

THE NADIR IN SERUM GLUCOSE AS A PREDICTOR OF ANAEROBIC THRESHOLD

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Introduction

The existence and measurement of anaerobic threshold has been a controversial topic but remains a pivotal measure within exercise and sport science (Hollmann, 2001; Svedahl & Macintosh, 2003). Blood lactate measurements and ventilatory parameters have been the most widely used methods of anaerobic threshold determination and have been examined for reliability and validity (Wasserman et al, 1972; Bhambhani and Singh, 1980; Wasserman, 1984; Prud'homme et al, 1984). A method of threshold identification using blood glucose measurement has been supported as a possible alternative or addition to these established measures (Northius et al, 1995; Simoes et al, 1999; Simoes et al, 2003; Ribeiro et al, 2004). This glucose response to graded exercise follows the identification of a low point or nadir in blood concentration during exercise and has been shown to evaluate aerobic capacity as well as being related to the lactate and ventilatory thresholds (Simoes et al, 1999).

Objective

The purpose of this study is to investigate the response of serum glucose levels and the associated hormones glucagon, insulin and cortisol to incremental exercise. It was hypothesized that there is a nadir of serum glucose which occurs in a predictable fashion to anaerobic threshold. It was further hypothesized that the occurrence of glucose threshold would be mirrored by the increased concentration of glucagon and cortisol, and

decreased concentration of insulin to maintain euglycemia amidst the metabolic demands leading up to and beyond anaerobic threshold.

Design

Quasi-experimental design.

Setting

University of Alberta, Edmonton.

Subjects

Twenty-two healthy active males residing in the city of Edmonton volunteered to participate in this investigation. A healthy, active individual was defined as a person who participated in regular aerobic physical activity a minimum of 3 times a week and was free of conditions that may have impeded their metabolic function or their effort and performance during the graded exercise test. This study was approved by a University Research Ethics Board.

Intervention/Main Outcome Measures

The exercise testing involved three visits to the exercise physiology lab. One session for maximal oxygen consumption (VO_2 peak) testing, one for anaerobic threshold (AT) testing, and a third for a fasted blood sample. The peak VO_2 test was conducted first to also provide participants with experience to the testing environment. Between 2 and 5 days after the peak VO_2 test the participants returned to the lab in the rested state for the AT test. This test included blood samples taken at rest before exercise and in the last minute of each power output. Between 2 and 5 days

after the AT exercise test and the morning after an overnight fast, the participants returned on a different day to provide a fasting blood sample. The exercise testing was conducted on a cycle ergometer beginning at 74w and 75 rpm and increasing by 37w every 2 minutes in the VO₂ peak test and every 3 minutes in the anaerobic threshold test. Blood was analyzed for glucose, glucagon, insulin, cortisol and lactate.

Main Results

An identifiable nadir in serum glucose was observed in 20 of 22 participants. There was no significant difference between the workloads of lactate threshold and the nadir in serum glucose. There was a significant difference ($p < 0.05$) and a significant correlation with the nadir in serum glucose and ventilatory threshold, with the ventilatory measure being approximately one workload greater than the glucose measure. In hormone analysis, insulin was significantly lower and glucagon significantly higher after the nadir in serum glucose.

Conclusions

These observations support the nadir in serum glucose as a predictor of anaerobic threshold and also provide possible evidence for the hormonal mechanism of this association. It was concluded that during a graded exercise test a nadir in serum glucose does occur in predictable fashion to ventilatory threshold and thus, the exercise intensity of optimal serum glucose clearance may be identifiable.

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Commentary

Anaerobic threshold has been widely used as an indicator of aerobic fitness and as well as a marker for exercise training intensities. The most often used methods of threshold determination have been lactate and ventilatory measures with the use of glucose only recently being published. This study was performed in continuation of the previous research to provide further evidence of the relationship between glucose metabolism and anaerobic threshold and to provide new research on the hormones glucagon, cortisol and insulin related to the glucose threshold, as it had not been previously examined. The present findings agree with previous research in finding a relationship between the nadir in serum glucose and the anaerobic threshold. Further, the current findings suggest a possible hormonal mechanism for this association as insulin was significantly lower and glucagon significantly higher after the nadir in serum glucose. The significance these findings includes the further information for the research community, as well as support for the use of the glucose nadir as a possible alternative for anaerobic threshold determination in athletic populations.