Opinion

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How to Seek the Oxygen Uptake Plateau

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ABSTRACT

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Opinion

The maximal oxygen uptake (vo_{2max}) is an important physiological parameter, which is associated with the cardio-respiratory health, physical fitness and athletic performance. The vo_{2max} is defined as the maximal capacity of inhaling, transporting and utilising oxygen in the energetic metabolism during the maximal effort. Therefore, this parameter is limited by cardiovascular transport capacity of the oxygen from the lungs to the active muscles. Moreover, a high level of the vo_{2max} is an important pre-requisite for the elite endurance performance [1-3]. A plateau of the oxygen uptake (vo_{2pl}) is the gold standard criterion to establish the vo_{2max}. This criterion means a levelling of the vo_2 near the maximal effort, although the workload has still been increasing. If the vo_2 measurements do not increase more than 150 mL·min-1 (or 2 mL·kg^{-1}·min^{-1}) with the workload increments, then the plateau is achieved [4]. The vo_{2pl} is a physiological phenomenon, even though it is not seen in a large number of subjects who are submitted to the maximal effort test. This vo_{2pl} absence can mainly be caused by a wrong choice of the test protocol. This mistake is made when a researcher intends to save time or to give priority to another physiological parameter, such as: Anaerobic Threshold. As a result of this common mistake, some researchers have debated whether the vo_{2pl} is a protocol artefact or true physiological phenomenon. However, Taylor, et al. [4] observed that only seven within 115 men had failed to reach vo_{2pl}. These authors applied a protocol test in which each incremental stage occurred on different days. Moreover, Duncan, et al. [5] investigated the incidence of the vo_{2pl} during discontinuous versus continuous protocol tests and they concluded that the vo_{2pl} incidence was equal to 60% of the discontinuous and 50% of the continuous tests. Furthermore, non-published data from our laboratory show a much greater incidence of the vo_{2pl} on discontinuous tests. The incidence of an oxygen uptake plateau at the vo_{2max} is associated to the ability of maintaining the maximal effort and postponing the test interruption, which informs us about the exercise tolerance and, consequently, the anaerobic capacity [6,7]. The test interruption occurs when the accumulation of the metabolic wastes is bigger than their elimination. Thus, the discontinuous protocol test will provide enough time to eliminate

part of those metabolic wastes, to buffer the internal milieu and to postpone the exhaustion. Likewise, four minutes of passive resting among the stages will be enough to recover completely the myoglobin, [ATP] and [CP] stores.

On the other hand, if the workload is increased continuously without any rest time, then those metabolic wastes produced in one stage will be added to more metabolic wastes produced in the next stage, thereby the exhaustion will have occurred early. The ceiling effect of the circulatory system is needed to show the vo_{2pl}; to do that, the test must involve a big muscular mass, which means running on the treadmill with 3 degrees of slope or wearing toe clips on the cycle ergometer. The effort should also be maintained for 3 minutes, because of the circulatory and respiratory delays, which means that the fast oxygen uptake kinetics phase should be completed. Finally, the increments on the workload should be approximately 1 Metabolic Equivalent [8]. Summing up, the discontinuous test is the best one to show the oxygen uptake plateau and, consequently, to point out the maximal oxygen uptake. Yet, the individual variability in body size, cardio-respiratory fitness, muscular strength, etc. may change the vo_{2pl} occurrence. Thus, more studies about the rest time among the stages, the stage duration time, the vo_{2pl} cutoff criterion, and the treadmill slope should be done. Even though above rules sound a little bit arbitrary, they are effective.

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