BOOK OF ABSTRACTS **Open Access**

Changes in whole body and local muscle oxygen consumption during prolonged cycling

C O'Grady [1] ✉, B Pageaux [1] and JG Hopker [1]

Abstract

Background: Cycling efficiency is a measure of the power output to power input and is a key determinant of cycling performance (Hopker et al., 2013: Journal of Applied Physiology, 115, 723-729). However, the determinants of cycling efficiency are yet to be fully elucidated. Past research has demonstrated that the majority of energetic cost that arises from endurance exercise can be attributed to the exercising muscle (Poole et al., 1992: Journal of Applied Physiology, 72, 805-810), however cycling efficiency is commonly determined by measuring pulmonary oxygen consumption.

Purpose: This study aimed to investigate whether cycling efficiency calculated from pulmonary oxygen uptake was reflective of indices of local muscle oxygenation and oxygen consumption measured by near-infrared spectroscopy.

Methods: Thirteen competitive cyclists (30 ± 14 years, 173 ± 10 cm, 73 ± 2 mL.kg-1.min-1) performed a 120-minute bout of steady state cycling at 60 % maximum minute power (MMP), determined from a preceding maximal incremental exercise test performed on a separate occasion. Measurements of expired air were taken at minute 5 and then every 30 minutes throughout the rest of the steady state trial. Power input was calculated from the measured VO2 and its energetic equivalent according to the nonprotein respiratory quotient. Power output was recorded as the average power output over the gas collection time. Cycling Gross Efficiency (GE) was calculated as the product of work accomplished / energy expended x 100%. Near-infrared spectroscopy was used to assess the Tissue Saturation Index (TSI%), oxygenated hemoglobin (O2Hb), deoxygenated hemoglobin (HHb), total hemoglobin (tHb) and muscle oxygen consumption (mVO2) of the Vastus Lateralis muscle. NIRS measurements were taken at the same time as sampling of expired gases. To normalize the concentration changes in the NIRS signal, a 2-minute resting baseline was recorded prior to the cycling bout, which was then subtracted from all the NIRS measurements (except TSI%). Data were analysed using repeated measures ANOVA to assess changes over time.

Results: As shown in Figure 1, GE significantly decreased over the duration of the steady state cycling trial ($p=0.002$), as did TSI% ($p<0.001$). O2Hb increased over time, but this was not significant ($p=0.332$). Both HHb and tHb significantly increased over time ($p<0.01$). There was a mean increase in mVO2 over the first 30 minutes of exercise, but then a progressive decrease for the remaining 90 minutes of the trial. However changes were not significant ($p=0.289$).

Discussion: Tissue oxygenation of the Vastus Lateralis muscle significantly reduced over the 2-hour bout of cycling, which was mirrored by reductions in GE. The largest reductions in TSI% and GE occurred during the first 30 minutes of the trial, which is also reflected in the HbO2 concentration. tHb increased over the 2-hours cycling suggesting increased central delivery to the working muscle in an attempt to maintain the level of oxygen availability to the working muscle. However, it can be seen from the TSI(%) and mVO2 that tissue oxygenation and muscle oxygen consumption both decline over the 2–hour period of cycling.

Conclusion: Reductions in muscle tissue oxygenation and mVO2 during 2-hours of cycling at mirrored by GE calculated from whole body oxygen consumption.

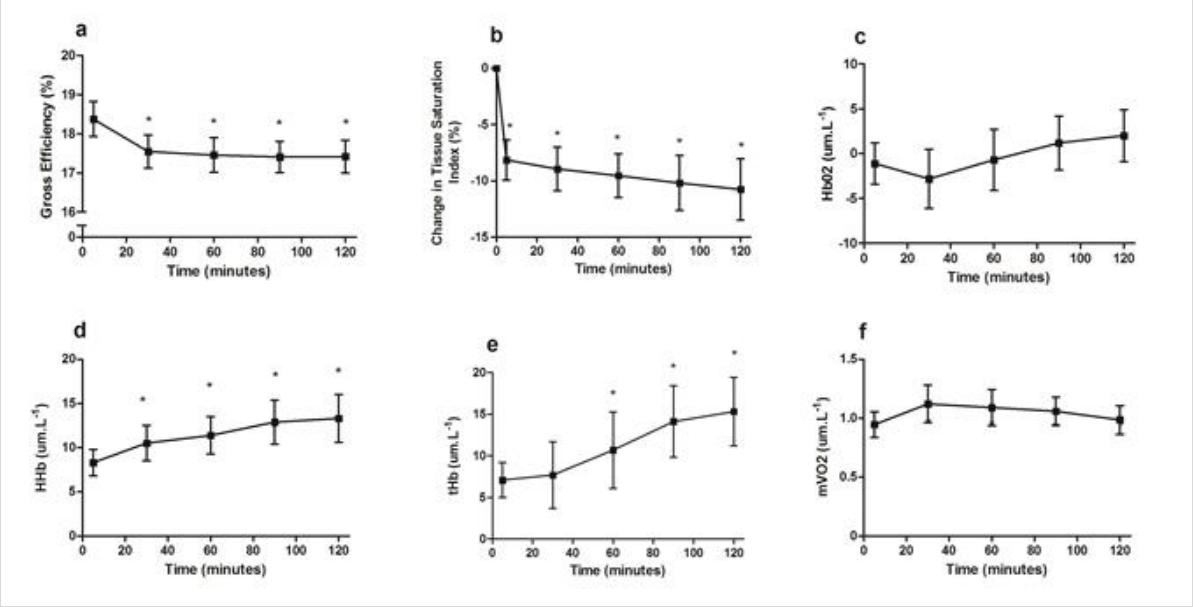

*Figure 1: Changes in (a) GE%, (b) TSI%, (c) HbO2 (uM.L), (d) HHb (uM.L), (e) tHb (uM.L), (f) mVO2 (uM.L) during 120 minutes of cycling at 60% MMP. *significant change from minute 5 ($p<0.05$).*

✉ **Contact email:** *ogradyc01@gmail.com* (C O'Grady)

[1] Endurance Research Group, School of Sport and Exercise Sciences, University of Kent, United Kingdom

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