Journal of Exercise Science & Fitness 15 (2017) 22–26

Contents lists available at ScienceDirect

Journal of Exercise Science & Fitness

journal homepage: www.elsevier.com/locate/jesf

Arterialized and venous blood lactate concentration difference during different exercise intensities

Leandro C. Felippe [a, *], Guilherme A. Ferreira [a], Fernando De-Oliveira [b], Flavio O. Pires [c], Adriano E. Lima-Silva [a, d]

[a] Sport Science Research Group, Federal University of Pernambuco, Pernambuco, Brazil
[b] Nucleus of Human Movement Studies, Federal University of Lavras, Minas Gerais, Brazil
[c] Exercise Psychophysiology Research Group, University of São Paulo, São Paulo, Brazil
[d] Human Performance Research Group, Technological Federal University of Parana, Parana, Brazil

ARTICLE INFO

Article history:
Received 25 January 2017
Received in revised form
14 April 2017
Accepted 4 May 2017

Keywords:
Anaerobic threshold
Arterialized-venous difference
Exercise domains
Lactate balance
Lactate clearance
Physiological assessment

ABSTRACT

Objective: The purpose of this study was to investigate the difference between arterialized and venous blood lactate concentrations [La] during constant-load exercises at different intensities.
Methods: Fifteen physically active men cycled for 30 minutes (or until exhaustion) at the first lactate threshold (LT_1), at 50% of the difference between the first and second lactate threshold ($TT_{50\%}$), at the second lactate threshold (LT_2), and at 25% of the difference between LT_2 and maximal aerobic power output ($TW_{25\%}$). Samples of both arterialized and venous blood were collected simultaneously at rest and every 5 minutes during the exercise.
Results: The arterialized blood [La] was higher at minute 5 than venous blood [La] for all exercise intensities ($p < 0.05$). After this period, the arterialized and venous [La] samples became similar until the end of the exercise ($p > 0.05$). The arterialized-venous difference during the first 10 minutes was greater for the two highest exercise intensities (LT_2 and $TW_{25\%}$) compared with the two lowest (LT_1 and $TT_{50\%}$, $p < 0.05$). Thereafter, arterialized-venous difference decreased progressively, reaching values close to zero for all exercise intensities ($p > 0.05$).
Conclusion: These results suggest a delayed lactate appearance in the venous blood, which is accentuated at higher exercise intensities. The lactate measured in arterialized and venous blood is interchangeable only when blood samples are collected at least 10 minutes after the exercise starts.
© 2017 The Society of Chinese Scholars on Exercise Physiology and Fitness. Published by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Blood lactate concentration ([La]) is a measure widely used to determine training intensity zones, quantify the effects of endurance training and/or to estimate the lactic energy expenditure of a given activity task.[1–3] This blood [La] is the result of the balance between its appearance and removal.[4,5] Lactate can be produced by red blood cells, by the brain, by the gut, and by the skin. During exercise, however, the main tissues producing lactate are the active muscles. Lactate produced during exercise is continually cleaned up by the inactive muscles, heart, liver and kidney.[4–6]

The gold-standard approach to measure lactate balance (release and uptake) is by the exercising lower limb muscles (e.g., cycling). This is done by taking femoral arterial and femoral venous blood samples while measuring femoral arterial blood flow. However, the access to the femoral artery and femoral vein is highly invasive, uncomfortable and technically difficult during whole-body exercise.[7,8] An alternative is to collect samples from the brachial artery, where the La matches the values observed in the femoral vein.[9] The most visible access sites are the small-caliber arm arteries, although they are easily missed during exercise, and demand a procedure which causes great discomfort.[10] Because of the cumbersome nature of these blood-collecting sites, the collection of femoral arterial/venous and brachial artery blood samples is not routine during either physiological research or diagnostic exercise testing. Rather, the most widely used collection sites are arterialized blood samples from easier-access sites such as the earlobe or fingertip, or venous

* Corresponding author. Sports Science Research Group, Department of Physical Education and Sports Science (CAV), Federal University of Pernambuco, Alto do Reservatório Street, Bela Vista, Vitória de Santo Antão, Pernambuco, 55608-608, Brazil.
E-mail address: leandro.camati@ufpe.br (L.C. Felippe).

http://dx.doi.org/10.1016/j.jesf.2017.05.001
1728-869X/© 2017 The Society of Chinese Scholars on Exercise Physiology and Fitness. Published by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

blood samples from the arm veins. Arterialized blood samples may be collected in micro samples from these sites, with minimal discomfort.[11,12] During incremental exercise, measurements of the [La] taken from the arterialized capillary blood samples seems to be similar to both the arterial blood [La] collected from the brachial artery and venous blood collected from antecubital vein.[9] On the other hand, it has also been observed that the blood [La] concentration in the arm vein is slightly lower than the blood [La] in arterialized capillary during the highest stages of an incremental exercise.[13] Similarly, concentrations in venous blood samples collected from the forearm vein during an incremental exercise seem also to be slightly lower than in the arterial blood [La] collected from the forearm artery, and the arterio-venous lactate difference becomes greater with the increase in the exercise intensity.[8]

Therefore, an important aspect that may contribute to maximize differences between arterialized capillary and arm venous blood [La] is the intensity of the exercise; this, however, has not been widely explored. An increase in intensity of the exercise should simultaneously increase lactate production by the active muscles and decrease peripheral blood flow to inactive arm muscles.[14,15] A decrease in this peripheral blood flow might delay the appearance of lactate in the arm venous blood, which might accentuate the differences between [La] there and in the arterialized capillary.[6]

A delayed arm venous [La] response may result in errors when determining lactate thresholds or when estimating lactic energy expenditure during a given task.[1,3] Although arm vein and earlobe blood collections are widely used for [La] determination during exercise,[16] these samples could have been interchangeably used and the venous-arterialized blood [La] relationship could have been influenced by the exercise intensity. The possible interrelationship between exercise intensity and exercise duration is also not known. The recent increase of interest in measuring energy system contributions in a variety of sports, in particular anaerobic lactic and alactic contributions, makes this an important area for study.[17–19] Usually, the lactic portion of the anaerobic energy system is largely estimated from blood [La].[20] Since anaerobic lactic contribution is both intensity and duration dependent, it is important to be aware of the blood collection sites and how they influence the blood [La] as well as influence the estimate of lactic energy expenditure during exercise of various intensities.

Therefore, the aim of this study was to determine the difference of blood [La] response in the arterialized earlobe capillary and antecubital vein during constant-load exercise performed at different intensities. We hypothesized that the venous blood [La] presents a delayed response compared to the arterialized capillary blood [La], and that this difference might increase as the exercise intensity increases.

2. Methods

2.1. Participants

Fifteen male participants (mean ± SD: 28.1 ± 4.5 years; 82.0 ± 9.7 kg; 177.7 ± 4.6 cm; 14.1 ± 5.8 % of body fat; and 41.8 ± 4.0 $mL \cdot kg^{-1} \cdot min^{-1}$ of VO_{2max}) were recruited to participate in this study. The participants were all recreationally active and were familiar with the experimental procedures. The participants were accustomed to cycle on a cyclo ergometer but were not cyclists. Participants were firstly informed of the requirements, benefits and risks of the study and thereafter signed a consent form. The study was approved by the Ethics Committee for Human Studies of the School of Physical Education and Sport of the University of São Paulo.

2.2. Procedures

Each participant visited the laboratory on five different occasions, with 72-h interval between visits. In the first visit, height, body mass, and skinfolds were measured (chest, abdomen and thigh). Body density was estimated according to Jackson and Pollock's equation[21] and converted to body fat percentage using Siri's equation.[22] Then, the participants performed a maximal incremental test on a cycle ergometer (Standart Lannoy Ergometer, Godart-Statham, Bilthoven, Holland) to determine their first (LT_1) and second (LT_2) lactate thresholds, and the peak power output (PPO). In visits 2 to 5, participants performed constant workload trials at: 1) LT_1; 2) 50% of the difference between the LT_1 and LT_2 ($TT_{50\%}$); 3) LT_2 or; 4) 25% of difference between the LT_2 and the PPO ($TW_{25\%}$).

The trials were performed randomly, and at the same time of day to avoid any effect of the circadian cycle.[12] Participants were instructed to consume their usual diet before the experimental sessions and to take all tests in a postprandial state (i.e., the last meal was taken 2h before the trial). They were recommended to avoid intense exercise, and to avoid consumption of food and drinks containing caffeine or alcohol in the 24 h preceding the trials.

2.3. Maximal incremental test

The maximal incremental test started with a 3-min, warm-up at 50 W, followed by increments of 20 W every 3 min until exhaustion. Participants were verbally encouraged to give their maximal effort during the test. At the end of each stage, 25 μL of arterialized blood sample from the vasodilated earlobe (Finalgon, Boehringer Ingelheim, Germany) was collected and immediately analyzed for [La], by using an automatic analyzer (YSI 1500 Sport, Yellow Springs Instruments, Yellow Springs, OH). The [La] was plotted as a function of the workload, and the LT_1 and LT_2 were identified by a 3-segment linear regression.[23–25] The 3-segment linear regression fitting was calculated using an interactive process with two initially unknown intercepts calculated from every possible combination of intersection. The intercepts that best shared the curve in three linear segments were assumed when the highest R^2 value and the lowest residual sum of squares were attained. The LT_1 was therefore defined as the workload corresponding to an initial change in the rate of lactate accumulation in the blood, while LT_2 was defined as the workload corresponding to the second change in the rate of lactate accumulation.

2.4. Constant workload trials

Constant workload trials were performed at intensities corresponding to LT_1, $TT_{50\%}$, LT_2 and $TW_{25\%}$, for 30 minutes or until exhaustion (if individuals were unable to tolerate the target duration). These exercise intensities corresponded to the upper boundary limit of moderate domain, mid-range of heavy domain, upper boundary limit of heavy domain, and first-quarter of very heavy domain, respectively.[24] Participants were instructed to maintain a pedal cadence between 60 and 70 rpm throughout the test. Exhaustion was defined when participants could not maintain a 60 rpm pedal cadence.

Before each test, a catheter was inserted into the antecubital vein for venous blood collection. The arterialized capillary samples were collected from the vasodilated earlobe (Finalgon, Boehringer Ingelheim, Germany). The venous (10 ml) and arterialized (25 μL) blood samples were collected simultaneously before the trial (at rest) and every 5 min during the trials, with the last sample taken at minute 30 or exhaustion. The venous and arterialized blood [La] was immediately determined in the automatic analyzer (YSI 1500

Download English Version:

https://daneshyari.com/en/article/5579872

Download Persian Version:

https://daneshyari.com/article/5579872

Daneshyari.com