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Cardiovascular rehabilitation increase arterial compliance in type 2 diabetic patients with coronary artery disease

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ABSTRACT

Aims: The effect of a cardiovascular rehabilitation program on arterial compliance in type 2 diabetes mellitus with coronary disease was studied.
Methods: Hemodynamic data and arterial compliance were measured with a tonometer (HDI/Pulse wave CR-2000) in coronary artery disease patients with ($n = 32$) and without ($n = 24$) type 2 diabetes before and after a 6-week multidisciplinary cardiac rehabilitation program.
Results: A decrease in heart rate and an increase in stroke volume without significant change in resting cardiac output were obtained in diabetic patients. Arterial compliance of both small and large arteries was significantly increased. In 10 diabetic patients, this increase could be related to an increase in the anti-hypertensive treatment and to the decreased blood pressure. In the 22 remainders, the small artery compliance was significantly increased independently of blood pressure change.
Conclusions: Exercise training as well as optimization of diabetes and dyslipidemia treatment could explain the improvement of arterial compliance. If these changes are long-lasting and if they improve prognosis remains to be evaluated.

1. Introduction

Type 2 diabetes mellitus is linked to ischemic cardiomyopathy. Prognosis of the cardiac disease is more severe in type 2 diabetic patients than in non-diabetic patients, mainly because of the extension of the coronary lesions and the "silent" characteristics of the myocardial ischemia. It has been assessed that in type 2 diabetic patients, acute coronary event occurs in approximately 2/3 of all cases. Short-term prognosis differs between diabetic and non-diabetic myocardial infarction patients [1,2]. Mortality is evaluated at 29% after 3.7 years and 45% after 7 years in diabetic patients [2]. This is clearly higher than that of a non-diabetic population, which is evaluated at 20% 7 years after a myocardial infarction [1].

As in the general population, an decrease in arterial compliance is correlated with an increased risk of acute coronary events in diabetic patients [3,4]. Diabetes accelerates the onset and progression of arteriosclerosis [5], and a decreased arterial compliance is present in type 2 diabetic patients [5–7,3,8,9]. Multidisciplinary cardiovascular rehabilitation with concomitant education, optimization of pharmacological treatment and exercise training allows improvement

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of the prognosis after an acute coronary event [10]. Therapeutic strategy aimed to reduce coronary events in type 2 diabetic patients should be accompanied by an increased arterial compliance [7], but this still need to be verified [11], especially because in diabetic patients with coronary artery disease, the positive effect of rehabilitation appears lesser than in non-diabetic patients [12]. With diabetic patients, it is necessary to strictly manage risk factors and glycemic control together with physical training to fully benefit from cardiovascular rehabilitation [13,14].

Previous results reported that short-term hospitalization with an educational program can improve arterial wall compliance [15]. This was thought to be due to improvements in blood pressure [15]. On the other hand, these results were obtained with a method which is strongly influenced by blood pressure [16]. Also, it was suggested that the most powerful therapy available for increasing arterial compliance in diabetic patients is to vigorously treat hypertension [3]. Thus, it is not clear whether or not arterial compliance per se could be improved with cardiovascular rehabilitation.

The aim of the present study was to investigate whether a cardiovascular rehabilitation program could improve arterial compliance in type 2 diabetic patients with coronary disease. In order to better evaluate the effect of blood pressure, we paid special attention to the anti-hypertensive treatment and to the change in blood pressure level.

2. Subjects

Thirty-two type 2 diabetic patients with ischemic cardiopathy admitted in the cardiovascular rehabilitation program of the Sainte Clotilde Cardiovascular Rehabilitation Center (La Réunion, France) and 24 patients with ischemic cardiopathy but without diabetes were prospectively recruited. All the subjects were free of valvular prothesis, valvulopathy (aortic stenosis or mitral insufficiency), arrhythmia, or non-stable heart failure. Furthermore, patients with arrythmias were excluded because of the impossibility to correctly estimate arterial compliance with the tonometer HDI/Pulse wave CR-2000. Indication and rehabilitation program were in accordance with the French Cardiological Society guidelines [17]. Every subject voluntarily participated and gave written informed consent after careful oral and written explanation. The protocol complies with the 1964 Helsinki declaration and was approved by the local ethics committee.

3. Materials and methods

3.1. *Rehabilitation program*

The rehabilitation program was a 6-week educational and exercise training program. It was preceded by an initial medical consultation including clinical examination, echocardiography, biological exam and stress exercise test. The initial medical history and physical examination allowed evaluation of individual risk factor and the efficacy of the pre-existing therapeutic measures. Special attention was given to smoking cessation, hypercholesterolemia correction with a LDL cholesterol target lower than 1 g/L (following the European guidelines for cardiovascular disease prevention [18] and French Cardiological Society guidelines for the myocardial infarction [19]), control of arterial blood pressure following the World Health organisation (WHO) guidelines [20], i.e. for diabetic patients an arterial blood pressure lower than 130/85 mmHg, diabetes control with a HbA1c lower than 6.5% target (following the French national agency for habilitation and evaluation in public health – ANAES – recommendations [21]).

All the therapeutic modifications potentially required by the medical examination were done in association with the attending cardiologist. When necessary, adaptation of the diabetes treatment was done by a diabetologist.

3.2. *Education*

Daily individual or personal courses were provided by a professor of sport, physiotherapist, dietician and cardiac rehabilitation nurses. Patient education was focused on the pathology, treatment, risk factors and physical practice. Patients were also educated regarding the use of self-monitoring glycaemia devices, injections and adaptation of insulin doses.

3.3. *Physical exercise*

Daily physical exercises were performed 5 times a week (for a total of 13 h per week) under the supervision of a physiotherapist or physical educator. The physical exercise training consisted in gymnastic exercise, balneotherapy and endurance training.

Endurance training was performed on cycle ergometer or treadmill, and consisted of a 5-min warm-up followed by 45 min exercise corresponding to the ventilatory threshold heart rate. Five minutes of active recovery with stretching and relaxation ended the exercise training. Weekly, a 1-h resistance exercise session was performed to improve muscular strength. Specific respiratory training and motor education were provided as necessary.

4. Arterial compliance evaluation

Estimation of hemodynamic variables including small and large artery compliance was done with the tonometer HDI/Pulse Wave TM CR—2000 (Hypertension Diagnostics, Eagan, MN). This device has a good reproducibility and correlation with data obtained by catheterization [22].

Every patient was investigated in the same conditions the first and last days of the rehabilitation. Evaluation was performed between 7 h 30 and 10 h, in a dimly lit air-conditioned room with an ambient temperature of 25°C. Patients were sitting in a fauteuil with a 60° inclined file. The evaluated arm was in supination on an armrest. Measures were done after a 10-min resting period in this position.

4.1. *Acquisition and analyse of pulse pressure*

An acoustic transducer (tonometer) was positioned over the patient's radial artery (right wrist) and held in place using a