The effect of eccentric exercise on plasma K^+ regulation and skeletal muscle Na^+,K^+-ATPase activity and content

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Intense exercise results in considerable muscle K^+ efflux, with consequently increased muscle interstitial $[K^+]$ and reduced intracellular $[K^+]$. These changes and the reduction in transcellular $[K^+]$ gradient have been linked with impaired skeletal muscle excitability and contractility (Sejersted & Sjøgaard, 2000). Eccentric exercise causes damage to involved muscles, with a commonly observed consequence being a reduction in the structural integrity of the sarcolemma and T-tubular system and release of intracellular proteins (Allen *et al.*, 2005). Hence, it is possible that the Na^+,K^+-ATPase inserted in these membranes may also be impaired, which may therefore also affect plasma $[K^+]$ and Na^+ and K^+ regulation in skeletal muscle. There have been no published investigations into the effects of unaccustomed eccentric exercise on plasma $[K^+]$ or on Na^+,K^+-ATPase activity and content and these were therefore investigated here. It was hypothesized that eccentric exercise would progressively increase plasma $[K^+]$ and depress both the Na^+,K^+-ATPase activity and content immediately post-exercise.

Six healthy subjects (3 males, 3 females) performed a single bout of one-legged, eccentric, knee extensor exercise, comprising 300 repetitions of maximal eccentric contractions, at 30^o/s. The eccentric exercise bout was conducted on an isokinetic dynamometer, and consisted of 10 sets of 30 repetitions, with a 1 min recovery period separating each set. Maximal isometric knee extensor torque was assessed pre-and immediately post-exercise. Plasma $[K^+]$ was measured in arterialised blood sampled from a dorsal hand vein immediately prior to exercise and at the end of sets 1, 2, 4, 6, 8, and 10. Muscle biopsies were taken from the vastus lateralis muscle at rest and immediately post-exercise and analysed for maximal Na^+,K^+-ATPase (3-*O*-MFPase) activity and Na^+,K^+-ATPase ($[^3H]$-ouabain binding) content.

Maximal isometric torque of the knee extensors was depressed ($P < 0.05$) immediately post-exercise by 26 ± 11% (Mean ± SD). Total work performed by the knee extensors during each set remained constant from sets 1 to 5 after which it was reduced for all subsequent sets ($P < 0.05$). Plasma $[K^+]$ was elevated above rest by the end of the first set ($P < 0.05$). However, despite the declining work output, plasma $[K^+]$ remained elevated throughout the remainder of the exercise bout. The rise in $[K^+]$ above rest ($\Delta[K^+]$) expressed relative to the amount of work performed ($\Delta[K^+]$/work ratio), increased from set 2 to set 4 ($P < 0.05$) and then remained elevated through to set 10. Although tendencies for declines were noted, no significant change was found after eccentric exercise in maximal 3-*O*-MFPase activity ($P = 0.095$) or $[^3H]$-ouabain binding site content ($P = 0.074$).

In conclusion, the observation that plasma $[K^+]$ remained elevated despite a decrease in work performed by the knee extensor muscles suggests an impairment in K^+ regulation during prolonged maximal eccentric exercise. This may reflect a reduction in muscle Na^+,K^+-ATPase and/or damage to the muscle membranes.

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