Convective and diffusive O₂ transport components of peak oxygen uptake following long-duration spaceflight

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Spaceflight reduces aerobic capacity and may be linked with maladaptations in the O₂ transport pathway. The aim was to 1) evaluate the cardiorespiratory adaptations following 6 months aboard the International Space Station and 2) model the contributions of convective (\( \dot{Q}_{O_2} \)) and peripheral diffusive (\( \dot{D}_{O_2} \)) components of O₂ transport to changes in peak O₂ uptake (\( \dot{V}_{O_2}^{PEAK} \)).

To date, 1 male astronaut (XX yrs) completed an incremental exercise test to measure \( \dot{V}_{O_2}^{PEAK} \) prior to and 2 days post-flight. Cardiac output (\( \dot{Q} \)) was measured at three submaximal work rates via carbon dioxide rebreathing. The \( \dot{Q}:\dot{V}_{O_2} \) relationship was extrapolated to \( \dot{V}_{O_2}^{PEAK} \) to determine \( \dot{Q}^{PEAK} \). Hemoglobin concentration was measured at rest via a venous blood sample. These measurements were used to model the changes in \( \dot{Q}_{O_2} \) and \( \dot{D}_{O_2} \) using Fick’s principle of mass conservation and Law of Diffusion as established by Wagner and colleagues (Annu. Rev. Physiol. 58: 21-50, 1996 and J. Appl. Physiol. 73: 1067-1076, 1992). \( \dot{V}_{O_2}^{PEAK} \) decreased post-flight from 3.72 to 3.45 l min⁻¹, but \( \dot{Q}^{PEAK} \) increased from 24.5 to 27.7 l min⁻¹. The decrease in \( \dot{V}_{O_2}^{PEAK} \) post-flight was associated with a 21.2% decrease in \( \dot{D}_{O_2} \), an 18.6% decrease in O₂ extraction, but a 3.4% increase in \( \dot{Q}_{O_2} \). These preliminary data suggest that long-duration spaceflight reduces peripheral diffusing capacity and that it largely contributes to the post-flight decrease in aerobic capacity.