

授与機関名 順天堂大学

学位記番号 甲第 25 号

Influence of Muscle Fibre Composition on Muscle Oxygenation during Maximal Running

(筋線維組成が最大走運動中の筋酸素化に及ぼす影響)

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Abstract

Near-infrared spectroscopy (NIRS) is a non-invasive method for measuring the oxygenated (oxy) and deoxygenated (deoxy) forms of haemoglobin (Hb) and myoglobin (Mb) within the microvasculature, which enables evaluation of muscle oxygenation in local tissues. Typically, oxy-Hb/Mb (muscle oxygenation) is influenced by blood flow and decreases if the oxygen supply is below oxygen consumption as during high-intensity exercise. If slow-twitch fibres have superior oxygen supply capacity than fast-twitch fibres, muscle oxygenation would be influenced by muscle fibre composition. However, the relationship between muscle oxygenation and muscle fibre composition remains unclear.

This study aimed to investigate the relationship between muscle oxygenation during maximal running and muscle fibre composition.

Eight male runners ($\dot{V}O_{2\max}$: $60.9 \pm 4.6 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) performed an incremental running test on a treadmill. Muscle oxygenation of the vastus lateralis was measured with a portable NIRS device during the run and was quantified by correcting for the skinfold thickness for inter-subjects comparison. Muscle fibre composition was determined through muscle biopsy. The biopsy samples were taken from the same regions that were measured with NIRS. The sum of type I and type IIa fibres was defined as oxidative muscle fibres.

Muscle oxygenation was the lowest at exhaustion in all subjects. The percentage of type I ($r = 0.755$, $p < 0.05$) or oxidative muscle fibres ($r = 0.944$, $p < 0.01$) were positively correlated with muscle oxygenation at exhaustion.

We conclude that a greater ratio of oxidative muscle fibres leads to a higher level of maintaining muscle oxygenation during maximal running; additionally, muscle fibre composition may be able to noninvasively be estimated from muscle oxygenation during the run.