Science & Sports (2017) xxx, xxx—xxx

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

ORIGINAL ARTICLE

Occurrence of a $\dot{V}O_2$ slow component during intermittent exercises performed at $\dot{V}O_{2peak}$

Composante lente de $\dot{V}O_2$ et exercices intermittents réalisés à $\dot{V}O_{2pic}$

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Received 14 May 2017; accepted 26 August 2017

KEYWORDS
Aerobic fitness;
Fatigue;
Tennis;
Training

Summary
Objective. — A $\dot{V}O_2$ slow component $(\dot{V}O_2\,SC)$ typically occurs during continuous, constant work rate exercises conducted at both intense and maximal intensities. The extent to which $\dot{V}O_2$ SC also develops during intermittent exercises in field condition warrants investigations. This study aimed to test the occurrence of a $\dot{V}O_2$ SC during a field-based intermittent exercise performed at an intensity that elicits $\dot{V}O_{2peak}$.
Material and methods. — For this purpose, ten male tennis players performed two intermittent field exercises that mimic several aspects of tennis activity: an incremental test to determine their peak rate of oxygen consumption, and a discontinuous, constant work rate exercise (DCWR) conducted at $\dot{V}O_{2peak}$ intensity until exhaustion. Cardio-respiratory variables were measured breath-by-breath using a portable device.

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https://doi.org/10.1016/j.scispo.2017.08.004

Please cite this article in press as: Sanchez AMJ, et al. Occurrence of a $\dot{V}O_2$ slow component during intermittent exercises performed at $\dot{V}O_{2peak}$. Sci sports (2017), https://doi.org/10.1016/j.scispo.2017.08.004

Results. — The coefficients of determination of the $\dot{V}O_2$ kinetics models were 0.74 ± 0.18 ($P < 0.001$) and 0.40 ± 0.16 ($P < 0.001$) for the incremental test and DCWR, respectively. During the incremental test, an extra $\dot{V}O_2$ was detected above a threshold intensity corresponding to $86 \pm 6\%$ of $\dot{V}O_{2_{peak}}$. During DCWR, the occurrence of the $\dot{V}O_2$ SC was significant for 6 subjects, with a magnitude of 4.0 ± 3.3 mL.min^{-1}.kg^{-1} representing $6.0 \pm 3.2\%$ of the total $\dot{V}O_2$ response.
Conclusion. — This study showed that a mathematical model used to describe $\dot{V}O_2$ response to an intermittent exercise is appropriate and a $\dot{V}O_2$ SC was detected for the majority of the participants during intermittent exercises that elicit $\dot{V}O_{2_{peak}}$.

MOTS CLÉS
Puissance aérobie ;
Fatigue ;
Tennis ;
Entraînement

Résumé
Objectifs. — Une composante lente de $\dot{V}O_2$ se développe classiquement au cours d'exercices continus réalisés à une charge constante à intensité élevée ou maximale. La caractérisation de ce phénomène au cours d'exercices intermittents réalisés dans des conditions de terrain reste méconnue. L'objectif de cette étude est de tester si une composante lente de $\dot{V}O_2$ peut se manifester au cours d'un test de terrain à une intensité maximale.
Matériel et méthodes. — Pour cela, 10 joueurs de tennis ont réalisé deux exercices intermittents qui miment plusieurs aspects de leur discipline : un exercice progressif afin d'établir leur $\dot{V}O_{2_{pic}}$ et un exercice à charge constante équivalent à $\dot{V}O_{2_{pic}}$ jusqu'à épuisement. Les paramètres cardio-respiratoires ont été enregistrés en cycle par cycle par un système portatif.
Résultats. — La modélisation de la cinétique de $\dot{V}O_2$ était significative ($p < 0{,}001$) et présentait un coefficient de détermination égal à $0{,}74 \pm 0{,}18$ et à $0{,}40 \pm 0{,}16$ pour le test incrémental et celui à charge constante, respectivement. Au cours du test progressif, une extra consommation en oxygène a été détectée à une intensité correspondant à 86 ± 6 % de $\dot{V}O_{2_{pic}}$. Au cours de l'exercice à charge constante, une composante lente de $\dot{V}O_2$ a été détectée pour 6 athlètes avec une amplitude de $4{,}0 \pm 3{,}3$ mL.min^{-1}.kg^{-1} représentant $6{,}0 \pm 3{,}2$ % de la réponse totale de $\dot{V}O_2$.
Conclusion. — Cette étude montre qu'un modèle mathématique peut être utilisé pour décrire la cinétique de $\dot{V}O_2$ au cours d'exercices intermittents et qu'une composante lente de $\dot{V}O_2$ peut être détectée chez la majorité des participants lors d'exercices intermittents réalisés à une intensité maximale.

1. Introduction

The slow component of O_2 uptake kinetics $(\dot{V}O_2\,SC)$ represents a classical phenomenon observed during continuous, constant work rate exercises performed at high intensities [1—3]. During continuous, constant work rate exercise at moderate intensity, pulmonary $\dot{V}O_2$ is characterized by an initial cardio-dynamic phase followed by an exponential increase in $\dot{V}O_2$ corresponding to the fundamental (or primary) phase. This phase reaches a steady state after approximately 2—3 min under ''normal'' circumstances (i.e., healthy young subjects, etc.). During exercise conducted at intensities higher than the so-called lactate threshold or gas exchange threshold, $\dot{V}O_2$ continues to rise after 2—3 min [4]. This $\dot{V}O_2$ increase is termed the SC of $\dot{V}O_2$. For severe exercise intensities, SC drives $\dot{V}O_2$ to its maximum and exercise cessation ensues rapidly. The SC phase is classically interpreted as an excess of O_2 consumption with respect to what would be expected if a steady-state value was reached when a constant work rate is maintained. The O_2 cost per unit of work becomes elevated compared to that which is observed at a moderate exercise intensity, consequently reducing muscle efficiency. Interestingly, a $\dot{V}O_2$ SC has also been shown to occur during a 3 min ''all-out'' exercise test [5]. These data strongly suggest that $\dot{V}O_2$ SC can occur during maximal and supramaximal exercises.

During incremental exercise, several studies demonstrated that the relationship between $\dot{V}O_2$ and work rate (WR) might not be a simple linear function [6—8]. The slope of the $\dot{V}O_2$/WR relationship was steeper at exercise intensities above the ventilatory threshold. This reflects the occurrence of excess $\dot{V}O_2$ compared to what would be expected if the sub-lactate threshold $\dot{V}O_2$/WR relationship has been maintained. This phenomenon is considered similar to the $\dot{V}O_2$ SC observed during continuous constant WR exercises. It has been postulated that the physiological mechanism(s) underlying the non-linear $\dot{V}O_2$/WR relationship during incremental exercise could also be responsible for the $\dot{V}O_2$ SC phenomenon during continuous, constant work rate exercises [6,7].

It is noteworthy that the majority of available studies that have quantified the $\dot{V}O_2$ SC implemented continuous, constant work rate exercises such as cycling or running [9—14]. To the best of our knowledge, only few studies have investigated the potential occurrence of this phenomenon during intermittent activities. Turner and coworkers described the $\dot{V}O_2$ response during cycling interval exercise (1:2 exercise to rest ratio) of increasing exercise

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