Effect of inorganic nitrate supplementation on $O_2$ uptake kinetics and exercise tolerance: influence of muscle oxygenation

Abstract
We tested the hypothesis that inorganic nitrate ($NO_3^-$) supplementation would improve muscle oxygenation, oxygen uptake ($\dot{V}O_2$) kinetics and exercise tolerance ($T_{lim}$) in normoxia and that these improvements would be augmented in hypoxia and attenuated in hyperoxia. In a randomized, cross-over study, ten healthy males completed work-to-work step cycle tests to exhaustion following acute consumption of 210 mL $NO_3^-$-rich beetroot juice (BR; 18.6 mmol $NO_3^-$) and $NO_3^-$-depleted beetroot juice placebo (PL; 0.12 mmol $NO_3^-$). These tests were completed in normobaric normoxia (FIO2: 21%), hypoxia (FIO2: 15%) and hyperoxia (FIO2: 40%). Pulmonary $\dot{V}O_2$ and quadriceps tissue oxygenation index (TOI), derived from multi-channel near-infrared spectroscopy, were measured during all trials. Plasma [nitrite] was higher in all BR compared to all PL trials ($P<0.05$). Quadriceps TOI was higher in normoxia compared to hypoxia ($P<0.05$) and higher in the hyperoxia compared to hypoxia and normoxia ($P<0.05$). $T_{lim}$ was improved after BR compared to PL ingestion (250 ± 44 vs. 231 ± 41 s), with the magnitude of improvement being negatively correlated with quadriceps TOI at exhaustion ($r = -0.78$), in the hypoxic trials ($P<0.05$). $T_{lim}$ tended to be improved with BR in normoxia (BR: 364 ± 98 vs. PL: 344 ± 78 s; $P=0.087$), but was not improved in hyperoxia (BR: 492 ± 212 vs. PL: 472 ± 196 s; $P>0.05$). BR ingestion increased peak $\dot{V}O_2$ in hypoxia ($P<0.05$), but not normoxia or hyperoxia ($P>0.05$). Therefore, $NO_3^-$ supplementation is more likely to improve $T_{lim}$ and peak $\dot{V}O_2$ as skeletal muscles become increasingly hypoxic.

Key Words: nitric oxide; vascular function; oxidative metabolism; exercise performance; fatigue; near-infrared spectroscopy