

運動による糖代謝活性化の分子機構に基づいた 新しい運動プログラムの開発

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Development of a New Exercise Program Based on the Molecular Mechanism of Exercise-Stimulated Glucose Metabolism

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ABSTRACT

Recent studies have shown that the 5'AMP-activated protein kinase (AMPK) is an important signaling intermediary leading to exercise-induced activation of muscle glucose utilization. We determined the effects of exercise on isoform-specific AMPK activity ($\alpha 1$ and $\alpha 2$) in human skeletal muscle. Needle biopsies of vastus lateralis muscle were obtained from seven healthy subjects at rest, after 20 and 60 min of cycle ergometer exercise at 70 % of $\dot{V}O_{2max}$, and 30 min following the 60 min exercise bout. In comparison to the resting state, AMPK $\alpha 2$ activity significantly increased at 20 and 60 min of exercise, and remained at a higher level with 30 min of recovery. In contrast, AMPK $\alpha 1$ activities were at basal levels at 20, 60 min of exercise and 30 min of recovery. The same subjects exercised for 20 min at 50 % of $\dot{V}O_{2max}$. Exercise at this

intensity did not change $\alpha 2$ activity, and similar to exercise at 70 % of $\dot{V}O_{2max}$, there was no significant change in all activity. These results suggest that the $\alpha 2$ -containing AMPK complex, rather than $\alpha 1$, may be involved in the metabolic responses to exercise in human skeletal muscle, and that the exercise intensity more than 50 % $\dot{V}O_{2max}$ may be required to activate AMPK $\alpha 2$. Studies should be performed to develop an exercise program that efficiently activates AMPK $\alpha 2$ -and thereby results in improved glucose metabolism.

要 旨

近年, 5'AMP-activated protein kinase (AMPK) が運動による骨格筋の糖代謝活性化にかかわるシグナル伝達分子であることが示唆されている. 本研究では, 運動がヒト骨格筋の AMPK 活性に与える影響を AMPK のアイソフォーム別 ($\alpha 1 \cdot \alpha 2$) に検討した. 7名の健常人に対して 70% $\dot{V}O_{2max}$ の強度で 60 分間の自転車運動を行い, 安静時, 運動開始 20 分後, 60 分後, 運動終了 30 分安静後に外側広筋の針生検を行った. 安静時に比して運動開始 20 分後と 60 分後で AMPK $\alpha 2$ 活性が顕著に亢進するとともに, 運動終了 30 分後も高値を維持した. AMPK $\alpha 1$ 活性は安静時と変化がなかった. 同じ被験者において 50% $\dot{V}O_{2max}$ の強度で 20 分間運動を行ったが AMPK $\alpha 2$, $\alpha 1$ ともに活性の変化を認めなかった. 以上より, AMPK $\alpha 2$ がヒト骨格筋の運動時の糖代謝促進に関与すること, そして, AMPK $\alpha 2$ を有効に活性化するためには 50 % $\dot{V}O_{2max}$ を超える運動強度が必要であることが示唆された. 今後, 糖代謝改善のための運動処方として効率よく AMPK $\alpha 2$ を活性化させる運動方法を明らかにすることが重要と考えられた.