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VO₂max in patients with chronic pain: The effect of a 4-week rehabilitation program

La VO₂max chez les patients douloureux chroniques : effet d'un programme de quatre semaines de réadaptation

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Abstract

Background. – In patients with chronic pain, aerobic deconditioning can explain part of observed disability and disadvantage. The objective of the present study was to assess the change in VO₂max after a four-week exercise rehabilitation programme in this population.

Methods. – In a prospective study, 121 patients underwent a cycle ergometer exercise tolerance test with VO₂max measurement before and after a four-week exercise rehabilitation programme (which included aerobic training, muscle strengthening, occupational therapy and stretching).

Results. – We observed a statistically significant increase in VO₂max ($P = 0.03$) and an improvement in the patients' distribution according to the Shvartz fitness classification after rehabilitation.

Discussion. – The four-week exercise rehabilitation program was associated with an improvement in aerobic capacities in patients with chronic pain. However, in all but one of the 121 patients, the VO₂max value at the end of the program was below average for gender and age. Maintenance of aerobic training after the end of a rehabilitation programme is essential.

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Keywords: VO₂max; Deconditioning; Rehabilitation; Chronic pain

Résumé

Contexte. – Il existe chez les patients douloureux chroniques un déconditionnement aérobie qui participe au maintien en situation d'incapacité et de handicap. Notre objectif est d'étudier la variation de la VO₂max après 4 semaines de réadaptation chez des patients douloureux chroniques.

Méthodes. – Il s'agit d'une étude prospective sur 121 patients douloureux chroniques (lombalgie chronique, syndrome douloureux chronique du membre supérieur ou syndrome douloureux chronique multifocal). Nous avons mesuré la VO₂max à l'aide d'un analyseur d'échanges gazeux au cours d'une épreuve d'effort sur cycloergomètre avant et après 4 semaines de réadaptation associant travail aérobie, renforcement musculaire, ergothérapie et assouplissements.

Résultats. – Nous avons observé une amélioration statistiquement significative de la VO₂max ($p = 0,03$) dans notre population, et une amélioration de la répartition des patients selon les catégories de Shvartz après un programme de 4 semaines de réadaptation.

Discussion. – Le programme de réadaptation proposé permet une amélioration des capacités aérobies chez les patients douloureux chroniques. Cependant, la VO₂max à la fin du programme reste chez 120 patients, inférieure à la moyenne pour l'âge et le sexe. La poursuite d'une activité aérobie régulière est donc indispensable au décours du programme de réadaptation.

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Mots clés : VO₂max ; Déconditionnement ; Réadaptation ; Douleur chronique

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1. English version

1.1. Introduction

Deconditioning syndrome is one reason for poor effort tolerance and a progressive decrease in physical ability in patients with chronic low back pain (LBP) [2,10,14,19,23,24] (particularly in patients who have been off work for a long period) [23]. $VO_2\text{max}$ is defined as the maximum volume of gaseous oxygen that the body can take up per unit time during maximal aerobic exercise; it corresponds to an individual's maximum capacity to transport and use oxygen and thus reflects his/her physical fitness. In chronic LBP patients, it has been hypothesized that a progressive decrease in physical activity impacts the maximum aerobic capacity; this creates a vicious circle (the “deconditioning spiral”) in which inactivity leads to the aerobic deconditioning, which in turn leads to a reduction in physical activity [8–10,13,14,17,19].

In previous work [6], we discussed this hypothesis and evidenced objective deconditioning and a collapse in aerobic capacity by measuring $VO_2\text{max}$ (using indirect calorimetry) during a cycle ergometer exercise tolerance test in patients with chronic LBP and patients suffering from musculoskeletal pain at various body sites (chronic pain of upper limb and multifocal chronic pain). We therefore decided to apply the deconditioning theory to chronic musculoskeletal pain more broadly and offer multidisciplinary exercise rehabilitation programs to chronic pain sufferers.

The primary objective of the present study was to measure $VO_2\text{max}$ before and after four weeks of exercise rehabilitation in patients suffering from chronic pain at various body sites. We hypothesized that effort training would improve aerobic capacities in all patients, regardless of the type of chronic pain syndrome. The study's secondary objectives were to characterize variations in objective and subjective fitness parameters after the rehabilitation programme and to look for correlations with $\Delta VO_2\text{max}$.

1.2. Materials and methods

1.2.1. The study population

Patients (aged from 18 to 60) hospitalized in the physical medicine and rehabilitation department at Château-Renault hospital (Château-Renault, France) in 2010 for chronic pain syndrome (chronic muscle or joint pain for more than three months) and who had participated in an exercise rehabilitation programme were eligible for inclusion in the study. The patients were variously in work, on sick leave or unemployed. Following application of the inclusion criteria, 121 patients were selected for this cohort study (Table 1). The mean \pm SD length of time off work prior to hospitalization was 10.1 ± 8.6 months. Eighty patients had been off work for more than 6 months.

In general, chronic pain syndrome patients admitted to our department for rehabilitation undergo an exercise tolerance test, during which $VO_2\text{max}$ is measured by indirect calorimetry. Patients over the age of 50 or those with two or more

cardiovascular risk factors prior to admission undergo an exercise tolerance test with a cardiologist, in order to detect any contra-indications to participation in an aerobic rehabilitation programme.

Our department's routine clinical evaluation procedure was applied in all cases. In accordance with French data protection guidelines, all patients were informed that their personal data would be computer-processed. Approval by an independent ethics committee was not required because the protocol did not involve any changes in the patients' normal standard of care or any additional procedures and analyses.

The study participants were classified into three groups, as a function of the type of pain (Table 1):

- the chronic LBP group: LBP pain with or without irradiation to the leg, and no known neurological disorders;
- the chronic pain of upper limb (ULP) group: chronic pain in one upper limb, with or without specific symptoms of musculoskeletal disorder, and no indication for a surgical treatment;
- the multifocal pain syndrome (MPS) group: pain at several body sites (i.e. LBP plus pain in one or both arms).

1.2.2. Methods

All the patients were evaluated by our department's physical and rehabilitation medicine specialists, physiotherapists and occupational therapists before and after the rehabilitation programme. The evaluation included a maximal exercise tolerance test on a Cardiocontrol[®] cycle ergometer, with measurement of $VO_2\text{max}$. This was an incremental test starting at a power of 30 W, with a 30 W increment every three minutes. The pedalling rate was maintained at 60 rotations per minute throughout the test. The participants were told that the goal was to achieve the best possible level of performance, despite the pain. The VO_2 measurement was performed using a MedGraphics Cardiorespiratory Diagnostic Systems[®] gas exchange analyser; the highest VO_2 value recorded during the test was considered to be the $VO_2\text{max}$. The measuring equipment was calibrated at the start of each session (which comprised 4 to 6 exercise tolerance tests over a half-day period). The heart rate was monitored continuously throughout the test and the arterial blood pressure was measured before the exercise tolerance test, at each increment and after three minutes of rest at the end of the test. The exercise tolerance test was stopped in the event of exhaustion (i.e. the test was submaximal) or if the theoretical maximum heart rate (HR_{max} , defined by the ‘220 minus age’ equation) was reached (i.e. the test was maximal). The $VO_2\text{max}$ values were related to the participant's body weight and expressed in mL/kg/min. The values were compared with Shvartz and Reibold's normative values for age and gender [18] and participants were classified into seven fitness levels: 1, excellent; 2, very good; 3, good; 4, average; 5, fair; 6, poor; 7, very poor. The perceived exertion rating (PER, on the Borg scale [11]) was recorded before the test, immediately afterwards and then after 3 minutes of rest.

Poor exercise tolerance can be measured in a number of objective tests:

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