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How Can we do Cardiac Rehabilitation in Patients after Percutaneous Coronary Intervention

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Abstract

Background: Exercise training improves the survival and quality of life of coronary patients but the optimal way of combining exercise training modalities in coronary heart disease is still unknown.

Methods: 74 coronary patients under pharmacological treatment were randomized into two groups: non-periodized training group (NPG n=37) and periodized exercise training group (PG n=37). The two groups were submitted to the same exercises during the 36 sessions making up the program, but prescribed in different ways. All the patients were submitted to an evaluation consisting of: medical admission consultancy, cardiopulmonary endurance testing, 1 maximum repetitions test (1RM) and a body composition evaluation.

Results: The VO2 peak improved in both groups, although in a more effective way in the PG (4% vs 1,7%, $p < 0.001$). In addition the functional capacity of this group improved by 13% and there was a significant reduction in the percent body fat (2,1%, $p < 0.005$) and body weight (1,9 kg, $p < 0.005$). The muscle strength of both groups improved and there was no significant difference between them ($p < 0, 05$). CONCLUSIONS: The present study showed that periodization of the treatment of coronary heart disease patients can improve their cardiopulmonary capacity and reduce the percent of body fat more effectively than the conventional one.

Keywords: Coronary disease; Exercise; Rehabilitation.

Introduction

According to the World Health Organization, Cardio Vascular Disease (CVD) is responsible for 33% of the total deaths occurring in the world per year [1]. Just in Brazil, more than 900,000 deaths of individuals over 30 years old were registered in 2011 [2]. Despite this, the number of patients over 60 years who survive a cardiovascular event and require secondary care is increasing every year [2]. Thus the regular practice of physical exercise and/or of cardiac rehabilitation has become fundamental for the reduction of mortality and co-morbidities associated with this disease [3,4]. Exercise training in Coronary Artery Disease (CAD) patients include improvements in cardiovascular and skeletal muscle functions, endurance, inflammation, quality of life, relieved clinical symptoms (dyspnea, sleep disorders, stress and depressive symptoms and cognitive functions [5,6].

Guidelines that involve physical exercise as a form of treatment for CAD respect a relationship of equilibrium between safety and effect of training [7,8] and recommended that resistance training (RT) be performed in combination with aerobic exercise (AT) training [5,6]. For RT, they provide recommendations concerning the maximum load limits during training, such as 50% of intensity in the 1 repetition maximum weight test [7-9]. For AT, based on the Ventilatory Threshold [VT] measured during maximum Cardiopulmonary Endurance Test (CPT) is often used in CAD patients. They recommend for beginners with low physical function/greater cardiac risk 40-50% of VO2 peak and 50 to 75% VO2 peak for CAD patients with higher fitness level or less cardiac risk [5,6] .

However none of these documents describe the way in which the prescription of these exercises should be organized by time. The maximum load limits for training allow for the elaboration of an exercise session but not for a progressive training program. Such organization, which should involve the type of stimulus according to the training phase (continuous and/or with intervals), the form of load progression (volume and/or intensity) [10], frequency (session/week) and the evaluation and reevaluation dates, is known as periodization [11].

Periodization has been used in sport training since the nineties [12], and recently its

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inclusion in rehabilitation has been debated [13-15]. The training can be described in more detail using periodization, valorizing its basic principles as: specificity, overload and reversibility. Periodization is the process of manipulating training variables to prevent overtraining, maximize training adaptations, and attain overcompensation or a training effect [9]. The classical approach to periodization is linear periodized training that appears in exercise guidelines for cardiac patients [8].This type consists of initial high volume and low-intensity. For this reason it is believed that the clinical and physical results obtained from periodized physical training in cardiopulmonary and metabolic rehabilitation programs could be improved, being reflected in a better quality of life for the patients involved. Thus the objective of this study was to create a periodization model for the prescription of exercises aimed at patients with coronary artery disease in phase II of the cardiac rehabilitation program, and compare the results with those of patients submitted to a non-periodized program.

Methods

Subjects

After approval of the project by the Ethics in Research Committee of the Parana Pontific Catholic University (434/2010), 534 patients referred to the rehabilitation service of the Costantini Cardiologic Hospital (CCH) were evaluated. The inclusion criteria were: men undergoing a Percutaneous Coronary Intervention (PCI angioplasty) or post-acute myocardial infarction with a left ventricular ejection fraction (LEVF) ≥ 50% (evaluated by trans-thoracic echocardiography) and stratified as of low or moderate risk for the practice of exercise according to the American Association of Cardiopulmonary Rehabilitation and Prevention (AACPRP) [16]. The exclusion criteria were: musculoskeletal injuries induced by exercise, failure to complete the 36 sessions and/or cardiovascular complications that lead to stop the exercise program. For stratified in low or moderated risk according ACSM [10], all patients were submitted a Medical Admission Consultancy (MAC).

Outcomes measures

Cardiopulmonary testing (CPT): The CPT was carried out by a doctor from the HCC using a gas analyzer (CORTEX, model METALYSER3B), an electric treadmill (IMBRAMED model IMBRASPORT SUPERATL) and a computer program (ERGOPC ELITE). The cardiopulmonary exercise test chosen was with ramp protocol individualized for each patient, with the blood pressure being measured every 3min using an analogical sphygmomanometer (MISSOURI) and a stethoscope (BD). In addition the electrocardiographic trace was monitored using electrodes (3M) throughout the entire endurance phase and recovery period. The volumes and gases ($O2$ and $CO2$) were calibrated before the tests. The V-slope method was used to determine the first ventilatory threshold (LVT1). The second ventilatory threshold (LVT2) was determined by respiratory point compensation, that is, transition between aerobic and anaerobic system in CPT. At this moment the production of carbon dioxide loses linearity, has exponential increase and exceeds the consumption of oxygen. This point was considered LVT2. The maximum oxygen ($VO2$) captured was defined as from the average measured during the last 30s of exercise.

One repetition maximum test: The 1RM was carried out by one of the instructors from rehabilitation service of the HCC. It was defined as the heaviest weight that can be moved of an exercise no more than 1 repetition. Before starting the test, all subjects performed a 5 min general warm-up of cycling and after the patient carried out 10 repetitions with no additional load in order to adjust the speed and angle of movement. The instructor first explained how to carry out each movement. The 1 RM test was done in the large muscle groups (quadriceps, hamstrings, pectoral, biceps, triceps and large dorsal), and the weight was increased by 5kg every 1 repetition, with 3-5 min of rest between lifts after three to four subsequent attempts. The test was interrupted when the patient was unable to complete the 1 repetition with the proposed load, and in this case, the previous load was considered to be the ideal one. The MEGAMOVEMENT station was used for the test in the following positions: extensor chair, leg curl, hip adduction and abduction, bench press, biceps curl, triceps and high pulley coast.

Body composition evaluation (BCE): The BCE was carried out by a rehabilitation instructor. The Faulkner protocol was used composed by 6 circumferences measures (calf, thigh, arm, forearm, hip and abdomen) and 4 skin folds (Abdomen (AB), Suprailiac (SI), Sub Scapular (SB) and Triceps (TR) [15]. A tape measure (WISO modelR88) was used together and an adipometer (CESCORF). The fat percentages, ideal body mass, lean and fat masses were calculated using the Faulkner equation [17]. The volunteers were reevaluated after 36 sessions (MAC+CPT+MR+CC).

Experimental design: This study was a randomized controlled trial, in which 62 (sixty two) men patients were included in the study and randomly assigned to two groups of 31: a Non-Periodized training Group (NPG) e and periodized exercise training group (PG). Blinded scaled envelopes prepared and kept secure by an independent person were used to randomize patients to NPG and PG (Figure 1).

Training protocols

All subjects of both groups carried out 12 weeks, 3 sessions per week (36 sessions) on non-consecutive days of Aerobic (AT) and Resistance Training (RT).

The AT carried out on a treadmill (MOVEMENT models RT250, LX160 and LX150) and the resistance training carried out using ankle weights, dumbbells and a muscle toning machine (MEGA MOVEMENTII station)

Resistance protocol: The RT was made in upper and lower limbs, being two sessions for lower limbs to one session to upper limbs. That is, twenty-four of the sessions of AT were carried out on the TreadMill (TM) and Lower Resistance Exercise (LRE) whereas in the other 12 sessions it was used the TM and Upper Resistance Exercise (URE).Thus every two consecutive sessions of TM+LRE were followed by one of TM+URE. Exercise selection and other for RT were similar among the two groups and included: leg extension, leg curl, hip flexion, knee flexion, hip abduction and adduction, ankles planti-flexion and hip flexion associated with knee flexion, elbow flexion and extension, shoulder abduction, scapulas adduction, shoulders

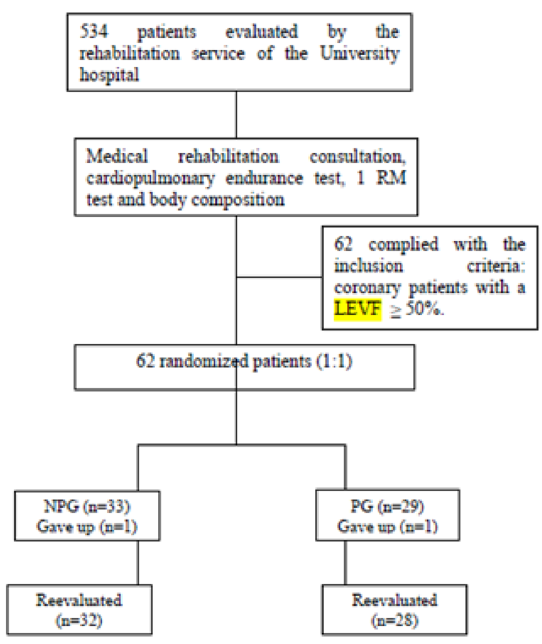


Figure 1: Study design
PG- Periodized Exercise training group. NPG- non-periodized exercise training group.

anterior flexion, pendulum exercise for the decoaptation of the shoulder joint, bench press, lat pull down, biceps and triceps curl and pulley. The two groups carried out 3 series of 15 repetitions of each exercise and the intensity of the resistance training varied between 30-50% of the loads obtained in the 1 RM test. The difference of two groups was that in PG the intensity was increased progressively in each micro cycle (4 weeks) and in NPG the intensity was increased according to patient resilience (Table 1). According to the ACSM10, the rest intervals between set were 1-2 min.

Aerobic protocol: The intensity of the AT on the electric treadmill for the two groups was defined as from the result obtained in the CPT. The artery rate (HR) corresponding to the Ventilatory Threshold 1 (VT1) was defined as the lower limit treatment (HRVT1), whereas the HR corresponding to the ventilatory threshold 2 (VT2) was defined as the upper limit treatment (HRVT2). The interval between HRVT1 and HRVT2 corresponded to the ideal training intensity for each patient, known as the target zone (TZ) [3]. The two groups started the aerobic training program with 25min of activity divided into 5 min, warm-up, 15 mins, training in the TZ and the 5 final minutes, cooling down. After each 3 sessions, 5 extra minutes of training within the TZ were added. As from the 10th and up to the 36th session, the total work time was 40min, of which 30 were within the TZ. The 5min each of warm-up and cool down were maintained throughout the 36 sessions.

The NPG trained along the 36 sessions within the range of target zone proposed prescribed by heart rate (corresponding LVT1 and LVT2 of the CPT) without a predict load progression. The patient chose the training intensity, since in target zone (Figure 2A).

The AT of PG was divided in two micro cycles of 18 sessions. First it was defined the average of heart rate (AHR) between HRLTV1 and HRLTV2, obtained from the formula: AHR= (HRVT2-HRVT1)/2. The training intensity until the 18 session was determined by HRVT1 + AHR. This is named target zone 1 (TZ1). The second targed zone (TZ2) was determined by .interval between HVT1+AHR and HRVT2. For example, if the patient obtained the artery rate in LVT1 of 100bpm and 130bpm in VT2, the TZ1 was the interval between 100 and 115bpm, and the TZ2 between 115 to 130bmp. After the 18th session, it was initiated the interval training, corresponding to two minutes of intensity in AHR and one minute in HRVT2. Thus, the difference between the models of aerobic training proposed was based on the progression of load, that is, pre-determined in PG (18 session), controlled by the increase of HR of training and change the target zone (TZ1 for TZ2), whereas in NPG, the intensity was controlled just by patient, always between TZ1 and TZ2 (Table 1). The patients of NPG and PG have trained with conventional artery rate monitor (OREGON model HR102). In addition, the instructors check regularly the artery rate with finger oximeters (NONIN). It is important to emphasize that coronary patient at low risk for the practice of exercises should train between the ventilatory thresholds, following the recommendation of the Brazilian Society of Cardiology [3]. Throughout the 36 training sessions of the NPG, the safety criteria for training and the intensity limits were respected, that is the loads for resistance training varied between 30-50% of the 1RM test and the TZ limits for aerobic training were also respected. In addition the volume of training was maintained, carrying out 3 series of 15 repetitions for each localized exercise and a maximum time of 40min of aerobic training after the 10th session. Having presented these limits to the patients, they defined their ideal training loads themselves according to their sensation of comfort, the instructor just orientating the implementation of the movements.

Training periods	Sets	Repetitions	Load (%1RM)
Resistance training			
NPG			
Weeks 1-12	3	15	30-50%
GP			
Weeks 1-4	3	15	30%
Weeks 5-8	3	15	40%
Weeks 9-12	3	15	50%
Endurance Training	**INTENSITY**		
NPG			
Weeks 1-12	HRVT1 to HRVT2		
Weeks 1-6	HRVT1		
Weeks 7-12	Interval training (2 min HVT1+AHR, 1 min HRVT2)		

Table 1: Resistance and endurance training programs for NPG and PG

PG- Periodized Exercise training group. NPG- non-periodized exercise training group; HRVT1- artery rate ventilatory threshold 1; HRVT2- artery rate ventilatory threshold 2; AHR- average artery rate

In the PG the prescription of their exercises was periodized. This group did the same volume of training with the same intensity intervals prescribed for the NPG, but with the prescription organized with time. Thus, 3 training macro-cycles were created, the first known as adaptation (MAD), the second fundamental (MFU) and the third specific (MSP). Each macro-cycle was composed of 12 micro-cycles and each micro-cycle was defined as a group of 3 classes or training sessions. Each macro-cycle presented a different objective. The objective of MAD was to improve neuromuscular coordination and cardiopulmonary adaptation. The objective of MFU was to improve the ventilatory threshold and the muscle fibers recruitment. And the objectives of MSP was to improve the VO2 peak (Figure 2) and resistance strength.

Data analysis: The results obtained in this study were expressed as the means, medians, minima and maxima and standard deviations (quantitative variables) or frequencies and percentages (qualitative variables). The data were tested through normal distribution using Kolmogorov-Smirnov test. The groups were compared in relation to the quantitative variables using the student t-test for independent samples or the Mann-Whitney non-parametric test. With respect to the qualitative variables the comparisons were made considering Fischer's exact test or the chi-squared test. The student t-test was used to compare the moments of evaluation in the case of paired samples or the Wilcoxon non-parametric test. In order to compare the groups and the evaluation moments (initial x final) a variance analysis model with a repeated measurements factor (split-plot) was considered. All variables that presented significant interaction between group and evaluation moment were analyzed by comparing the groups at each moment, and the evaluation moments within each group, where values for $p<0.05$ indicated statistical significance. The data were analyzed using the Statistical V 8.0 program.

Results

Baseline Characteristics

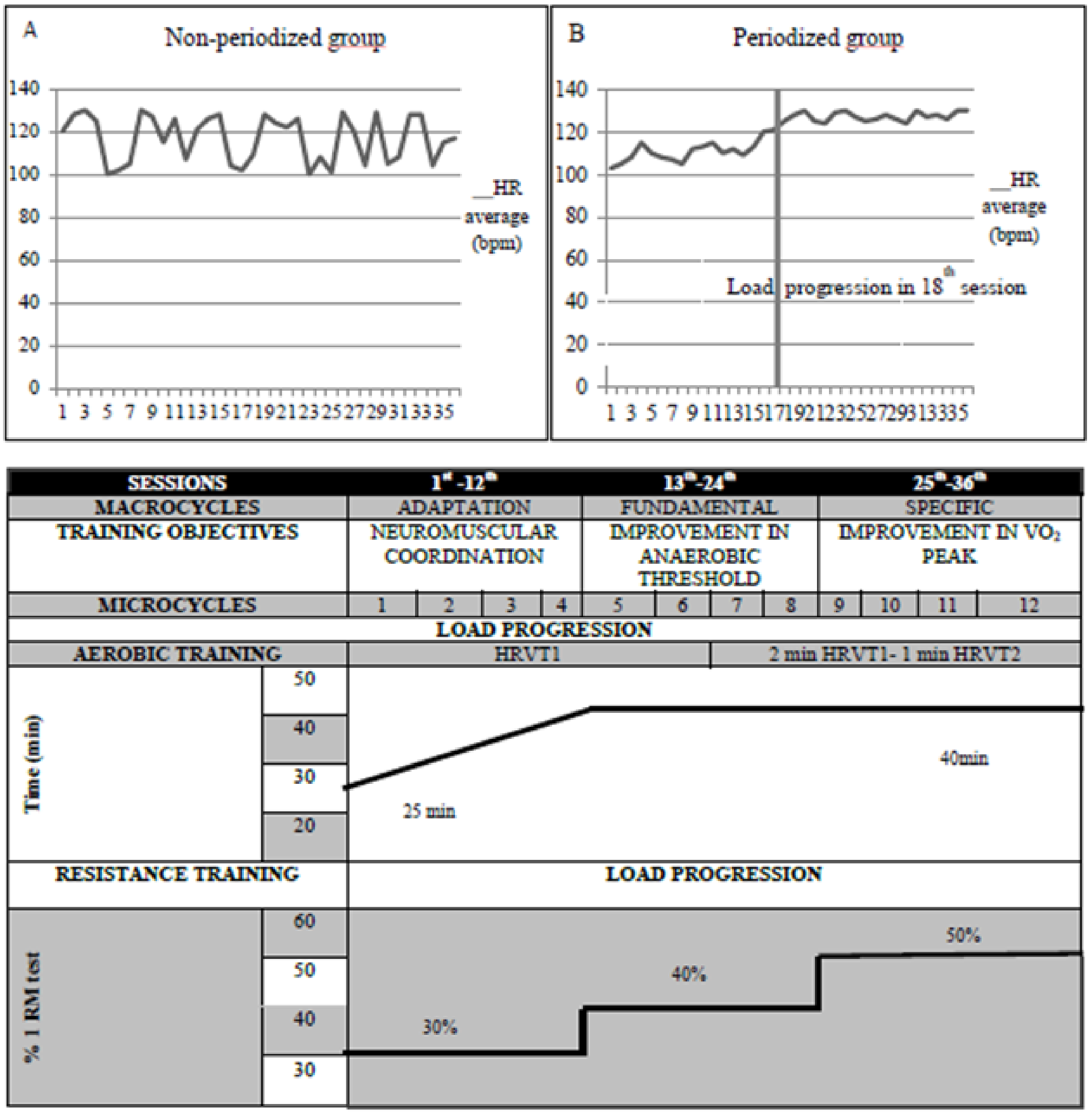
One NPG patient and another from the PG did not complete the 36 exercise sessions. Thus a total of 60 patients (NPG n=32 and PG n=28) were re evaluated.

Table 2 provides the baseline characteristics of the 60 patients who met the inclusion criteria. All variables evaluated were with normal distribution (Kolmogorov-Smirnov test, p >0, 05) (Table 2).

Adverse events during treatment period: No significant adverse events were registered during the training period.

Body composition parameters: No significance differences were observed between groups all variables. However, there was significance difference within group in all variables in PG and only in % fat above ideal in NPG (p < 0, 05) (Table 3).

Cardiopulmonary testing: There was no significance difference between baseline values for all cardiopulmonary variables between two groups (p > 0,05). However, significance changes post training were observed in functional capacity reached (FCR), VO2 peak and VO2 for the ventilator thresholds VT1 and VT2 with superior training effect for PG. In addition, there was a significance within group difference in FCR, VO2 peak, VO2VT1, VO2VT2, VT2 speed in both groups compared pre and post training (p < ,0,05). It was noted significance difference in maximum speed reached in PG and VT1 and



RM- maximal resistance; HRVT1- Artery rate ventilatory 1, HRVT2- Artery rate ventilatory 2

Figure 2: A, B- Artery rate variation in aerobic training. C- Exercise prescription model.

VT2 inclination in NPG within group comparison (p < 0,05) (Table 4).

Skeletal muscle function: The evaluation of the muscle strength parameters showed a significant improvement in both groups compared pre and post treatment (within groups). When compared between groups, no significance difference was found. (Table 5).

Discussion

The following outcomes were found in this study: superiority improvement for body fat, fat above ideal and body mass, VO2 peak and VO2 at VT1-2 in periodized group; muscle strength improvement in both groups. Periodization training is suggested in most recent guidelines [5,6,7,8]. However, the superiority of periodized training (RT and AT) has been poorly studied in CAD patients.

The main finding of this study was that the periodized exercise prescription program was superior to the conventional one with respect to the increase in the VO2 peak for the coronary patients taking part in a rehabilitation program. VO2 peak is closely associated with morbity and mortality in cardiac patients [18]. This information is very important since periodization is still not in rehabilitation programs of CAD patients [19]. In addition, the VO2 peak is recognized as being the best indicator of survival for this population [20,21,22]. Thus the inclusion of periodization as a fundamental basis for exercise prescription in cardiac rehabilitation programs could improve the results in VO2 peak.

Cardiopulmonary testing

The two training groups showed improvements in the VO2 peak and in the VO2 of the VT2, but only the periodized group showed a significant increase in the VO2 of the VT1. VO2peak is an independent predictor of mortality and morbidity in CAD patients [6]. When compared between groups, the PG showed significance effect compared to NPG. Also both groups improved their functional capacity (% of the predicted value), with more significance difference in favor of PG which was attributed to the better structuring of the load progression in this group. The classical approach to periodization is the linear periodization training (LPT) that appear in exercise training the patient trained 2min close to the HRVT1 followed by 1min close to the HRVT2, and maintained this alternating scheme until completing 30 min of workout. Due to its specificity, this intensity of training promoted a greater increase of the VO2 of the VT2, a fact confirmed by the findings of the present

Sample Characteristics	PG	NPG
n (men)	28 (100%)	32 (100%)
Age ± SD, years	55,89±1,6	62,4±2,0
Left ventricular ejectionfraction, ** %	65,57±1,0	66,09±1,0
Bodymass index	28,2±0,6	28,9±0,7
Abdominal circumference	100,7±1,7	101,0±1,8
Positive family history / cardiovascular disease	20 (71,5%)	24 (80%)
Dyslipidemia	27 (96,7%)	32 (100%)
Obesity	12 (42,8%)	22 (68,75%)
Sedentarylifestyle	22 (78,5%)	25 (78,1%)
Stress	25 (89,2,8%)	22 (68,75%)
Tabagism	4 (14,2%)	8 (25%)
Diabetes Melitus	5 (17,8%)	3 (9,3%)
High bloodpressure	12 (42,8%)	15 (46,8%)
Stratification of risk for exercises		
Low risk	21 (75%)	25 (78,1%)
Moderaterisk	8 (21,6%)	3 (8.1%)
Anatomic location of injuries		
Right coronary	5 (14,2%)	9 (28,1%)
Posterior descending	0	0
Trunk of left coronary	2 (7,1%)	4 (12,5%)
Anterior descending	18 (64,2%)	19 (59,3%)
Diagonal	5 (17,8%)	1 (3,2%)
Circumflex	6 (21,4%)	9 (28,1%)
Marginal	0	1 (3,1%)
Arteries with stent implants		
Right coronary		
1 Stent	4 (14,2%)	10 (31,5%)
2 Stents	1 (3,5%)	0
3 Stents	0	0
Posterior descending		
1 Stent	1 (3,5%)	0
Trunk of left coronary		
1 Stent	2 (7,1%)	4 (12,5%)
Anterior descending		
1 Stent	16 (57,1%)	17 (53,1%)
Diagonal		
1 Stent	1 (2,7%)	2 (6,2%)
Circumflex		1 (3,2%)
1 Stent	6 (21,4%)	6 (18,5%)
2 Stents	6 (21,4%)	3 (9,3%)
Marginal		
1 Stent	0	1 (3,1%)
Incomplete revascularization of myocardium	1 (3,5%)	4 (12,5%)
Prior surgery for revascularization of myocardium	2 (7,1%)	1 (3,1%)
Prior angioplasties	5 (14,2%)	3 (9,3%)
Medications, † % Anti-platetet agents Anticoagulant	28 (100%) 28 (100%)	30 (93,7%)
Antihypertensive	13 (46,4%)	17 (53,1%)
Beta blockers	26 (92,8%)	30(93,7%)

Table 2: Baseline characteristics of the study population

PG- Periodized Exercise training group. NPG- non-periodized exercise training group *(p ≤ 0.05); ** Obtained by trans-thoracic echocardiography; † Standard dose of medication.

study. It is important to highlight that this is aerobic training with intervals, limited by the maximum stable lactate phase, has already been proven. [26] Cornish et al, published a meta-analysis involving 213 patients with 7 randomized studies, which demonstrated the need for more studies in order to determine the risks and benefits of interval training above the VT2. In addition the authors noted different prescription methodologies, with the patients starting the exercise program yet with series of high intensity training with intervals in the majority of cases [27]. We believe that periodization allows for a greater chance of standardizing the prescriptions.

GROUP	PG (n=28)		NPG (n=32)	
	Pre	Post	Pre	Post
Bodyfat (%)	24,0±3,5	21,9±3,6*	23,9 ±4,4	22,9±41
Fat above ideal (%)	6,7±3,2	4,8±2,9*	5,6±5,7	4,5±5,1*
Bodymass (kg)	85,9±11,7	77,4±9,7*	83,9±15,1	83,2±14,9

Table 3: Bodycompositionparameters

PG- Periodized Exercise training group. NPG- non-periodized exercise training group. *p≤ 0,05 within-groupdifferences.

Body composition

The volunteers in the PG showed reductions in their fat mass, weight of fat above the ideal value and in their body weight. Increases in body mass and body fat are associated with several chronic diseases such as diabetes and cardiovascular disease [28]. Studies have shown that moderate aerobic training promotes an improvement in body composition [29,30]. This was important because obesity is considered to be an important modifiable cardiovascular risk factor [31]. A simple improvement in food habits is not sufficient for a rapid and appropriate decrease in fat mass. Therefore, the physical exercise association was fundamental for a body weight decrease and long-term maintenance of these changes [31]. Studies recognized aerobic exercise as the most suitable form of training by providing positive effects on glucose and lipids decrease on body fat and also the strength exercises [28,33]. Inoue et al showed that the association of strength and aerobic training were more effective than only aerobic training to improve lipid profile and insulin resistance sensitivity on obese adolescents [24].

The improvement in aerobic capacity or exercise tolerance results in a greater consumption of calories in order to maintain the activity and consequently burn more fat [24]. Lira et al had studied the effects of intensity and type of exercise on lipoprotein profiles and highlighted the higher energy expenditure achieved by associating volume and intensity . This fact justifies the finding that the periodized group, with its greater cardiopulmonary evolution and tolerance to exercise, was the group that presented greater body fat decrease. This is because improving the aerobic capacity, it increases the caloric intake per session, since the patients was walking more within a same time interval.

Skeletal muscle function

Both training groups presented a significant improvement in strength after the training period. In this case the periodized group showed no advantage. During MAD the patients worked with loads equivalent to 30% of the maximum determined in the 1RM test, in the MFU with 40% and in the MSP with 50%. This organized progression of the load was not more effective than the random progression used for the NPG. This could be attributed to the fact that these low training loads did not recruit different energy sources and/or types of muscle fibers. In addition, in the first 12 weeks of training the increase in strength occurs due to neural adaptation and not to hypertrophy, which is independent of the load [8,11]. The increase in strength noted in both groups could have contributed to the improvement in the VO2 peak, in the walking speed and in the inclination reached during the treadmill test [27]. Therefore, the training study is extremely important to both athletes to reach high performance but also to patients, like cardiopatics, which in addition to reducing the risk of mortality, has great social relevance.

Conclusion

The present study showed that, within the cardiac rehabilitation

GROUP	PG (n=28)		NPG(n=32)	
	Pre	Post	Pre	Post
FCR (% ofpredictedvalue)	88,7±12,4	101,9±13,8* †	80,2±15,3	86,5±12,2*†
VO2 peak (ml/kg/min -1)	27,2±6,3	31,5,3±7,3* †	22,9±5,7	24±6 * †
VO2 VT2	23,64±4,8	27,7±3* †	19,9±5,4	21,6±5,4* †
VO2 VT1	17,0±2,3	20,7±2,3* †	15,8±3,5	16,4±3,4†
HR maximumreached	159,7±22	162,6±18,5	138,3±18,3	136,1±18,69
HR VT2	169,9±21	141,9±20,5	119,2±16,2	118,8±15,84
HR VT1	110±14,5	114,3±15,7	100±15,6	96,1±20,6
Maximum speed reached (km/h)	8,2±2,4	8,8±2,4*	6,8±1,9	7,2±1,9
Speed VT2 (km/h)	7,1 ±1,8	7,9±1,8*	5,7±1,5	6,3±1,3*
Speed VT1 (km/h)	5,4 ±1,4	6 ±1,9	4,5±1,3	4,8±1
% maxinclination (degrees)	13±6,1	14,3±6,1	12,3±4,4	13,8±4,3
% inclination VT2 (degrees)	12 ±5,4	12,5±6,6	10,3±4	12,2±3,3*
% inclination VT1 (degrees)	8,4 ±4,2	9,6 ±5,2	7,4±3,2	8,7±3*

Table 4: Cardiopulmonary testing

PG- Periodized Exercise training group. NPG- non-periodized exercise training group Where: FCR= Functional capacity reached; HR= artery rate; *Intra-group difference ($p \leq 0, 05$); † Difference between groups ($p \leq 0,05$).

GROUP	PG		NPG	
	Pre	Post	Pre	Post
Legextension (kg)	13,5±5,5	24,0±8,3*	10,4±5	20,6±8,4*
Legcurl (kg)	7,9±3,3	14,1± 4,3*	6,5±3	11±6,5 *
Benchpress	12,6±4,5	21,2±6,5*	9,7±5	18,2±6,9*
Triceps	8,9±3,6	15,5±4,4*	7,2±3,5	12,3±3,5*
Biceps	8,4±2,5	13,3±3,4*	7,2±3,1	11,4±3,6*
Latpulldown	15,5±5,7	28,5±7,9*	11,8±7,2	23,9±11,4*

Table 5: Muscle strength parameters

PG- Periodized Exercise training group. NPG- non-periodized exercise training group. *withindifference ($p \leq 0,05$).

programs for coronary disease patients, periodization of the treatment can improve the results as compared to the conventional model, when considering the following variables: VO2 peak, VO2 for the VT2, VO2 for the VT1, % fat and body weight. These findings are very important for future studies involving physical training and cardiac rehabilitation.

We believe that at the present moment, before evolving into comparative studies between continuous exercises of moderate intensity versus high intensity exercises with intervals, periodization should be included as a prescription tool with the objective of improving the results of the intervention or treatment of those with coronary disease with physical exercise.

Study limitations

Low number of patients evaluated and Faulkner protocol utilization to evaluate body composition.

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