

筋温上昇による熱ショックタンパク質発現と 筋損傷・筋肉痛の予防効果

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Protective Effect of Increased Muscle Temperature to Induce Heat Shock Proteins on Muscle Damage and Muscle Soreness

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ABSTRACT

This study investigated the hypothesis that eccentric exercise-induced muscle damage would be attenuated in muscles subjected to passive hyperthermia to a level where heat shock proteins (HSPs) were produced. Eleven male students performed a bout of 24 maximal eccentric actions of the elbow flexors of one arm, and the opposite arm performed the same exercise 2-4 weeks later. One day prior to the exercise, the elbow flexors of one arm received microwave diathermy treatment resulting in muscle temperature elevation from 33-35 °C to 40-42 °C. The contralateral arm acted as an untreated control. Maximal isometric force (MIF), range of motion (ROM), upper arm circumference, muscle soreness with palpation, extension (SORE), and flexion, plasma creatine kinase and aldolase activity, and myoglobin concentration were measured one day prior to exercise, immediately pre- and post-exercise, and then daily for 4 days. The control arm repeated a second bout of the same exercise 4-6 weeks after the first. Changes in the criterion measures were compared between conditions (treatment vs control), or between bouts (first vs second for the control arm) by a repeated measures ANOVA. Significance level was set at

$P < 0.05$. The hyperthermia treatment had no short-term effects on muscle function prior to the exercise bout and force output and total work during exercise were not significantly different between treatment and control arms. All measures changed significantly following exercise, but the treatment arm showed significantly smaller decreases in MIF and ROM after exercise, and significantly smaller development of SORE compared to the control arm. However, these attenuation effects were not as strong as those observed following the second bout in the control arm. No significant differences between conditions were shown for other measures. These results demonstrate that elevation of muscle temperature one day prior to eccentric exercise was effective in reducing muscle damage to some extent. Although HSPs may play some role in the repeated bout effect, it is likely that other also contribute to this phenomenon.

要 旨

あらかじめ筋温を上昇させておいた筋では、伸張性筋活動に伴う筋損傷・筋肉痛が抑制され、回復も早まるという仮説を検討することを目的とした。被験者（ $n=11$ ）は上腕屈筋群が最大筋力発揮下で肘関節屈曲位から伸展位に15秒に1回、24回繰り返し強制的に引き伸ばされる伸張性筋運動を2～4週間の間隔をおいて、右腕、左腕それぞれで行った。一方の腕では、運動実施1日前に、上腕屈筋群に極超短波を20分間照射し、筋温を41度程度まで上昇させた（T条件）。他方の腕では筋温上昇を行わずに運動を実施した（C条件）。運動に伴う、等尺性最大筋力（筋力）、肘関節可動域（ROM）、筋肉痛などの運動前から運動直後ならびに1～4日後の変化を、二元分散分析を用いて両条件間で比較した。運動直後の筋力低下率はC条件に比べT条件で有意に小さく、回復もT条件で有意に早かった。ROMの減少もT条件で有意に小さく、筋肉痛の程度もT条件で有意に低かった。筋温上昇によって熱ショックタンパク質が発現し、伸張性筋活動の損傷刺激を減弱させた可能性が考えられる。