	p-value
MV Time	- 0.85	0.0001
Initial peripheral muscle strength	- 0.15	0.2166
Cardiopulmonary bypass time	-0.04	0.7429

MV – mechanical ventilation; CPB – cardiopulmonary bypass; MRC – Medical Research Council
*Spearman correlation

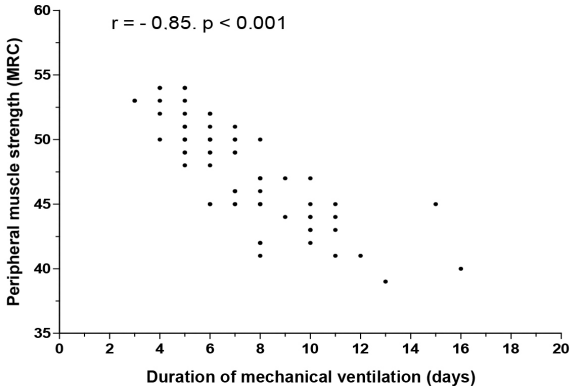

Figure 1
Correlation between duration of mechanical ventilation and MRC.
MRC – Medical Research Council

Discussion

Invasive mechanical ventilation is required in the postoperative period of heart surgery due to the action of sedative drugs that depress the respiratory center.[7] However, the presence of ventilatory prosthesis may cause worsening of lung capacity and reduced muscle strength.[3] This study showed that prolonged MV time has an adverse impact on the peripheral muscle strength of patients undergoing heart surgery.

According to França et al.[8], some factors may contribute to the worsening of peripheral muscle strength, especially: immobility in bed, sepsis and mechanical ventilation, which may lead to longer intubation and hospitalization. Immobility and mechanical ventilation on the early days after heart surgery should be noted.

In recent years, protocols of mobilization and early withdrawal of sedation are being used to shorten the time of MV and improve muscle strength[8]. The study of Feliciano et al.[9] found gain on peripheral muscle strength in the group that executed a mobilization protocol, being a viable and safe strategy, reducing the effects of immobility and preserving the final peripheral muscle strength.

Fonseca et al.[7] showed that some factors, such as age, duration of CPB and respiratory complications such as atelectasis may increase MV duration. This, in turn, is associated with increased hospital stay.[5]

In studies with patients undergoing cardiac surgery, complications such as infections, kidney failure, stroke, hypertension, arrhythmia and acute myocardial infarction are significantly adverse factors, determining increased MV and, consequently, longer hospital stay times.[5,8 10] In this study, the longer the ventilation time the smaller was the final peripheral muscle strength and this may be associated with the effects of inertia, as well as the use of sedating drugs. This data generates significant aggravation that should be considered in order to establish mobilization protocols and timely identify decreased strength.

In another national study, Piotto et al.[11] evaluated the independent risk factors for prolonged mechanical ventilation in patients undergoing heart surgery. They divided the groups into MV time: >48 hours and <48 hours, and found the following factors in both groups: age, chronic obstructive pulmonary disease and CPB time. They also stated that early discontinuation of mechanical ventilation is associated with better outcomes.

Although the CPB time was brought by these two studies as factors that contribute to the increase in MV time, this study found no association between this variable and the behavior of peripheral muscle strength (-0.04; p=0.7429).

Studies report that the longer the immobility time the greater the functional deficit and, in that context, physical therapy is important as early as possible.[6,12] The procedures performed by the physiotherapist after heart surgery include ambulation, a procedure that generates hemodynamic impact, but is safe and feasible, not generating risks to patients of that profile.[13]

In a research study with 22 patients, Morais et al.[14] reported that physical therapy has shown the benefit of preventing and reducing complications, and providing the patient with improved functional performance in the postoperative period of heart surgery.

Chiang et al.[15] observed loss of peripheral muscle strength, deconditioning and decline in functional independence in patients mechanically ventilated for 14 days. The authors applied a physical training program for six weeks in a unit specializing in respiratory care, where the patients obtained gain in peripheral muscle strength in the arms and legs, more days out of MV, and gains in functional independence assessed using the functional independence measure (FIM) and the Barthel score.

Conclusion

This study found that the duration of invasive mechanical ventilation had a negative influence on peripheral muscle strength in patients undergoing heart surgery. Therefore, new strategies for early weaning should be developed aimed to shorten the IMV time.

Potential Conflicts of Interest
This study has no relevant conflicts of interest.

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This study had no external funding sources.

Academic Association
This study is not associated with any graduate programs.

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