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Research Article

The Effect of Intermittent Capillary Blood Sampling During Load Incremented Cycling on Physiological, Psychological and Perceptual Variables

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Abstract

Introduction: The measurement of capillary blood to assess the lactate inflection point is used for health-fitness application and to predict sports performance. However, it is unknown if capillary blood sampling impacts physiological, psychological or perceptual responses during exercise testing.

Purpose: To compare the effect of capillary blood sampling on physiological, psychological, and perceptual during a load incremented cycle protocol.

Methods: A multiple observation, within subject, cross-sectional design was employed. Twenty males (20.4±2.76 years), and twenty females (22.3±3.31 years) performed two load incremented cycle ergo meter tests (Trial A and Trial B) to obtain VO_2 peak ($lmin^{-1}$), Ventilation (Ve) ($lmin^{-1}$), VCO_2 ($lmin^{-1}$). VO_2 ($lmin^{-1}$), and HR ($bmin^{-1}$) were recorded each minute. The Vpt was determined as the $\%VO^2$peak at which Ve: VO_2 increased without an accompanying increase in Ve: VCO_2. Trial A included capillary blood lactate (BLa) measures taken during the last minute of each stage. Trial B used an identical protocol without BLa measures. The order of administration of Trial A and Trial B were counter-balanced. The psychological/perceptual dependent variables measured during the last 30 seconds of each stage were:

1) Affect Valence (AV)

2) Felt-Arousal (FAS)

3) Rating of Perceived Exertion for the overall body (RPE- O)

4) Exercise Enjoyment (EE) and

5) Perceived intensity level (INT). A paired samples t-test was used to examine between trial differences in psychological and perceptual variables measured at the Vpt along with physiological variables.

Results: There were no significant differences in $VO_{2\ peak}$, HR_p, TCT, and Vpt between Trial A and Trial B ($p>0.05$). There were no statistically significant between trial differences found for AV, FAS, RPE-O and EE measured at the Vpt. The perceived INT at the Vpt was significantly (*$p<0.05$) higher in Trial A than Trial B.

Conclusion: Capillary blood sampling does not appear to influence aerobic fitness variables during exercise testing or most psychological and perceptual variables. This can provide reassurance when incorporating capillary blood sampling into exercise testing protocols.

Introduction

The measurement of blood lactate to assess and monitor exercise performance is a common practice in sports physiology laboratories worldwide. Lactate analysis is performed for the prescription of training velocities, to evaluate longitudinal changes in aerobic and anaerobic fitness, and to evaluate individual responses to specific training sessions [1]. Most prescriptive research involving blood lactate is directed towards determination of the anaerobic threshold and estimation of the relative anaerobic contribution to exercise based on lactate formation. The theory behind this application is that lactate increases in the blood during heavy to very heavy exercise. As exercise intensity increases above a certain metabolic threshold, anaerobic energy pathways are initiated causing lactate to increase significantly above resting levels. This is accompanied by an almost equal reduction in bicarbonate concentration in the blood causing CO_2, production to accelerate, evidenced as an increased respiratory CO_2 output. The threshold at which this begins is termed the anaerobic threshold. This threshold has been used as an effective gauge of endurance level in patients with cardio-respiratory disease, healthy normal subjects, and athletes [2]. Some of the common techniques used for blood sampling include, finger stick, ear stick and indwelling catheter methods. It has also been observed that blood sampling during exercise may be uncomfortable for subjects being tested; multiple punctures in the same area can be painful, and the site of blood may disturb some participants [3]. Capillary blood sampling may even cause anxiety in some subjects, which could in turn affect test responses. It is currently unknown if capillary blood sampling during exercise testing impacts physiological, psychological or perceptual responses. Therefore the Purpose of this study is to determine the effect of intermittent capillary blood sampling during a load incremented cycle protocol on selected physiological, psychological and perceptual variables.

Methods

There were 40 total subjects recruited from the university community. They were healthy individuals who participated in aerobic activity 2 days per week for at least 30 minutes each and for no more than 150 total minutes per week. Initially Subjects underwent an orientation session to familiarize them with the incremented cycle protocol and the finger stick method. During the orientation stages (2 minutes in length), capillary blood samples were measured twice, at rest and during the first stage, and subjects were required to cycle to 85% of there age predicted max heart rate after the Orientation Session subjects participated in 2 experimental sessions; Trial A and Trail B. The order of administration was determined by counterbalance. Each session was separated by 48-72 hours. Before each session Height, Weight and % Fat were assessed using a Tanita BIA system. The Peak Cycle Ergo-meter Protocol was load incremented and included 3 minutes stages which increased in resistance by 25 watts per stage, women began at 50 watts and men began at 75 watts the subject was required to maintain a continuous 50 rpm pace until exhaustion. The finger stick method utilizing the lactate pro meter was used for all capillary blood sampling procedures.

Measures

Psychological and perceptual measures were determined by the use of 5 different scales Affect Valance (AV), Felt Arousal (FAS), Ratings of Perceived Exertion (RPE-O), Exercise Enjoyment (EE), and Exercise Intensity (INT). All variables were measured during the last 25 seconds of each minute with the exception of perceived Intensity, which was measured at the end of each stage. AV is defined as the most basic or elementary component of all valenced (positive/negative) subjective responses [4]. Affect valence was measured using a bipolar Feeling Scale [5] ranging from +5 (very good) to -5 (very bad). FAS measures the perceived activation during exercise. High arousal might be experienced as excited, anxious or angry. Low arousal might be experienced as relaxed, bored or calm. Arousal was measured using the Felt Arousal scale ranging from 1 (low arousal) to 6 (high arousal). RPE-O is defined as a measure of the intensity of effort, strain, discomfort and/or fatigue that is felt during exercise [6]. Rating of perceived exertion of the overall body was measured using the cycle format 0 (extremely easy) to 10 (extremely hard) Omni RPE scale [7]. EE was defined as "desire to have fun, pursue interests, and/or be stimulated" during exercise participation. The level of exercise enjoyment was measured using a bipolar enjoyment scale that ranged from +5 (very enjoyable) to -5 (very un-enjoyable). INT represents 5 different levels of exercise intensity. The scale ranges from 1 (Light) to 3 (Moderate) to 5 (Vigorous). Moderate exercise intensity was defined as an intensity that noticeably increases your heart rate and breathing. Vigorous exercise intensity was defined as an intensity that substantially increases heart rate and breathing [8-11].

The Ventilatory Breakpoint (V_{pt}) was determined for each subject as the absolute VO_2 at which Ve: VO_2 increased without an accompanying rise in Ve: VCO_2. The ventilatory breakpoint was expressed as a % of peak oxygen uptake and served as a dependent variable. Paired-Samples t-tests were used to compare Peak Oxygen Consumption, Heart Rate at $VO_{2\ peak}$, Total Cycle Time, and Ventilatory Breakpoint between Trial A and Trial B for males and females [12]. A paired samples t test was also used to examine the differences in psychological and perceptual variables between trials at the ventilatory breakpoint for all psychological and perceptual variables [13,14].

Results

Table 1: Demographics.

	Males (n=20)	Females (n=20)	Combined (n=40)
Age (yrs)	20.4±2.76	22.3±3.31	21.35±3.16
Height (cm)*	174.4±5.82	164.8±5.40	169.60±7.37
Weight (kg)*	72.08±8.50	59.98±5.98	66.03±9.50
Body Fat (%)*	13.30±4.62	23.10±5.24	18.2±6.96
BMI	23.75±2.76	22.18±1.88	22.97±2.46
p=0.05			

Table 2: Mean score of physiological variables at the ventilator breakpoint.

	Comb A	Comb B	Male A	Male B	Female A	Female B
VO_2peak	2.81	2.8	3.23	3.29	2.38	2.31
Heart Rate peak	185.72	185.54	185.11	185.58	186.3	185.5
Total Cycle Time	15.88	15.43	17.81	16.44	13.94	14.42
Vpt	70.68%	71%	67.20%	69.60%	74.10%	72.40%
p=0.05						

Subjects did not differ in age or level of Physical activity (Table 1). Males were significantly taller, weighed more, and were lower in % body fat when compared to the females [15-17]. There was no significant differences found between Trial A and Trial B for males or females in: VO_{2peak} , HR_{peak} Total Test Time, or Ventilatory Breakpoint (Table 2). There were also no statistically significant differences between trial A and B for affect, arousal, perceived exertion and exercise enjoyment measured at the V_{pt}. The perceived

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intensity at the Vpt was significantly higher in Trial A than Trial B (Table 3). Mean change scores were determined from the end of the first minute for affect, felt arousal, rating of perceived exertion, and exercise enjoyment and the end of the first stage for intensity to immediately post exercise for all variables. No significant differences were found between the mean change scores for any variables.

Table 3: Mean score of psychological variables at the ventilator breakpoint.

	Trial A	Trial B	Sig.
AV	1.20±1.77	1.00±1.83	0.468
FAS	3.41±1.33	3.23±1.13	0.213
RPE-O	5.48±1.46	5.35±1.49	0.655
EE	.95±1.83	1.00±1.91	0.824
INT	2.98±.69	2.63±.84	*.037
p=0.05			

In Summary we were able to find that there is no significant differences between Trial A and Trial B for males or females in: VO_{2peak}, HR_{peak} Total Test Time, or Ventilatory Breakpoint. There were also no significant differences in change score for perceptual and psychological variables. However there was a significant difference in perceived intensity at the ventilatory breakpoint between Trial A and Trial B.

Discussion

The purpose of this study was to evaluate the impact of capillary blood sampling on physiological (VO_{2peak}, HR_{peak}, Total Test Time, Ventilatory Breakpoint) psychological, and perceptual (AV, FAS, EE, RPE-O, EE, INT) variables during a load incremented cycle protocol to peak. Of particular interest was the behavior of the psychological and perceptual variable in relation to the ventilatory breakpoint. The primary finding of this study was that the inclusion of capillary blood sampling during a load incremented cycle ergometer exercise test does not adversely effect most physiological, psychological or perceptual responses to exercise. However, there was a significant difference in the perception of exercise intensity between Trial A and Trial B. This may have been due to an increased anxiety level of subjects during Trial A as a result of the capillary blood sampling. A Future direction from this study may include the determination of anxiety prior to exercise with the use of an anxiety scale or questionnaire. To determine if anxiety level may have been the cause of the increased perception of intensity. Another direction might be to examine pre test heart rate and blood pressures with an anxiety scale prior to tests. The use of other sampling techniques such as Venipuncture, Ear stick, or the use of an Indwelling catheter could be used along with different exercise protocols such as using a treadmill protocol. Testing specific populations including children, older adults or sedentary individuals could also be a possible direction for further research. Investigators should feel confident proceeding with physiological, psychological and perceptual testing that incorporates blood lactate protocols. In Summary we were able to find that there is no significant differences between Trial A and Trial B for males or females in: VO2peak, HRpeak Total Test Time, or Ventilatory Breakpoint. There were also no significant differences in change score for perceptual and psychological variables. However, there was a significant difference in perceived intensity at the ventilatory breakpoint between Trial A and Trial B.

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