

前腕部の繰り返し冷却に伴う ハンドグリップ運動時骨格筋酸素動態の適応

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Adaptation in Oxygen Consumption of Hypothermic Skeletal Muscle During Handgrip Exercise after Repeated Forearm Tissue Cooling

by

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ABSTRACT

This study aimed to investigate the effect of repeated local forearm tissue cooling on the metabolism in hypothermic skeletal muscle. It is hypothesized that repeated decrease of muscle temperature increases the oxygen consumption in hypothermic skeletal muscle. Eight healthy males participated in this study. Their right forearm tissues were locally cooled to 25°C by cooling pads attached to the skin. This local cooling was repeated eight times on separate days. To evaluate adaptation in non-shivering thermogenesis in skeletal muscle, local cooling test was conducted at pre and post the repeated cooling period. The muscle oxygenation (oxy- and deoxy-hemoglobin) during 25-second isometric handgrip (10% maximal voluntary construction) was measured by Near-infrared spectroscopy every 2°C reduction in the forearm tissue temperature. The arterial blood flow was occluded for 15 seconds by upper arm cuff inflation during the isometric handgrip. The oxygen consumption in the flexor digitorum muscle was evaluated by a slope of the oxy- and deoxy-hemoglobin difference during the arterial occlusion. In both test experiments the skeletal muscle oxygen consumption decreased significantly depending on the muscle temperature reduction ($P < 0.05$). The oxygen consumption in hypothermic skeletal

muscle was significantly higher at post local cooling test than pretest over the range of tissue temperature 35 to 31°C ($P<0.05$). This result indicated that repeated local tissue hypothermia and suppression of muscle oxygen consumption might facilitate non-shivering thermogenesis in the skeletal muscle. In summary, non-shivering thermogenesis in hypothermic skeletal muscle in human was facilitated after repeated local tissue cooling.

要 旨

本研究は、前腕部を局所的に繰り返し冷却し、組織冷却下でのヒト骨格筋の非震え代謝に見られる適応現象を検討した。8名の成人男性が本研究に参加した。右前腕部を組織温度が25°Cに達するまで、別日に合計8回繰り返し冷却した。冷却期間前後に、同様の方法で冷却された前腕部組織代謝の適応現象を評価した。組織温度を熱流補償法により測定し、2°C低下毎に最大下等尺性掌握運動を行い、その間の15秒間動脈阻血した。近赤外線分光法により測定した阻血時の指屈筋酸素動態の変化から、骨格筋酸素摂取指標を算出した。その結果、繰り返し冷却期間前後とも、組織温度の低下に伴い有意に指屈筋の酸素摂取指標が低下した ($P<0.05$)。冷却期間後において、指屈筋の酸素摂取指標が組織温度35～31°Cの範囲で冷却期間前よりも有意に高値を示した ($P<0.05$)。本研究の結果から、前腕部組織の局所的な繰り返し冷却により、ヒト骨格筋における非震え代謝が亢進する適応現象が示された。