

Study of the effect of whole body vibration exercise in cardiac surgery postoperative care: a protocol proposition

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Abstract

Introduction: Cardiac surgery is of great importance in the treatment of cardiovascular disease, which contribute to the increase of morbimortality. The mechanical vibration generated by an oscillating/vibratory platform causes the production of whole body vibration and can be used as a physical exercise modality (WBVE). **Objective:** To present a protocol for evaluation of WBVE effects in postoperative patients of cardiac surgery. **Methods:** Adult subjects undergoing cardiac surgery post-op who are discharged from the Intensive Care Unit on up to the fourth day will be randomly assigned to two groups: the control group (CG) who will receive conventional physiotherapeutic care; the intervention group (IG), in addition to the conventional care, will be submitted to the WBVE. IG patients will remain with their knees flexed at 15° on the side-alternating oscillating/vibratory platform. They will perform three rounds of 1 min (for 1 min rest) at 5 Hz and 8 mm of peak-to-peak displacement, twice a day. Each day, the sessions will increase, reaching a maximum of seven series of 1 min and 9 Hz, on the seventh postoperative day. We will evaluate respiratory muscle strength, lung function, peripheral muscle strength, functional capacity and sensation of pain through manovacuometry, spirometry, dynamometry, Time Up and Go (TUG), Functional Independence Measure (FIM), Visual Analog Pain Scale (VAS), and POWERbreathe K5. **Discussion:** Studies have demonstrated beneficial effects with EVCI in different clinical conditions, and it's a promising form of intervention during the rehabilitation of patients in the postoperative period of cardiac surgery. **Conclusion:** The application of this protocol will provide evidence that justifies a rehabilitation program with WBVE for individuals undergoing cardiac surgery.

Keywords: Whole body vibration exercises; Exercise therapy; Intensive Care Unit, Heart surgery.

Resumo

Estudo do efeito do exercício de vibração de corpo inteiro no pós-operatório de cirurgia cardíaca: proposição de um protocolo

Introdução: A cirurgia cardíaca é uma intervenção de grande importância no tratamento de doenças cardiovasculares, as quais contribuem para o aumento da morbimortalidade. A vibração mecânica gerada por uma plataforma oscilante/vibratória pode ser usada para exercícios de vibração no corpo inteiro (EVCI), modalidade de exercício físico aqui proposta.

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Objetivo: Apresentar protocolo para avaliação de efeitos do EVCI em indivíduos no pós-operatório de cirurgia cardíaca. **Métodos:** Indivíduos adultos, submetidos a cirurgia cardíaca, que receberem alta da Unidade de Tratamento intensivo até o quarto dia de pós-operatório, serão distribuídos randomicamente em 2 grupos: grupo controle (GC), que receberá atendimento fisioterapêutico convencional; e grupo Intervenção (GI), que, além do atendimento convencional, será submetido ao EVCI. Os pacientes do GI permanecerão com os joelhos flexionados a 15° na plataforma oscilante/vibratória alternada, realizarão três séries de 1 min (por 1 min de repouso) a 5 Hz e 8 mm de deslocamento pico a pico, duas vezes ao dia. A cada dia, as sessões serão modificadas, atingindo o máximo sete séries de 1 min e 9 Hz, no sétimo dia de pós-operatório. Serão avaliadas a força muscular respiratória, função pulmonar, força muscular periférica, capacidade funcional e sensação de dor através da manovacuometria, espirometria, dinamometria, Time Up and Go (TUG), Medida de Independência Funcional (MIF), Escala Visual Analógica de Dor (EVA), POWERbreathe K5. **Discussão:** Estudos recentes demonstraram efeitos benéficos com EVCI em diferentes condições clínicas, que se apresenta como uma promissora forma de intervenção durante a reabilitação no pós-operatório de cirurgia cardíaca. **Conclusão:** A aplicação desse protocolo de estudo poderá preencher as lacunas sobre evidências que justificam um programa de reabilitação com EVCI para o indivíduo submetido à cirurgia cardíaca.

Descritores: Exercício de vibração de corpo inteiro; Terapia por exercício; Unidade de Terapia Intensiva. Cirurgia cardíaca.

Resumen

Estudio del efecto del ejercicio de vibración de cuerpo entero en el post-operatorio de cirugía cardíaca: proposición de un protocolo

La cirugía cardíaca es una intervención de gran importancia para las enfermedades cardiovasculares, que contribuyen al aumento de la morbilidad y mortalidad. La vibración mecánica generada por una plataforma oscilante/vibratoria provoca la producción de ejercicios de vibración de cuerpo entero (EVCE) y se puede utilizar como una modalidad de ejercicio físico. Objetivo: Presentar un protocolo para la evaluación de los efectos de EVCE en individuos después de la operación de cirugía cardíaca. Métodos: Los sujetos adultos sometidos a cirugía cardíaca que son dados de alta de la Unidad de Cuidados Intensivos hasta el cuarto día del post-operatorio se asignarán al azar a dos grupos: el grupo de control (GC) que recibirá atención fisioterapéutica convencional; El grupo de intervención (GI), que además de la atención convencional, se presentará al EVCE. Los pacientes con GI permanecerán con las

rodillas flexionadas a 15° en la plataforma oscilante/vibratoria de alternancia lateral. Realizarán tres series de 1 minuto (para un descanso de 1 minuto) a 5 Hz y 8 mm de desplazamiento pico a pico, dos veces al día. Cada día, las sesiones serán modificadas, alcanzando un máximo de siete series de 1 minuto y 9 Hz, en el séptimo día post-operatorio. Evaluaremos la fuerza muscular respiratoria, la función pulmonar, la fuerza muscular periférica, la capacidad funcional y la sensación de dolor a través de manovacometría, espirometría, dinamometría, Time Up and Go (TUG), Medida de independencia funcional (MIF), Escala de dolor analógico visual (EAV), POWERbreathe K5. Discusión: Los estudios han demostrado efectos beneficiosos con EVCI en diferentes condiciones clínicas, por lo tanto, una forma prometedora de intervención durante la rehabilitación de pacientes en el período postoperatorio de cirugía cardíaca. Conclusión: La aplicación de este protocolo llenará los vacíos en la evidencia que justifique un programa de rehabilitación con WBVE para personas que se someten a cirugía cardíaca.

Palabras clave: Ejercicios de vibración de cuerpo entero; Terapia por ejercicio; Unidad de Terapia Intensiva, Cirugía cardíaca.

Introduction

Cardiovascular diseases have some of the highest morbidity and mortality rates in contemporary healthcare, and cardiac surgery is an important procedure in the treatment of these diseases.¹ Even with the modernization of procedures, cardiac surgeries are major interventions that lead to physiological changes throughout the body, such as reduction of lung function, loss of respiratory muscle strength, loss of peripheral muscle strength, and decreased functional capacity.² These changes are due to: cardiopulmonary bypass (CPB), anesthesia, surgical incision, mechanical ventilation, bed rest, and pain.³

Whole body vibration exercises (WBVE) performed on an oscillating/vibratory platform are widely used as an aid to physical activity. Regular physical training on vibratory platforms promotes physiological adaptations such as those observed in aerobic training. WBV can be understood as the reciprocating motion of a solid body relative to its equilibrium center or as a characteristic oscillatory movement which is repeated around a reference position. Vibration-producing devices are commercially available, being used for physical rehabilitation and improving physical performance.^{5,6}

Besides the cardiovascular benefits, WBVE can also be used in pulmonary rehabilitation programs. Studies have demonstrated that patients with chronic

obstructive pulmonary disease (COPD) submitted to vibratory platform treatment showed an increase in exercise capacity, muscle strength and quality of life. The vibratory platform generates repeated and fast oscillations, and thus promotes automatic body adaptations.⁷ These repeated dynamic oscillations generate intense eccentric and concentric muscle contractions, which improve normal muscle work.^{8,9}

Several studies have demonstrated the beneficial effects of mechanical vibration in different clinical conditions. However, there is a research gap in the effects and safety of the procedure in individuals undergoing cardiac surgery during the hospital phase.^{5,6,7}

In view of the above considerations, this study aims to present the protocol to investigate the effects of early WBVE in post-operative cardiac surgery patients hospitalized, if it is safe and feasible, if it may cause beneficial effects on respiratory muscle strength, peripheral muscle strength, pulmonary function, functional capacity and painful sensation. We will produce a prospective, randomized, controlled study to identify the efficacy of 5-day WBVE in post-operative cardiac surgery subjects. The results of this study will identify beneficial effects and provide scientific evidence for the use of the oscillating/vibrating platform for individuals in the postoperative period of cardiac surgery.

Methods

Research strategy

Project approved by the Comitê de Ética em Pesquisa, Hospital Universitário, Universidade Federal do Maranhão (Sponsored links nº 1.554.207).

Study design

Prospective and randomized controlled trial.

Individuals submitted to elective cardiac surgery will be selected in the cardiology department by a physiotherapist at the university hospital of Universidade Federal do Maranhão. These individuals will be randomly assigned to two groups: control group (CG), which will receive conventional physiotherapy care twice a day until the 7th postoperative day; and the intervention group (IG), which in addition to conventional care will be submitted to WBVE.

Participants

Ongoing recruitment.

Inclusion criteria

All patients submitted to elective cardiac surgery in the proposed period and who are admitted to the cardiology department after the 3rd postoperative day will be included after signing the Informed Consent. The individuals will be randomized and allocated into 2 groups: control group (CG), who will receive conventional physiotherapeutic care twice a day until the 7th day of PO; and the intervention group (GI), which in addition to conventional care will be submitted to WBVE.

Exclusion criteria

Individuals with congenital heart disease; with preexisting pulmonary or neurological disease; with limitation of mobility in upper and/or lower limbs that interferes with evaluation methods; who die in the perioperative period; who develop pulmonary or neurological complications that impair the evaluations.

Withdrawal criteria and management

Withdrawal from the study will be allowed if the participant (i) makes such a request, (ii) develops a serious disease, such as lung disease or stroke, and continuing their participation becomes inappropriate in the opinion of the investigator and (iii) has an

adverse reaction related to the WBVE.

Characterization of the parameters used in the intervention with WBVE

The type will be a side alternating oscillating/vibratory platform (OVP) (KIKOS P204I, São Paulo). Patients will stand with their knees bended at 15° on the side-alternating oscillating/vibratory platform. Initially, they will perform three rounds of 1 min (per 1 min rest) at 5 Hz and 8 mm peak-to-peak amplitude, twice a day. Each day, the sessions will be extended in one round, and the frequency will be raised 1 Hz, achieving at maximum seven rounds of 1 min at 9 Hz on the 7th postoperative day.¹⁰⁻¹¹ A supervisor will follow every procedure and will instruct the patient to report any discomfort. Depending on the situation, the procedure may be interrupted.

Manovacuometry

Using digital manovacuometer (MVD300, Globalmed, Porto Alegre, Brazil) for measurements of respiratory muscle strength, using maximal inspiratory and expiratory pressures (MIP and MEP), according to recommendations for evaluation of respiratory muscles of the American Thoracic Society/European Respiratory Society.¹²

Spirometry

A spirometer (model Microlab Cardinal Health, Dublin - Ohio, USA) for measures of lung function - forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), forced expiratory coefficient in the first second (FEV1/ FVC%), and peak expiratory flow (PEF) will be used. This evaluation will also follow the criteria established by the American Thoracic Society/European Respiratory Society (ATS/ERS) pulmonary function test recommendations.¹²

Dynamometry

A hydraulic handheld dynamometer (Saeham®, model SH5001, Masan, South Korea) will be used. The evaluation of the measures of peripheral muscle strength in the upper limbs will be performed according to recommendations of the American Society of Hands Theraphists (ASHT).¹³

Timed Up and Go test

Timed Up and Go test (TUG) will be used to evaluate performance during the execution of some

activities, this test consists in the evaluation of the time necessary for the individual to get up from a chair, to walk three meters and return to a sitting position in the same chair. Normal individuals perform it in less than 10 seconds. Duration greater than 14 seconds is correlated with a high risk of falling.¹⁴

Functional Independence Measure

The functional capacity will be evaluated through the Functional Independence Measure (FIM) scale, which evaluates performance in the execution of a set of 18 tasks, referring to subscales such as: self-care, sphincter control, transfers, locomotion, communication, and social cognition. Each item will be scored on a scale of 7 levels of dependency, where 1 represents total dependence and 7 represents total independence. Later they will be classified as dependent and independent.¹⁵

Visual Analog Scale for Pain

Visual Analog Scale for Pain (VAS Pain) is scale that seeks to more simply and objectively assess the perception of pain will be used, illustrated as a horizontal line in the form of a ruler ranging from 0 to 10 at its extremities, where 0 equals no pain sensation and 10 equals pain maximum. Scores smaller than 4 indicate "mild pain"; scores between 5-7 indicate "moderate pain" and greater than 7 indicate "severe pain".¹⁶

Inspiratory muscle dynamics

The dynamics of inspiratory muscle strength (S-index), peak of inspiratory flow (PIF) and volume (V) through the use of the POWERbreathe K5 electronic device (POWERbreathe International Ltd. Warwickshire England) will be performed.

Statistical analysis

The data collected will be submitted to statistical analysis through the program Stata/SE 12.1 (Statacorp, College Station, Texas, USA). To identify the normality of the groups the Shapiro-Wilk test will be applied. Depending on normality, the quantitative variables will be expressed by mean and standard deviation or median and interquartile deviation and their differences verified using the paired Student's T test or Wilcoxon. The qualitative variables will be expressed as proportions and the association between these variables and the outcome variables will be tested using

the Fisher's exact test or the Chi-Square test. The results will be considered statistically significant when $p < 0.05$.

Discussion

Cardiovascular diseases present one of the highest morbimortality indexes in healthcare systems, and cardiac surgery is an important procedure in the treatment of these diseases.¹ However, they are major interventions that lead to physiological changes in the whole body, such as reduced lung function, respiratory muscle strength loss, peripheral muscle strength loss and decreased functional capacity.²

Strategies to prevent or ameliorate physiological changes in the postoperative period of cardiac surgery may have a major impact on the health burden of this clinical condition and thus improve morbidity and mortality indicators.¹⁷

The oscillating/vibrating platform can be used for the purpose of physical therapy, and its use is correlated to muscle strength and endurance improvement.^{7, 18} Pleguezuelos and contributors¹⁹ verified that WBVE provides significant improvements in functional capacity in patients with severe COPD, without changes in muscle strength.

Other studies have demonstrated that the surgical influence leads to a series of functional disorders, both respiratory and motor, contributing to increased length of stay and delaying the return to productive life. Post-surgical complications and the fact that patients stay in the intensive care unit (ICU) up to the 4th postoperative day can influence functional loss. With mechanical vibration training in the oscillating/vibratory platform, the muscular energy generated by WBVE can promote beneficial effects in cardiovascular indexes and can also be used in pulmonary rehabilitation programs.^{3, 7, 20}

Studies have demonstrated, regarding exercise capacity, muscle strength, and quality of life in patients with COPD, that WBVE induces clinically significant benefits. Another study has demonstrated the feasibility and safety of mechanical vibration in patients admitted to the Intensive Care Unit (ICU), and in patients submitted to lung transplantation.^{18, 21}

Several studies have pointed to the significant effects of mechanical vibration in many clinical conditions, such as hemiplegia, spinal cord injury, cerebral palsy, and osteoporosis.²²⁻²⁵ Given the known effects of WBVE on peripheral muscle function, functional independence, and all considerations, it is possible to suggest that WBVE seems to be an important

modality of exercise for the management of individuals with physiological changes related to decreased quality of life.

However, data on the oscillating/vibration platform protocol and its effects on patients submitted to cardiac surgery has not been specifically collected. In view of this current reality, our protocol is based on the beneficial effects on respiratory muscle strength, lung function, peripheral muscle strength, functional capacity and pain sensation of these patients when compared to a conventional physiotherapy protocol.

In conclusion, this clinical study, with a strict and through protocol, will allow us to investigate the effects of the use of WBVE on oscillating/vibratory platform in patients in the postoperative period of cardiac surgery. It'll help to determine if it is safe and viable and if it can lead to improvements in respiratory muscle strength, peripheral muscle strength, lung function, functional capacity, and pain sensation in these patients.

In addition, the results of this study will provide a possible strategy for early rehabilitation, providing previously unavailable data on the efficacy of WBVE in postoperative cardiac surgery subjects. Further comprehensive research on the rehabilitation of patients in the postoperative period of cardiac surgery will still be necessary, and these results will be a solid place to start.

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