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Use of Cycle Ergometer in Early Mobilization After Cardiac Surgery: Randomized Comparative Study of Cycle Ergometer *versus* Habitual Treatment

Uso do Cicloergômetro na Mobilização Precoce Após Cirurgia Cardíaca: Estudo Comparativo Randomizado do Cicloergômetro versus Tratamento Habitual

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The cycle ergometer has been proposed during the early mobilization of critically ill patients to improve muscle strength and reduce the length of stay. Although this strategy consists of greater complexity, there is no evidence that it is superior to the usual treatment. This study aims to explore the hypothesis that the use of a cycle ergometer, during early mobilization, increases functional performance after cardiac surgery, compared to active exercise. This is a randomized-controlled study that included patients undergoing valve heart surgery or coronary artery bypass grafting from June to December 2016. Patients initiate the exercise with cycle ergometer or received the usual treatment (assisted active exercise) on the first day after surgery. Both interventions were performed twice a day, without imposing a load, and a mean duration of 15 minutes, while the patients remained in the intensive care unit (ICU). The primary outcome was defined as walking speed, assessed after discharge from the ICU, measured by a blind evaluator for the patient's allocation group. Considering this was an exploratory and preliminary study, we opted for protocol analysis, excluding patients who did not complete the exercises as a way to optimize the potential generation of hypothesis for efficacy. One hundred and eighty-seven patients completed all phases os the study (intervention and evaluation), in a total of 85 in the cycle ergometer group (CyG), and 102 in the control group (CG). In the cycle ergometer group, 18 patients had the intervention discontinued against 6 in the control group. There was no difference in the number of sessions between the groups (2.8±1.9 in CyG *vs* 3.2±1.5 p= 0.25). According to the BORG scale, the cycle ergometer generated a greater perception of effort (9.9±2.7 *vs* 8.21±1.8; p = 0.009) and promoted a better increase in respiratory rate (3.2±4.5 *vs* 0.3±6.1 ipm, p = 0.02). However, the walking speed did not differ between groups (0.44 ± 0.23 *vs* 0.47 ± 0.21 m/s; p = 0.34). Despite imposing a higher level effort, the use of cycle ergometer during the early mobilization in the ICU does not promote an increase in functional capacity when compared to active assisted exercise in patients' underground cardiac surgery.

Keywords: Critical Care; Early Mobilization; Rehabilitation; Exercise Therapy; Walking Speed.

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O cicloergômetro vem sendo proposto durante a mobilização precoce de pacientes críticos a fim de melhorar força muscular e reduzir tempo de internamento. Embora essa estratégia consista em maior complexidade, não existe comprovação de que esta seja superior ao tratamento usual. O objetivo deste estudo foi o de explorar a hipótese de que a utilização de cicloergômetro, durante a mobilização precoce, incrementa o desempenho funcional após cirurgia cardíaca, comparado ao exercício ativo. Este foi um estudo controlado, envolvendo pacientes submetidos a cirurgia cardíaca valvar e/ou revascularização miocárdica no período de junho a dezembro de 2016. Os pacientes foram randomizados, no primeiro dia após a cirurgia, para exercícios com cicloergômetro ou tratamento usual (exercício ativo assistido). Ambas as intervenções foram realizadas duas vezes ao dia, sem imposição de carga, com duração média de 15 minutos, enquanto os pacientes permaneciam na unidade de terapia intensiva (UTI). O desfecho primário foi definido como velocidade de marcha, avaliada após a alta da UTI, mensurada por um avaliador cego para o grupo de alocação do paciente. Em se considerando este um estudo exploratório e preliminar, como forma de otimizar a potencial geração de hipótese para eficácia, optou-se pela análise por protocolo, excluindo os pacientes que não completaram os exercícios. Cento e oitenta e sete pacientes concluíram todas as etapas de intervenção e avaliação, totalizando 85 no grupo cicloergômetro (GCi) e 102 no grupo controle (GC). No grupo cicloergômetro, 18 pacientes tiveram a intervenção descontinuada contra 6 do grupo controle. Não houve diferença no número sessões entre os grupos (2,8±1,9 no GCi *vs* 3,2±1,5 p= 0,25). De acordo com escala de BORG, o cicloergômetro gerou maior percepção de esforço (9,9±2,7 *vs* 8,21±1,8; p = 0,009) e promoveu maior elevação da frequência respiratória (3,2±4,5 *vs* 0,3±6,1 ipm, p = 0,02). No entanto, a velocidade de marcha não apresentou diferença entre os grupos (0,44 ± 0,23 *vs* 0,47 ± 0,21 m/s; p = 0,34). A despeito de impor maior nível de esforço, a utilização de cicloergômetro durante a mobilização precoce em UTI não promove incremento de capacidade funcional quando comparado ao exercício ativo assistido livre em pacientes submetidos à cirurgia cardíaca.
Palavras-chave: Cuidados Críticos; Mobilização Precoce; Reabilitação; Terapia por Exercício; Velocidade de Marcha.

Introduction

Bed restriction during hospitalization in an Intensive Care Unit (ICU) reduces mobility, which leads to muscle weakness and global functional impairment.[1] Early mobilization proposes the application of exercise or physical activity gradually within 72 hours after the end of the surgical procedure to reduce the harmful effects.[1] Recent studies have emphasized early mobilization to increase oxygen transport and venous return, in addition to reducing postoperative complications.[2] Among the physical resources, which stimulate early mobilization in intensive care units, the cycle ergometer presents as stationary cyclic equipment that can alter muscle work, preventing mass loss with exercises with or without resistance by the passive way, active-assisted or active exercises.[3] In the intensive care environment, however, the application of this resource requires the presence of a multidisciplinary team involved in the process, and with prior attention to safety criteria for mobilization, in addition to care for catheters and other peripheral devices.[4,5]

Although early mobilization is prescribed in postoperative care, there is no consensus information on the best type of mobilization or its effects on the functional performance of patients undergoing cardiac surgery.[6] Therapeutic strategies should be implemented to provide additional benefits to functional capacity, autonomy and quality of life to the patients to reduce their length of stay in the ICU.[7] Therefore, the objective of this study is to explore the hypothesis that the use of a cycle ergometer can improve functional capacity, compared to active kinesiotherapy during early mobilization in the ICU.

Material and Methods

Study Design

This study is a randomized controlled clinical trial, blind to the evaluator, and unicentric. Sample and allocation selection. The individuals undergoing cardiac surgery, at the time of hospital admission, received an invitation to participate in the research by the Informed Consent in a referral hospital in cardiology (Salvador, Bahia, Brazil), between the period of June to December 2016. The criteria of inclusion were adult patients of both sexes, scheduled-elective-cardiac surgery with sternotomy for revascularization and / or valve repair. The criteria of exclusion were patients with new neurological deficits, hemodynamic instability, time on mechanical ventilation above 12 hours after arrival at the ICU. The eligible subjects were randomly allocated with the digital tool, www.randomizer.org, stratified by type of surgery. The randomizer was done by a participant unrelated to collection and evaluation through numbered, opaque, and sealed envelopes. The patients allocated to the control group (CG) performed free active kinesiotherapy, according to the institution's protocol; and, the cycle ergometer group (CyG) used this equipment instead of free exercise. Both groups started their activities up to 12 hours of extubation.

Procedures

All patients met the criteria for safe mobilization when performing motor activity: FC (40-120), SBP (100-180), MAP (65-110), RF < 35ipm, and SpO_2 > 90% with FiO_2 < 31%, without the use of vasoactive drugs or in the process of weaning these drugs.[8]

The control group (CG) performed breathing exercises and active limb-free kinesiotherapy. For this protocol, 1 series of 10 repetitions performed for each limb, without load: diagonal shoulder flexion up to 90°; hip and knee flexion up to 60°. The exercises performed two times a day, according to the unit's routine, with sessions of 10 minutes on average. The cycle ergometer group (CyG) also performed breathing exercises, and later, the use of the cycle ergometer for upper limbs and lower limbs. The Mini Bike Acte® cycle ergometer was used, and individuals oriented to rotate the pedal actively, with comfortable speed, without load, for 5 minutes for each group of members. The performance of the upper limb, patients were positioned with a headboard elevated to 60°, and the cycle ergometer positioned on a support table on the bed. The equipment positioned on the bed and the head reduced to 30° to lower limbs, to allow a better adaptation to the pedals and to avoid compensatory flexions and movements of the hips. Hemodynamic and respiratory data were monitored in both groups throughout the activity: systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory rate (RF), heart rate (HR) and oxygen saturation (SpO_2). Measures such as blood glucose and capillary lactate were also measured immediately before and after exercise. The Borg scale (6-20) was used to assess the subjective perception of effort. Daily, patients were evaluated under the same analgesia protocol for pain using the Visual Analogue Scale (VAS). All invasive catheters and drains were maintained during the exercises. The protocol for both groups was maintained until discharge from the ICU.

This study was approved by the Human Research Ethics Committee of Santa Izabel Hospital, under the number CAAE: 55241616.6.0000.5520.

Study Design

This study was a randomized controlled clinical trial, reviewer-blind, and unicentric.

Sample Selection and Allocation

Subjects undergoing cardiac surgery were invited to participate in the study at the time of hospital admission, accepting and filling the Informed Consent Form (ICF). Adult patients of both sexes, scheduled for cardiac, elective, revascularization and / or valve repair, with a sternotomy, were included in a referral hospital in cardiology in the city of Salvador / Bahia-Brazil, between the period of June to December 2016. Those with a new neurological deficit, hemodynamic instability, time on mechanical ventilation above 12 hours after arrival at the ICU were excluded. The eligible subjects were randomly allocated through the digital tool www.randomizer.org, stratified by type of surgery, though numbered, opaque, sealed envelopes, which were discriminated by a participant unrelated to collection and evaluation. The patients allocated to the control group (CG) underwent free active kinesiotherapy, according to the institution's protocol; and, the cycle ergometer group (CyG) used this equipment instead of free exercise. Both groups started their activities up to 12 hours of extubation.

Primary Outcome

The performance of the gait speed test was the primary. After discharge from the ICU, patients underwent the 10-meter walk test to obtain walking speed. During the test, patients were instructed to walk, without assistance, at maximum comfortable speed in a 10m corridor. Two distance meters was added before the start and at the end of the route, to eliminate the acceleration and deceleration components, without the use of verbal incentives. The speed was obtained by dividing the distance covered (in meters) and the timed time (in seconds). The evaluators were blinded because they had not participated in the intervention, and patients were asked not to disclose their allocation. Considering this an exploratory study, to generate a hypothesis whose primary outcome is a physiological variable, the primary outcome was analyzed by protocol.

Second Outcomes

Other results included the length of stay in the ICU, and the length of hospital stay (counted from the day of the surgical procedure until discharge).

Extra Data

The participant answered the International Physical Activity Questionnaire (IPAQ-short version)[9] at the time of hospital admission, in which it could be classified the individual as active, irregularly active, or sedentary, according to the time spent on physical activities before hospitalization.

The medical record collected the sociodemographic, clinical, and surgical information to characterize the population of this study.

Statistical Method

The software Statistical Package for Social Sciences (SPSS), version 15.0 for Windows, was used for the elaboration of the database, descriptive and analytical analysis. Categorical variables were frequencies and percentages, the continuous ones, in mean and standard deviation or median and interquartile range.

Pearson's Chi-square test was applied to categorical variables. Student's T-test compared the averages of gait speeds between groups, length of stay, and the subgroups of analysis by previous physical activity. The intragroup Student T-test compared cardiorespiratory responses before and after the intervention of each group. A bivariate p value <0.05 was considered statistically significant for all analyzes. In the case of a randomized allocation, the baseline characteristics of the two groups were described but not statistically compared.

The study was designed to have 80% power (two-tailed alpha = 5%) to detect a difference of 0.17 m/s in walking speed between the groups, with a standard deviation of 0.16 m/s in the cycle ergometer group and 0.11 m/s in the control group.[10] For that, 36 patients would be necessary per group, and this amount being adopted by surgery in each group. However, to reach the estimated number of valve surgery, which is less frequent, it was necessary to include patients for a longer time.

Results

Individuals

From June 1 to December 20, 2016, 247 patients were invited to participate in the study. After surgery, 35 participants were excluded: 8 due to altered level of consciousness, 15 due to hemodynamic instability, and 3 due to neuromuscular impossibilities. So, 212 patients participated in the study, which was randomized to the cycle ergometer group (104) and control group (108). Up to 12 hours after extubation, both groups submitted patients to intervention with limb exercise. During the intervention, 18 participants of the CyG did not complete the exercise session due to reports of muscle discomfort (10), pain (5), or because of arrhythmia (3). In the CG, 4 patients reported pain and 2 arrhythmias. The final study population was of the 85 participants for the cycle ergometer group and 102 for the control group (Figure 1).

Table 1 compared the characteristics of the patients included in each group, which shows homogeneity. Both groups consisted predominantly of men (55% in the CyG *vs* 62% in the CG), where the average age for the CyG was

Figure 1. Fluxogram of eligible patients.

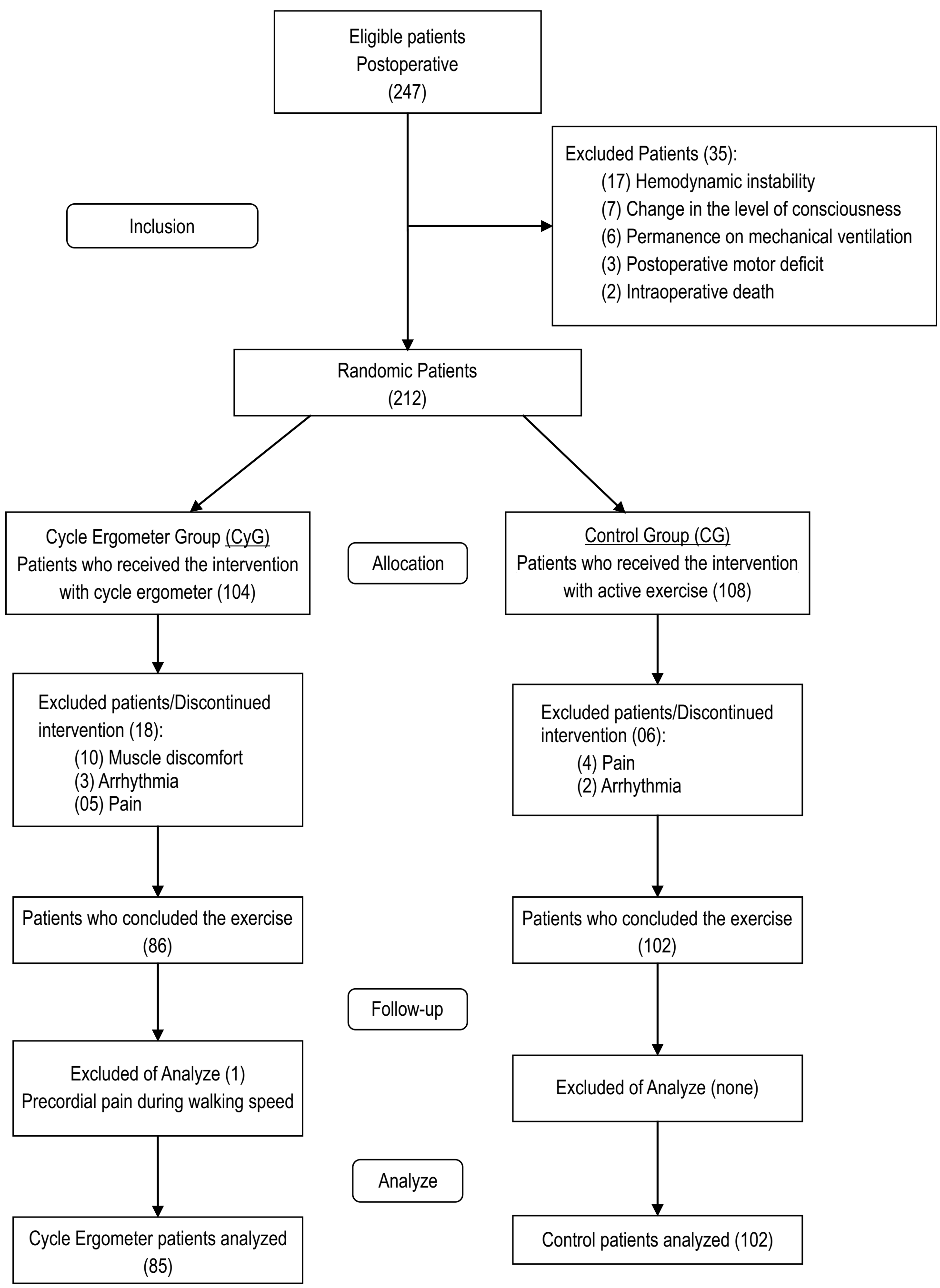


Table1. Anthropometric and clinical profile of patients in the control group and cycle ergometer group before the intervention.

	Cycle Ergometer Group (85)	Control Group (102)
Age (years)*	56 ±12	59 ±13
Male‡	47 (55%)	62 (60%)
BMI (Kg/m²)*	25 ± 4.3	25 ± 3,9
Revascularization‡	49 (57.6%)	63 (61,8%)
LV Ejection Fraction (%)*	61 ± 13	62 ± 11
Patients (Nº) EF<50%	14 (16%)	10 (10%)
CPB time (min) †	90 (65;117)	95 (75;120)
ICU time (dias) †	2 (2;3)	2 (2;3)
Mechanical ventilation time (hours) †	5,6 (3.4;8.6)	4,6 (3,3;7.4)
Duration of mediastinal drain (days) †	28 (22;36)	28 (24;37)
Time / walking (hours) §*	45 ± 21	46 ± 18
IPAQ‡		
Active	37 (51%)	47 (53%)
Sedentary	36 (49%)	41 (47%)
SAH‡	57 (67.9%)	66 (64.7%)
Diabetes mellitus‡	21 (251%)	23 (25%)

BMI: body mass index; LV: left ventricle; EF: ejection fraction; CPB: cardiopulmonary bypass; ICU: intensive care unit; IPAQ: international physical activity questionnaire; (*) data expressed as mean ± SD (unpaired Student's T test); (†) median; IQ: interquartile range, Mann-Whitney Test; (‡) absolute number (percentage), chi square; (§) Time to get out of bed and start walking in the ICU.

56 ± 12 years and in the CG 59 ± 13 years. The body mass index (BMI) presents a sample varying between eutrophic and slightly overweight in both groups (25 ± 4.3 Kg/m² on the CyG *vs* 25 ± 3.9 CG). Most of the individuals were considered active, according to IPAQ - short version, 37 (51%) in CyG, and 47 (53%) in CG. Myocardial revascularization was the most frequent surgical procedure in both groups compared to valve surgery (57% in CyG and 61.8% in the CG). All underwent cardiac surgery with cardiopulmonary bypass presented similar mechanical ventilation time [5.6 (3.4; 8.6) hours in CyG *vs* 4.6 (3.3; 7.4) in CG)]. There was no difference in the number of sessions between the groups (2.87 ± 1.92 h to CyG *vs* 3.22 ± 1.57 h CG to conventional exercise, p = 0.25).

All patients included underwent elective procedures with similar previous clinical characteristics (with no difference in the number of patients with an ejection fraction below 50%). Comorbidities between groups also showed no difference with 57 (67.9%) of hypertensive patients in the GCi and 66 (64.7%) in the CG, and 21 (25%) with diabetes mellitus in the CyG *vs* 33 (25%) in CG (Table 1).

Table 2 presents the effect of exercise on cardiorespiratory variables during sessions in both groups. Exercise in the conventional group caused a significant change in heart rate and lactate, while in the cycle ergometer group, the systolic, diastolic blood pressure varied, heart and respiratory rate, as well as lactate. In the intergroup analysis, respiratory rate [3 (1; 6) *vs* 2 (-3; 3) ipm)], diastolic blood pressure [-2 (-7; 2) *vs* -0.5 (-4; 3) mmHg] and the perception of effort (9 ± 2 *vs* 8 ± 1) were discreet, but significantly higher in the cycle ergometer group (Table 3).

<u>Comparative Efficiency of the Cycle Ergometer</u>

Functional performance measured through gait speed immediately after discharge from the ICU

Table 2. Variation of hemodynamic and metabolic measures during intragroup interventions.

	Cycle Ergometer Group			Control Group		
	Before	**After**	**p**	**Before**	**After**	**p**
SBP (mmHg)	120 ± 19	125 ± 20	0.01	123 ± 17	126 ± 19	0.19
DPB (mmHg)	62 ± 9	60 ± 12	0.04	61 ± 9	61 ± 8	0.72
MAP (mmHg)	80 ± 10	79 ± 11	0.18	82 ± 13	81 ± 13	0.18
HR (bpm)	89 ± 11	93 ± 13	0.001	84±13	86±11	0.03
FR (ipm)	17± 4.7	22±6	<0.001	17,6±5.9	17±3	0.61
Lactate (mmol/L)*	3.4 (2.3;4.6)	3.8 (2.8;4.9)	0.001	2.8 (2;3.9)	3.5 (2.5;4.8)	0.004
Glucose (mg/dL)	171±38	175±37	0.5	174±35.1	176 ±38	0.5

Data expressed as mean ± SD (paired Student's T test). SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; HR: heart rate; FR: respiratory rate. (*) median and interquartile range (Wilcoxon test).

Table 3. Variation of hemodynamic and metabolic measures between groups.

	Cycle Ergometer Group	Control Group	p
SBP variation (mmHg)	3 (-3;13)	5,5 (-4.7;9.7)	0.82
DPB variation (mmHg)	-2 (-7;2)	-0,5 (-4;3)	0.04
MAP variation (mmHg)	-2 (-5;3)	-2 (-4;5)	0.69
HR variation (bpm)	2 (1;6)	2 (0;5)	0.28
FR variation (ipm)	3 (1;6)	2 (-3;3)	0.02
Lactate variation (mmol/L)	0.5 (0.1;1)	0.6 (0.2;1.2)	0.40
Glucose variation (mg/dL)	2.5 (-8;10.5)	1,5 (-7,7;11)	0.83
BORG (6-20)*	9.9 ± 2.84	8.2 ± 1.8	0.009

Data expressed as median; IQ interquartile range, Mann-Whitney test. (*) mean ± SD (unpaired Student's T test). SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; HR: heart rate; FR: respiratory rate; BORG: effort perception scale from 6 to 20.

Table 4. Comparison of gait speeds and length of stay between the cycle ergometer and control groups.

	Cycle Ergometer Group (85)	Control Group (102)	p
Walking speed (m/s) *	0.47 ± 0.21	0.44 ± 0.23	0.34
ICU time (days) †	2 (2-3)	2 (2-3)	0.7
Total length of stay (days) †	9 (7-17)	9 (7-15)	0.66

(*) Data expressed as mean ± SD (unpaired Student's T test); (†) median; IQ interquartile range, Mann-Whitney Test; ICU: intensive care unit.

Table 5. Comparison of walking speed between the cycle ergometer group and the control in each sex.

	Cycle Ergometer Group	Control Group	p
Man	0.52±0.22	0.49±0.25	0.48
Women	0.4±0.17	0.36 ± 0.17	0.24

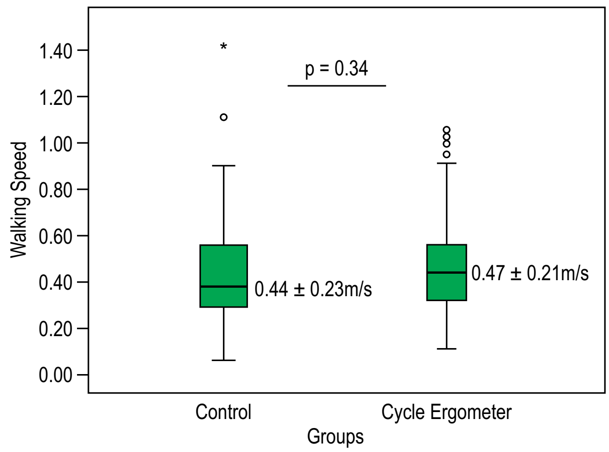
Data expressed as mean ± SD (unpaired Student's t test). Travel speed values expressed in m / s.

Table 6. Comparison of gait speed between active and sedentary individuals in each group.

	Active	Sedentary	p
Cycle ergometer group	0.52±0.24	0.41±0.15	0.01
Control group	0.46±0.23	0.41±0.24	0.35

Data expressed as mean ± SD (unpaired Student's T test). Travel speed values expressos em de m/s.

Figure 2. Comparison of walking speed between groups.



to the ward was similar between groups (0.47 ± 0.21m/s *vs* 0.44 ± 0.23m/s; p = 0 (Figure 2). About length of hospital stay, the CyG presented a median of 9 days (7; 15) as well as for CG (7; 17) (p = 0.66) (Table 4).

There was no significant difference in gait speed when only the subgroups of men and women were analyzed (Table 5). After active kinesiotherapy in the CG, no difference in gait speed was observed between previously active and sedentary patients (p = 0.35), however, this difference was present in the CyG, with a higher response of the active ones in a relation of the sedentary ones (0.52 ± 0.24 m/s *vs* 0.41 ± 0.15 m/s, p = 0.01) (Table 6).

Discussion

The results of this study did not show superiority in physical performance or length of stay of the cycle ergometer in the postoperative period of cardiac surgery when compared to the usual exercise protocol in-hospital rehabilitation.

In the current study, we observed that the bed restriction period is relatively short (2 days); therefore, a few sessions were held. Although the cycle ergometer seemed to impose a greater effort on the patient, it did not promote functional recovery. The protocol analysis implied in extracting from the gait speed analysis, the patients with unfavorable clinical conditions, which would allow more positive responses for this group. However, the superior functional response was not seen after the use of a cycle ergometer, suggesting new studies about the need for a cycle ergometer for patients with short periods in the ICU.

Increasingly, technological assistance has been improving in an attempt to reduce tissue damage from an open surgical intervention, with less time on mechanical ventilation. Therefore, physiotherapy has played an essential role in minimizing respiratory complications and restoring functional capacity. Thus, special attention should be paid to maximizing functionality and / or minimizing the functional decline of patients admitted in the ICU.[11] In this scenario, there is an increase in evidence to reduce bed-time and implement exercises as soon as possible after the surgery, avoiding early mobilization. Although some studies demonstrate the advantage of early mobilization for critically ill patients, there are still few controlled studies with a significant sample size that agree on the best type of activity to be performed.[12-15]

Both free active kinesiotherapy and the cycle ergometer consist of therapeutic resources, which promote repeated dynamic muscle activities without additional loads. However, the resistance inherent to the pulley system of the cycle ergometer equipment and the support against gravity for longer without pause represented greater effort for patients, which was demonstrated by the perceived effort (BORG) and the significant increase in the respiratory rate observed between the groups. It also observed a more significant effort, the number of patients who did not complete the treatment session exercise in CyG.

Several studies have demonstrated the advantages of using the cycle ergometer for critically ill patients since the period of mechanical ventilation.[16-19] However, some of them are not controlled studies, and other studies have a control group without any intervention.[20-22] In the postoperative period of cardiac surgery, many study protocols do not have any blinding or bring the cycle ergometer as an additional resource to the protocol of these institutions.[23-25] In the current study, the cycle ergometer replaced the exercise protocol without producing changes in physical performance during the gait speed test. Our results indicated that the use of the cycle ergometer in place of other exercises during the early period of cardiac rehabilitation does not present additional responses.

The gait speed reflects the organic responses to the demand for physical activity and indicates the physical performance of these individuals. This is pointed-out as the sixth functional sign and a predictor for mortality in cardiac patients and the postoperative period of cardiac surgery.[26-29] In this study, the average gait speed after immediately discharge from the ICU was 0.4 m/s in both groups. This observation intended to check if the interventions would have repercussions on gait development, removing the influence of other therapeutic elements still in the hospital phase.

In another study, the gait speed values during the first walk after cardiac surgery demonstrated that patients who achieved a result above 0.42m/s could be discharged from the hospital without the need for acute or subacute rehabilitation.[10] In the current study, the average gait speed in both groups was higher than 0.42m/s, i.e., the functional capacity at the exit from the ICU was not influenced by the type of resource used in the immediately previous period, which demonstrated that with the intervention it possible to follow-ups in cardiac rehabilitation in a similar way. Patients classified as active achieve higher gait speed than those sedentary in the cycle ergometer group can be explained by the ability to make better use of exercise in previously adapted muscles. Muscle discomfort during exercise was reported in this study to lower limbs due to gravity. Some patients presented exertion-related arrhythmias with clinical repercussions, making it impossible to maintain the protocol and replace extremity exercises just to prevent thromboembolism. These situations reflect the need for further studies involving the use of the cycle ergometer in the 1st DPO and further adjustments regarding the prescribed time and the risk for this population.

As for the length of hospital stay, previous studies show that the implementation of a cycle ergometer in critically ill patients reduces the loss of functional capacity due to bed restriction; and therefore reduces the length of hospital stay.[30-32] However, they involve units with diverse surgical and clinical populations. In the present study, both groups were in the same ICU, with the same fast track routines applied to anesthesia, similar mechanical ventilation time, and glycemic control. All patients remained in bed on the 1st PDO or until the removal of the mediastinal drain, and when leaving the bed, on the 2nd PDO, walked and were discharged from the ICU, i.e., the implementation of an exercise modality using the cycle ergometer did not enable to change the length of stay in an environment where all clinical processes are already optimized. This highlights the need for future studies to choose better candidates who could be benefited from the efforts of other therapeutic resources while in the ICU.

The use of cycle ergometer requires availability of the equipment (cost of purchase and maintenance), care for transportation, and adaptation to the bed and the presence of the physiotherapist to ensure safety during the activity.

Stiller and colleagues and Pires-Netoand colleagues[8,18] in their studies stated that the cycle ergometer could be used early; however, it is necessary to observe the safety of the patient (hemodynamic condition and cardiorespiratory reserve), and external factors (presence of catheters, drains and the multidisciplinary team involved in the process).[4] Another study states that when the cycle ergometer is compared to out-of-bed kinesiotherapy, it has the advantage of reducing the risk of falls and has the possibility of being suspended in the presence of an acute hemodynamic alteration or a respiratory impairment.[25] The provision of additional oxygen during the effort is also more easily installed during the cycle ergometer.

The lack of patient's data on functional capacity in the period before surgery was due to the impossibility of clinical evaluation of many patients in this phase. However, the surgical intervention and the period of restriction to the bed under mechanical ventilation promote the loss of strength, conditioning, and neural activation, impairing the correlation of functional tests before the exercises' intervention and the subsequent results.

Conclusion

For the parameter of imposing a higher level of effort, the use of a cycle ergometer during early mobilization in the ICU does not promote an increase in functional capacity when compared to free active kinesiotherapy in patients undergoing cardiac surgery. The cumulative contributions provided by changes in the care process should not be underestimated or undermined. However, they need to be understood and quantified so that future interventions can be designed to target specific modifiable factors that affect recovery after cardiac surgery. Further studies should seek to observe whether the use of the cycle ergometer can modify variables such as quality of life, adherence to cardiac rehabilitation, among other issues.

Authors' Contribution

Conception and Design: Alcântara P, Lordello GG; Data: Correia LS, Moura MA, Rosier GL, Lordello GG; Analysis and Data Interpretation: Alcântara P, Lordello GG, Correia LC; Statistical Analysis: Alcântara P, Correia LS; Text: Alcântara P; Critical Review: Alcântara P, Feitosa GS, Viana VJ, Correia LC.

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