Long-term creatine intake is beneficial to muscle performance during resistance training

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INTRODUCTION

There is increased evidence showing that short-term high-dose creatine intake raises muscle creatine stores and improves capacity to perform maximal intermittent high-intensity exercise. The effects of long-term creatine intake have not been investigated as systematically but recent results suggest potential and anabolic effects of prolonged low-dose creatine intake *[1-3]*.

The aim of this study is to evaluate *1)* whether the elevated muscle PCr level after short-term creatine loading can be maintained by prolonged low-dose supplementation and *2)* whether creatine supplementation may add to the effects of resistance training on muscle strength and capacity to perform high-intensity exercise.

METHODS

A double-blind study was performed whereby 19 healthy but sedentary female subjects (age 19-22 years) were assigned to either a creatine (CR, n=10) or a placebo (P, n=9) group. During the first 4 days CR received 4x5g of creatine monohydrate per day while P received a placebo (4x5g maltodextrine per day). This was followed by a period of 10 weeks during which CR consumed 2x2.5g of creatine per day (LD) and P continued on placebo. During the latter period the subjects followed variable resistance training during three times one hour per week (5 series of 12 repetitions of 7 exercises performed at 70% of the 1 repetition maximum (1 RM)). At the end of this period a subgroup of subjects (n=13) continued for another 10 weeks of detraining (DTR). Training was stopped but LD supplementation was continued in CR (n=7) and P (n=6).

^{31}P muscle ATP and PCr concentration, maximal strength of trained muscle groups, and maximal intermittent arm flexion torque were measured before and after HD, after 5 and 10 weeks of LD, after 3 and 10 weeks of DTR and 1 and 4 weeks thereafter.

NMR measurements of the m. gastrocnemius were performed at rest in a horizontal 4.7 T magnet with 30 cm bore, using a 50 mm surface coil mounted in a wooden mold with an adjustable footholder for a reproducible positioning. Axial proton NMR images were used to check the position of the muscle.

^{31}P NMR signals were acquired at 81.1 MHz (64 acquisitions every 5s). The PCr and ATP peaks were manually integrated and corrected for partial saturation. Since β-ATP areas remained unchanged over the various treatments, a mean β-ATP area was calculated from all measurements and subjects, and normalized to a concentration of 5.5 mmol/kg ww. Individual ATP and PCr areas were referred to this mean ATP value and were expressed in mmol/kg wet muscle.

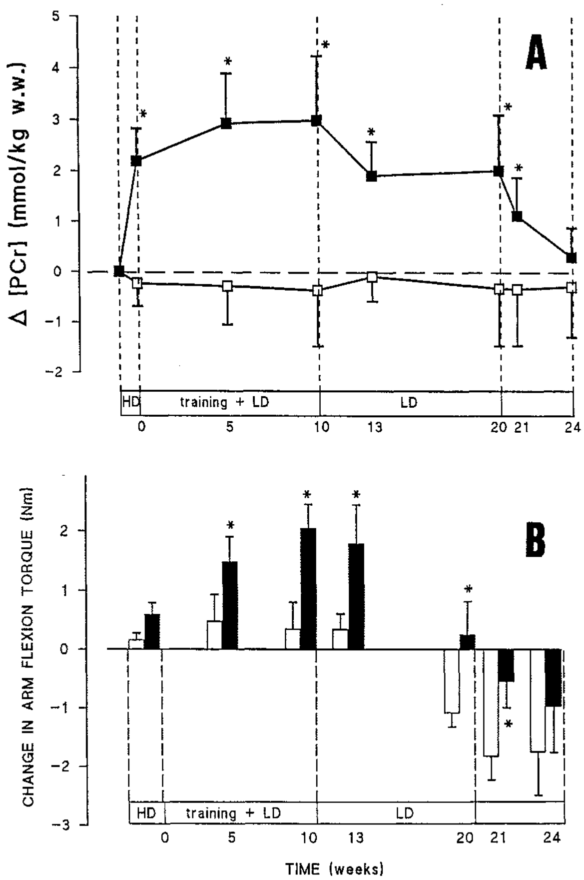
Arm flexion torque was measured during right arm flexion, in a sitting position, on an isokinetic dynamometer. Five series of 30 contractions were separated by 2 min rest periods.

RESULTS

PCr concentation ***(Fig.1A)*** Baseline values were similar for CR and P subjects. After 4 days of HD, PCr was increased by 6% in CR relative to P ($p<0.05$). Thereafter this increase in the CR group was maintained during the 10 weeks of LD combined with training. During the subsequent LD period combined with DTR, the PCr level remained at a higher level ($p<0.05$). Finally, when LD was stopped, the higher PCr concentration faded towards the end of the 4 weeks.

Dynamic arm extension torque ***(Fig.1B)*** was not higher in CR than in P during HD, but was significantly increased (10-25%) after LD and training. During DTR, exercise capacity remained higher in CR than in P ($p<0.05$) and returned to normal within 4 weeks after cessation of creatine.

Fig. 1. Change in PCr concentration (A) and in arm flexion torque (B), before, after 4 days of high-dose (HD), 5 and 10 weeks of low-dose (LD) and resistance training, 3 and 10 weeks of LD, and 1 and 4 weeks without creatine, in the CR group (n=7) (■) and in the P group (n=6) (□).



Values are X±S.E.M. *significant ($p<0.05$) vs. P.

CONCLUSION

The present study demonstrates that oral creatine intake markedly increases the effect of resistance training on maximal muscle strength and the capacity to perform high-intensity intermittent exercise. The beneficial effects of high dose creatine loading on muscle PCr and intermittent exercise capacity are maintained by sustained low dose intake. Upon cessation of long-term creatine supplementation, body creatine balance is rapidly normalized.

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