HYPERTHERMIA, EXERCISE AND CENTRAL FATIGUE IN HUMANS

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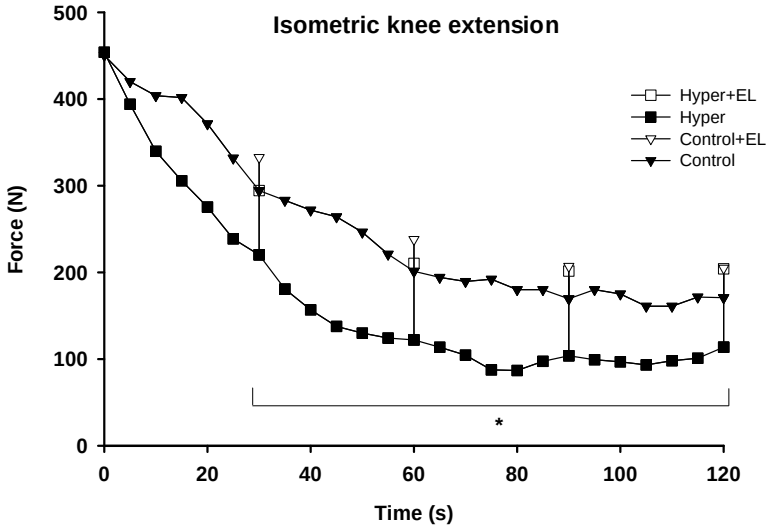
The mechanism(s) underlying hyperthermia-induced fatigue resulting from prolonged exercise in hot environments, is not well understood. Oxygen consumption, muscle blood flow and brief maximal voluntary contraction force (MVC) are similar in hyperthermic and normothermic athletes. Furthermore, neither the small increase in muscle glycogen breakdown, lactate production nor potassium release can explain the early fatigue with hyperthermia (Nielsen *et al*.1993, Parkin *et al.* 1999). This study tested the hypothesis that "central fatigue" is a major factor associated with hyperthermia-induced fatigue. Seven endurance trained men [VO_{2max} 65±2 ml min^{-1} kg^{-1}(mean ± SE)] exercised at 60% VO_{2max} on a cycle ergometer in a hot (40°C;18% rh; hyperthermia) and in a thermoneutral environment (18°C; 48% rh; control). In the hyperthermic trial, the oesophageal temperature increased throughout the exercise period reaching a peak value of 39.9±0.1°C at exhaustion after 48±4 min of exercise. In the control trial, exercise was continued for 1 h without signs of fatigue with a stable core temperature of ~38.0±0.1°C. Immediately after the cycle trials, subjects performed 2 min of sustained maximal isometric knee extension (MVC). During MVC electrical stimulation (250 ms square wave, EL) was delivered every 30 s to *n. femoralis*, in order to assess the degree of voluntary activation.

Results: MVC was similar during the first 5 s of contraction (454±38 N in hyperthermia vs. 450±48 N in control). Hereafter the force declined in both trials, but the reduction in MVC was more pronounced in the hyperthermic trial, and significantly lower from 30 s to the end of the contraction in hyperthermia compared to control (see the Figure). Calculation of the voluntary activation percentage (MVC/MVC+EL) showed that voluntary activation was markedly lower in hyperthermia (54±7%) compared to control (82±6%). In contrast, total force of the knee extensors (MVC+ force from EL) was not different in the hyperthermic and control trial (see the Figure).

Conclusion: These data demonstrate that hyperthermia results in a reduced force development during prolonged maximal isometric contractions, and the attenuated performance is associated with a "central fatigue" - i.e. reduced voluntary activation.



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