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Effect of A Slow Ramp Rate on Exercise Testing: A Healthy Volunteer Study

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Abstract

Ramp rates for incremental ramp rate exercise testing are not standardised. The ramp rate may influence the values obtained during exercise testing. We compared a slow ramp rate (SR) (3watts/minute) to a fast ramp rate (FR) (20 watts/minute) in 8 fit non elite cyclists using cycle ergometry. We measured peak power ,oxygen consumption (VO2) at anaerobic threshold (AT) and maximum aerobic capacity (VO2 max). A lower mean peak work (369 Watts vs 406 watts, P=0.004), higher mean AT (42.1 ml/min/kg vs 38.6 ml/min/kg, p=0.16) , lower mean VO2 max (51.7 ml/min/kg vs 54 ml/min/kg p=0.25) and higher ratio of AT to VO2 max (0.82 vs 0.71 p = 0.03) were obtained using the SR protocol. These results suggest that ramp protocols need to be considered when interpreting exercise tests clinically. We would suggest standardising ramp test protocols..

Keywords: Anaerobic threshold; Exercise testing; Ramp rate; Maximum aerobic capacity

Introduction

Submaximal exercise testing is now used routinely to assess fitness for surgery. The anaerobic threshold determined by expired gas analysis during ramped exercise predicts surgical morbidity and mortality [1]. Cycle ergometry with a ramped protocol is typically used but there is little standardisation of protocols. A comparison between 20,30,50 and 100 watts per minute increments [2] showed no difference in anaerobic threshold and VO2 max but lower ramp increments were not tested. In another study comparing 10,30 and 50 watts per minute anaerobic threshold was unchanged but "VO2 peak" was reduced with a 10 watts per minute protocol [3]. Using a running treadmill test V Vucetić et al. [4] showed differences in peak running speed using different ramp rates but no difference in VO2max or AT. Ramp rates of 6 watts per minute and 12 watts per minute have been compared using arm crank ergometry, yielding higher end exercise lactate and VCO2 [5,6]. To date ramp rates below 10 watts per minute have not been compared using cycle ergometry. We investigated the difference between a 3 watts per minute and 20 watts per minute in healthy volunteers.

Methods

Participants

8 non-elite experienced cyclists were tested on two occasions using cycle ergometry. The subjects were all experienced non-competitive cyclists with a mean age of 40 years, mean height 180 cm and mean weight 77kg. The study was approved by the Local Research and Ethics Committee.The study was performed in accordance with the Declaration ofHelsinki and the Ethical Standards in Sport and Exercise Science Research [7]. Subjects were asked to refrain from strenuous exercise in the 24 hours prior to each test. Tests were carried out in random order with a minimum of 3 days interval.Subjects were blinded to the study protocols.

Protocol

Tests were carried out on a Zan 200 metabolic cart (NSpire). Subjects were monitored throughout with continuous ECG and pulse oximetry. Subjects warmed up for 3 minutes at 100 Watts and then started one of two incremental ramp tests. Fast ramp (FR) incremented at 20 watts/ minute and Slow Ramp

(SR) incremented at 3 watts/minute. Twenty minutes into the SR subjects were allowed to drink briefly whilst continuing to exercise. Tests continued until subjects were unable to continue due to exhaustion.

All data were analysed off line by a clinician experienced at interpreting exercise tests, blinded to the study protocol. The "V-slope" method was used to determine anaerobic threshold.

Statistical analysis

The results are expressed as mean (+/- standard deviation). All calculations were carried out in an Excel Spreadsheet with internal statistical package. Atwo-tailed paired t test was used to compare differences between means for AT, VO2 max and the ratio of AT to VO2 max. P values are quoted with significance assumed to be a P value less than 0.05.

Results

Maximum power was significantly higher for FR than for SR. Mean AT was lower for FR (37.6 (7.1) ml/min/kg) than the slow ramp (43.1 (4.2) ml/min/kg) (p= 0.07). Conversely mean VO2 max was higher for the fast ramp (54.6 (3.2) ml/min/kg) than the slow ramp (52.6 (4.3) ml/min/kg) (p=0.28). Mean ratio between AT and VO2 max was significantly lower for the slow ramp (9.46 (3.9) than the fast ramp (16.9 (6.52) (p = 0.02).

Discussion

Our study showed that a slow ramp rate (3 watts/minute) gave significantly different results for peak power and the ratio of anaerobic threshold to VO2max compared to faster ramp (20 watts / minute).

We showed a non-significant reduction in VO2 max for the slower ramp which confirms the findings of Weston at 10 watts/ minute [3]. Our anaerobic threshold appeared higher (non-significant) in contrast with others [2,3]. Using arm ergometry there was no difference in VO2 peak but a higher VCO2 at VO2 peak [5,6]. We showed a significant difference in the ratio of AT to VO2 using a slow ramp test. We used a very slow ramp (3 watts per minute) which has not been previously tested. This very slow ramp rate has two potential effects which higher ramps may not achieve. Our subjects exercised for 40 minutes allowing them to potentially "warm up" effectively but also allowing them to potentially fatigue by the end of the test. We are undertaking further research to determine if a long sub maximal "warm up" prior to testing accounts for the differences seen. Our subjects were relatively young fit experienced cyclists. Further research would be required to quantify these changes in older less fit subjects. For clinical testing using cardiopulmonary testing the values obtained may be used to guide treatment or surgery. Ramp rates may need to be adjusted objectively to standardise interpretation of results.

Summary

Our study has shown that the ramp rate used during exercise testing can influence the values obtained. Clinical use of cardiopulmonary exercise testing should be standardised as it may influence the values and hence surgical risk prediction.

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