Effect of creatine ingestion on muscle bioenergetics during intermittent maximal exercise: a $^{31}$P-NMR study

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Introduction

During high-intensity intermittent exercise, there is a decline in muscle power output related to a decrease in muscle phosphocreatine (PCr) during the first 10-s of a 30-s maximal exercise; PCr is almost completely depleted and yields ~50% of energy supply [1]. This important participation suggested that pre-exercise PCr may play a role in muscle power generation. Little is known about the dynamics of metabolism during all-out exercise and recovery, and few NMR studies have investigated the effect of creatine ingestion [2].

The present $^{31}$P-NMR study was designed to examine the effect of Cr ingestion on muscle power output and on muscle PCr resynthesis, during repeated brief bouts of maximal exercise.

Methods

Subjects.

Nine healthy males (24.1 ± 3.5 yrs, 178.8 ± 7.8 cm, 73.4 ± 9.6 kg) volunteered to participate in this study. All subjects gave their informed written consent to take part in the present study. The protocol was approved by the local Ethical Committee.

Exercise protocol

Subjects performed seven bouts of all-out dynamic plantar flexion. Each 8-s or 16-s bout of plantar flexion was performed as rapidly as possible against a resistance corresponding to 66% maximal isometric contraction. The experimental protocol was composed by a first session of five 8-s bouts (bout 1 to 5) interspersed by 0.5-min recovery, followed by bouts 6 (8-s) and 7 (16-s) separated by 1-min (R1) and 2-min (R2) recovery periods, respectively (Fig.1). Bout 7 was followed by 10 minutes of passive recovery (R10). The same protocol was repeated on a second occasion, just after Cr ingestion.

Results

Muscle power output.

The highest MPO (mean power output, expressed in Watts) was reached in the first bout (45.1 ± 8.8 vs. 46.3 ± 9.1 W after Cr ingestion, NS), after which there was a decline in MPO. After Cr ingestion, MPO was increased by ~10% (P < 0.05) during exercise bout 3 to 7. At the end of the first session, MPO's were 77 ± 6% before and 81 ± 8% (P < 0.01) after Cr ingestion. One minute after rest, MP06 was 81 ± 4% before and 86 ± 6% after Cr (P < 0.05). Two minutes of rest later, MP07 of 16-s bout was 77 ± 5% before and 81 ± 6% (P < 0.01) after Cr ingestion.

Correlation between power output and pre-exercise PCr concentrations

After creatine ingestion, resting PCr was increased by 15%. As expected, the first session of five bouts resulted in a marked fall in PCr in both situations, but PCr degradation was less after Cr ingestion (P < 0.05). During the 0.5-min recovery periods, PCr before bout 2, and before bout 5 were higher after Cr ingestion (P < 0.05).

Although there was no relation between MP06, MP07 and pre-exercise PCr concentrations before Cr ingestion, a clear-out relation was observed after Cr ingestion, also noted with MPO. Those individuals who had the highest pre-exercise PCr, generated the highest MPO during bout 5 (r = 0.7, P < 0.05), bout 6 (r = 0.8, P < 0.05) and bout 7 (r = 0.7, P < 0.05). Creatine ingestion did not significantly alter the time constant of PCr resynthesis, $\tau_r$, and there was no relation between MPO6, MP07 and PCr resynthesis $\tau_r$ either before or after Cr ingestion.

Conclusion

The main finding was that creatine ingestion enhanced muscle PCr resynthesis rate over the 0.5, 1 and 2-min recovery periods, with a correlation between the resynthesis of PCr and the recovery of power output.

References
