

## Muscle deoxygenation kinetics in cycling time trial

Peter Leo, Matthias Hovorka, Bernhard Prinz, Alfred Nimmerichter

Training and Sports Sciences, University of Applied Sciences, Wiener Neustadt, Austria

**Keywords:** cycling time trial, muscle deoxygenation kinetics, NIRS

**Background:** Concentration changes of oxygenated and deoxygenated hemoglobin ( $O_2Hb$  and  $HHb$ ) measured by near infrared spectroscopy (NIRS) provides information about oxygen delivery and extraction at the muscular level. The kinetic response of  $HHb$  reflects the adjustment of the oxidative metabolism in skeletal muscle and could therefore be related to exercise tolerance (see Figure 1).

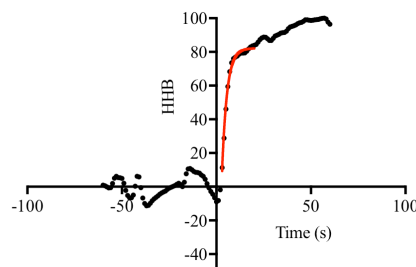


Figure 1: Muscle deoxygenation kinetics of deoxyhemoglobin during the 4-minute cycling time trial

While most studies used laboratory cycling to investigate the kinetic responses, the effect of cycling time trials in field conditions remains to be shown. Therefore, the aim of this study was to investigate changes in  $HHb$  during maximal effort cycling time trials in field conditions.

**Methods:** Thirteen trained cyclists and triathletes ( $N=13$ ; mean  $\pm$  SD: age  $32 \pm 7$  years; body mass  $74.6 \pm 7.4$  kg; stature  $182 \pm 5$  cm; maximum oxygen uptake  $67.9 \pm 3.0$  mL $\cdot$ min $^{-1}\cdot$ kg $^{-1}$ ; maximal power output  $406 \pm 39$  W), completed 3 cycling time trials lasting 10, 4 and 1 min on a flat road, interspersed by a 30 min recovery period after each trial. Relative changes in  $HHb$  were recorded on the right vastus lateralis muscle with a portable continuous-wave NIRS device. Second-by-second data normalised to 100% of the response were used to resolve the amplitude, the time delay and the time constant by nonlinear regression. A repeated-measure ANOVA was used to compare the parameter estimates across the time trial durations.

**Results:** The mean power output during the 10-, 4- and 1- minute cycling time trials was  $352 \pm 45$ ,  $385 \pm 49$  and  $525 \pm 73$  W, respectively ( $p=0.001$ ). No significant differences were observed for cadence during the 10- vs. 1-minute cycling time trials ( $p=0.264$ ), however significant differences were observed between 4- vs. 1-minute ( $p=0.05$ ). The parameter estimates of the kinetic response were significantly affected by time trial duration. The amplitude for 10- vs. 1- minute ( $78.20 \pm 8.42$  vs.  $89.16 \pm 6.82$ ;  $p = 0.022$ ) as well as for 4- vs.

1-minute ( $74.99 \pm 6.12$  vs.  $89.16 \pm 6.82$ ;  $p = 0.006$ ) cycling time trial duration showed significant differences (see Figure 2).

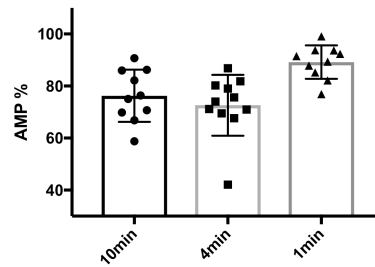


Figure 2: Individual amplitude (AMP) responses during the 10-, 4- and 1-minute cycling time trials (mean  $\pm$  SD; 95 % confidence intervals)

Moreover, significant effects can be reported for the 10- vs. 1-minute time delay parameter ( $9.54 \pm 2.07$  s vs.  $3.65 \pm 1.71$ s;  $p = 0.001$ ). Mean response time also demonstrated significant differences for 10- vs. 1-minute cycling time trials ( $13.45 \pm 2.39$  s vs.  $6.85 \pm 1.90$  s;  $p = 0.001$ ). No significant differences were reported for the time constant among the different cycling time trial durations ( $p > 0.05$ ).

**Discussion:** These findings support that the physiological response to high intensity exercise during multiple cycling time trial durations could be monitored by alterations in muscle deoxygenation kinetic parameters. Furthermore, these results imply that changes at the microvascular level are time dependent when exposed to maximal exhaustion. However further research is recommended to support these findings of muscle deoxygenation kinetics during cycling time trial in field conditions.