Effect of long-term physical activity practice after cardiac rehabilitation on some risk factors

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The objective of this study was to evaluate the effects of long-term physical activity practice after a cardiac rehabilitation program on weight, physical capacity and arterial compliance. The Dijon Physical Activity Score was used to identify two groups: sedentary and active. Weight, distance at the 6-min walk test and the small artery elasticity indice were measured at the beginning, at the end of the rehabilitation program and at 18.3 ± 5.3 months after. After the cardiac rehabilitation, sedentary patients showed a significant increase in weight and a significant reduction in distance on the 6-min walk test and in the arterial compliance. Active patients did not show any alteration in these parameters. We concluded that, after a cardiac rehabilitation program, the sedentary lifestyle has a negative influence on weight, physical capacity and arterial compliance, which are major markers of risk factors. In contrast, the practice of physical activity preserves these parameters.

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Introduction

The benefits of cardiac rehabilitation and exercise training programs are well documented in literature (Casillas *et al.*, 2007), and these programs induce a significant increase in physical capacity. Numerous physiological improvements result in a better control of cardiovascular risk factors. Rehabilitation programs improve glycemia balance, reduce hypercholesterolemia, hypertension and obesity indices and therefore decrease the overall cardiovascular risk (Lavie and Milani, 2000; Casillas *et al.*, 2007). Moreover, arterial compliance, which reflects the mechanical properties of arteries, increases significantly during a 6-week rehabilitation program, probably through improving endothelial function (Trzos *et al.*, 2007).

Pursuing regular physical activity after a rehabilitation program seems necessary to maintain its acquired benefits, but that remains to be confirmed (Boesch *et al.*, 2005). Although rehabilitation benefits are many and well documented, there is little information on the fate of patients after rehabilitation.

Therefore, the aim of this study was to examine the influence of maintaining the recommended physical activity after achieving a regular and continuous 6 weeks of cardiac rehabilitation on three risk factors: weight, physical capacity and arterial compliance.

Methods

Patients

We investigated the clinical course of 42 patients [mean age, 56.2 standard deviation (SD) ± 10 years; nine women and 33 men], having made their cardiac rehabilitation between January 2007 and June 2008 in a cardiac rehabilitation center. All these patients have suffered from cardiovascular diseases such as myocardial infarction and angioplasty with added risks factors such as diabetes, obesity, smoking, cholesterol and hypertension. Patients with heart failure and left ventricular ejection fraction of less than 40 ml and patients with chronic obstructive pulmonary disease were excluded from the study. Patients were evaluated at the beginning (T0), at the end (T1) and at 18.3(SD) ± 5.3 months after their cardiac rehabili-tation (T2).

Cardiac rehabilitation program

The patients underwent a 6-week program including physical activity and educational sessions. The physical activity consisted of 13 h of exercise per week conducted under the supervision of a physiotherapist or a sports teacher and nurse.

Measurements

The assessment of physical activity level after cardiac rehabilitation was performed at T2 by the Dijon Physical

Activity Score, which is reliable for measuring physical activity in patients with stable coronary artery disease (Gremeaux *et al.*, 2008). The Dijon Physical Activity Score was conducted following a standardized protocol and with the same staff member who asked multiple choice questions to patients.

Patients were then divided into two groups. Twenty patients who had a score of less than 10 were included in the sedentary group (SG) and 22 patients who had a score of more than 20 were included in the active group (AG). Patients with a score between 10 and 20 were excluded from further analysis.

Functional capacity was assessed using a 6-min walk test (6MWT). It was conducted following a standardized protocol described by guidelines (Brooks *et al.*, 2003).

Small artery compliance was measured noninvasively with the pulse wave method (HDI/Pulsewave CR-2000 Research CardioVascular Profiling System; Hypertension diagnostics, Eagan, Minnesota, USA). Measurements with this device are repeatable over both short and intermediate periods of observation(Prisant *et al.*, 2002). Measurements were taken in the morning before any physical exercise, in a partially extended position, after a 5-min period of rest, under identical conditions.
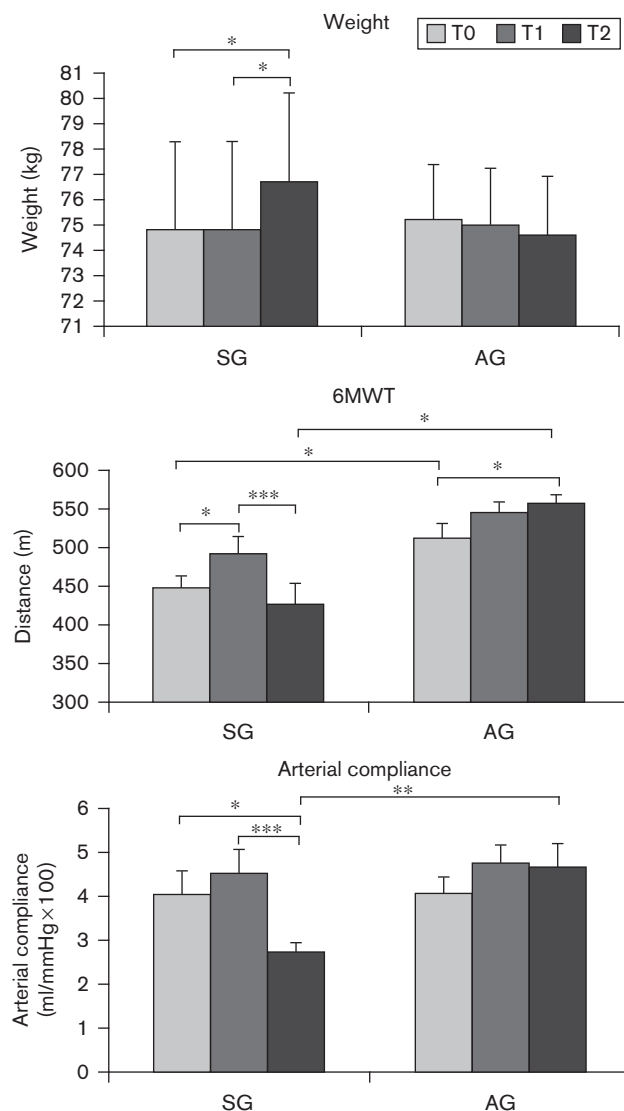
Statistical analysis
Two-way analysis of variance with group and time as factors and a-posteriori tests (Tukey) were performed for each studied variable. Statistical significance was set at a P value of less than 0.05.

Results
At T0, no significant difference was observed between groups except for the distance calculated on the 6MWT (SG, 448; SD, 81 months vs. AG, 513; SD, 91 months; $P = 0.022$). For SG, the weight was significantly higher at T2 (mean, 76.7; SD, 15.9 kg) in comparison with T0 (mean, 74.8; SD, 15.5 kg; $P = 0.021$) and in comparison with T1 (mean, 75.0; SD, 15.3 kg; $P = 0.036$; Fig. 1). The distance calculated at the 6MWT was significantly higher at T1 (mean, 495; SD, 104 months) compared with T0 (mean, 448; SD, 81 months; $P = 0.017$) for SG and tended to be higher at T1 (mean, 546; SD, 75 months) compared with T0 (mean, 513; SD, 91 months; $P = 0.09$) for AG. For SG, this distance was significantly reduced at T2 (mean, 428; SD, 123 months) in comparison with T1 ($P < 0.001$); whereas for AG, this distance was significantly increased at T2 (mean, 558; SD, 60 months) in comparison with T0 ($P = 0.012$). For SG, the index of arterial compliance was significantly lower at T2 (mean, 2.7; SD, 0.9 ml/mmHg × 100) in comparison with T0 (mean, 4.0; SD, 2.5 ml/mmHg × 100; $P = 0.013$) and in comparison with T1 (mean, 4.6; SD, 2.2 ml/mmHg × 100; $P < 0.001$). At T2, this index was significantly higher for

Fig. 1

Weight, distance at the 6-min walk test (6MWT) and arterial compliance at T0, T1 and T2 for sedentary group (SG) and active group (AG). Bars represent mean, error bars represent their standard errors. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

AG (mean, 4.6; SD, 2.6 ml/mmHg × 100) than for SG ($P = 0.004$).

Discussion
The main results of our study are that at T2 in comparison with T1, the weight was increased in SG but not in AG, the distance calculated at the 6MWT was decreased in SG and was improved in AG and, lastly, the arterial compliance was decreased in SG but not in AG.

The lack of weight increase in patients in the AG could be due to their regular practice of physical activity after rehabilitation. Despite the fact that we did not control their

food during this 18-month period, our result is concordant with the literature and confirms that physical activity helps to stabilize weight and that the sedentary lifestyle facilitates the weight gain (Roberts and Barnard, 2005). As weight is considered to be a risk factor for cardiovascular disease, it underlines the importance of physical activity after the rehabilitation program for these patients.

With regard to the 6MWT results, the rehabilitation program improved the physical capacity in SG but not in AG (we note only a tendency for AG). The performance at the 6WMT at T0 was better for AG than for SG indicating that AG had a superior physical capacity than SG at the beginning of the rehabilitation program. It could explain the lack of improvement of physical capacity with rehabilitation in this group. The difference observed in the 6MWT for SG between T1 and T2 shows that a sedentary lifestyle after rehabilitation diminished the physical capacity and canceled the benefits on the physical capacity acquired during the rehabilitation program. Pursing regular physical activity allows maintenance of physical capacity and can even further improve it, as indicated by the significant increase in the distance at the 6MWT for AG between T2 and T0. As the level of physical capacity is a determinant of the overall cardiovascular health and is a predictive factor of cardiovascular mortality (Myers *et al.*, 2002), pursuing regular physical activity after rehabilitation is of importance.

With regard to peripheral artery compliance at rest, the rehabilitation program had no influence over it for either groups (no significant change between T0 and T1). However, the sedentary lifestyle after rehabilitation reduced the compliance of peripheral arteries as shown by the decrease in the arterial compliance in SG at T2 compared with T0 and T1. In contrast, the fact that, for AG, the arterial compliance was not altered at T2 in comparison with T0 and T1 suggests that pursuing physical activity contributed to maintaining the level of arterial compliance. The reduction of small artery elasticity is due to an endothelial dysfunction, which is highly associated with cardiovascular events (Grey *et al.*, 2003). Indeed, endothelial dysfunction plays a key role in the development of atheroma and in the arterial blood pressure regulation (Casillas *et al.*, 2007). Therefore, protecting the endothelium is a key element in reducing cardiovascular risk (Cohn, 2001); and regular physical activity after a rehabilitation program could contribute to this protection, as it seems to reduce endothelial dysfunction.

Conclusion
This study shows that pursuing physical activity after cardiac rehabilitation allows counteracting the worsening of cardiovascular risk factors such as weight, physical capacity and arterial compliance. Therefore, physical activity after cardiac rehabilitation must be considered central in the management of cardiovascular risk.

Further investigations are necessary to explore the impact of a quantified physical activity on a larger set of cardiovascular risk factors in patients who are suffering from different cardiovascular diseases.

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