BOOK OF ABSTRACTS **Open Access**

A contiguous ramp and all-out exercise test to determine critical power in competitive cyclists

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Abstract

Background: Critical power (CP) represents the highest metabolic rate at which oxygen uptake and blood lactate stabilizes during exercise and is strongly associated with endurance exercise performance. Determination of CP typically requires the completion of two to five constant power tests to exhaustion (TTE). An alternative test involves measurement of mean power during the final 30 s of a single 3-minute all-out cycling test, and this test agrees well with CP (Vanhatalo *et al.,*2007: Medicine and Science in Sports and Exercise, 39, 548-555). However, the 3-minute all-out test requires a preliminary Ramp test to determine the ergometer settings for the subsequent CP assessment.

Purpose: To quantify the reliability of a single contiguous Ramp and 3-minute All-Out test (RAO), and to appraise validity relative to CP determined from serial TTE tests.

Methods: All participants provided written informed consent prior to participation, tests were separated by 2 – 7 d, and studies by 6 – 12 months. Reliability study: Four male triathletes, six male and one female road cyclist ($\dot{V}O_{2peak}$ 4.32 ± 0.70 L·min^{-1}) completed two RAO (RAO 1 & 2) cycle ergometer tests (Lode Excalibur Sport, Groningen, The Netherlands). The RAO was a contiguous 5-min warm up at 50 W, a ramp-incremental (30 W·min^{-1}) to exhaustion, and a 3-min all-out exercise test. Exhaustion was defined as a cadence ≤ 50 rpm. The ergometer resistance during the AO phase was defined prior to exercise using: (body mass (kg) x 3.5) / 85^2. Cadence and duration was withheld during the AO phase. Validity study: Five triathletes and two road cyclists ($\dot{V}O_{2peak}$ 3.96 ± 0.53 L·min^{-1}) completed the RAO before and after a series of at least four constant power TTE designed to elicit exhaustion between ~ 3-15 min. For TTE tests the asymptote (CP) and curvature constant (W´) of the power-duration relationship were quantified using 2-parameter nonlinear regression models. For RAO tests the estimated CP (ECP) was calculated as the mean power output over the final 30 s of the RAO, and estimated W´ (EW´) was calculated as the power-time integral above ECP during the RAO. Statistics: Data are reported as mean, standard deviation. Data was appraised using a repeated measures general linear model for quantification of bias and typical error (TE). The relationship between protocols was quantified using coefficient of variation (CV).

Results: Reliability study: ECP in RAO1 (289, 38 W) and RAO2 (292, 41 W) were not different (*P* = 0.24, TE 7 W, mean bias of 4 ± 19 W). ECP between repeats were very strongly related (CV 2%). EW´ in RAO1 (12.6, 3.4 kJ) and RAO2 (12.0, 4.2 kJ) were not different (*P* = 0.49, TE 2.0 kJ, mean bias of -0.6 ± 5.5 kJ), and were related (CV 13%). Validity study: Durations of TTE ranged from 170 (34) to 861 (202) s. A 5 W (1.8%) standard error was associated with the estimate of CP using the 2-parameter model. ECP (280, 36 W) was not different to CP (279, 34 W; *P* = 0.95, TE 10 W). Comparisons revealed a mean bias of 1 ± 27 W, (CV 3%). EW´ (17.1, 3.4 kJ) was not different to W´ (15.8, 2.8 kJ; *P* = 0.461, TE 1.8 kJ, mean bias of -1.35 ± 8.9 kJ), EW´ and W´ were related (CV 14%).

Discussion: The RAO test parameters were sufficiently reliable for use in future studies. Similar to previous studies investigating alternative methods for power-duration curve estimation, the reproducibility of ECP was small (CV 2%), but EW´ was wider (13%). The mean difference between parameter estimates of CP and W´ using the traditional TTE test and single RAO test was negligible. The limits of agreement between the CP estimate derived from a series of maximal constant power TTE tests and the single test RAO protocol were moderately wide (27 W) but similar to previous reports of AO-exercise strategies for CP estimation.

Conclusion: The CP and W´ estimates from a single test were similar to traditional testing methods that require multiple maximal exercise tests. Therefore, the RAO test may simplify CP estimation in competitive cyclists.

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