

Impact of acute and prolonged cooling on skeletal muscle force in young males

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INTRODUCTION:

In athletes, exposure to cold during winter sports may impair physical performance. Severe muscle cooling appears to reduce maximal force and induces a shift towards a slower contractile profile. However, whether moderate muscle cooling and the duration of cooling affect muscle contractile profile (assessed from electrically evoked torque at low and high frequencies) and maximal voluntary force (isometric and isokinetic contractions) remains to be clarified. Therefore, the aim of this study was to investigate the impact of acute and prolonged cooling on electrically evoked torque and maximal voluntary contraction torque in young males.

METHODS:

Twelve active males (27.2 ± 6.6 years old) were recruited for this study, consisting of 2 phases: acute and prolonged exposures. During each phase, participants were randomly exposed to cold water immersion (CWI, 10°C , up to the iliac crest) or passive resting (PR). Exposure to CWI was either continuous during 45min (acute CWI, A-CWI) or intermittent during a period of 300min [prolonged CWI (P-CWI) including immersions between baseline to 45min, 165 to 180min, and 255 to 270min]. Muscle (T_{mu} , average across 1, 2 and 3cm depth) and rectal (T_{rec}) temperatures were assessed using thermo-sensors. Transcutaneous electrical stimulation of the quadriceps muscle was performed to determine torques at low (20 Hz: P20) and high (100 Hz: P100) frequencies, and P20/P100 ratio was calculated. Maximal voluntary isometric torque of the knee extensors (MVIC), as well as peak isokinetic torques ($90^{\circ}/\text{s}$) of knee extensors (KE-IsoC) and flexors (KF-IsoC) were determined. Neuromuscular tests were performed at baseline (BL) and 60min after BL during acute exposure, and at BL, 60, 90, 150 and 300min after BL during prolonged exposure.

RESULTS:

T_{rec} did not change after A-CWI while it was reduced ($0.8 \pm 0.4^{\circ}\text{C}$, $p < 0.001$) after P-CWI compared to BL. T_{mu} decreased during A-CWI and P-CWI compared to BL ($6.1 \pm 2.2^{\circ}\text{C}$ and $4.6 \pm 1.1^{\circ}\text{C}$, respectively, $p < 0.001$), with larger reduction of T_{mu} after A-CWI than P-CWI ($p < 0.05$). P20 was not affected by the conditions. P100 was lower after 60min in A-CWI and P-CWI compared to PR ($p < 0.05$). After the last bath (60min in A-CWI and 300min in P-CWI), P100 was nearly significantly higher in A-CWI than P-CWI ($p = 0.05$). P20/P100 was higher after 60min in A-CWI and P-CWI compared to PR ($p < 0.001$), but this ratio was lower in P-CWI than A-CWI after the last bath ($p < 0.05$). MVIC torque remained unchanged during A-CWI and P-CWI, while KE-IsoC and KF-IsoC torques were similarly reduced after A-CWI and P-CWI compared to PR ($p < 0.05$).

CONCLUSION:

Moderate muscle cooling preferentially impairs maximal force production of dynamic contractions, but not isometric contractions, regardless of exposure duration. A shift towards a slower contractile profile (i.e., increased P20/P100) is more evident after A-CWI than P-CWI, which may be partially explained by a larger reduction of T_{mu} rather than the exposure duration or reduced T_{rec} .

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