Releasing the anti-inflammatory potential of paralysed skeletal muscle: the circulating cytokine response to voluntary upper-limb exercise with/without the addition of functional electrical stimulation (FES)-evoked lower -limb contractions

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ABSTRACT

Skeletal muscle is a rich store of inflammatory mediating 'myokines'. Following release from contracting muscle, the myokine interleukin-6 (IL-6) promotes a circulating anti-inflammatory environment associated with a reduced risk of cardiovascular disease (CVD). The metabolic and functional consequences of lower-limb paralysis, including the gain in relative adiposity and physical inactivity, result in a high prevalence of CVD in individuals with a spinal cord injury (SCI). However, the magnitude of any contraction-induced myokine response in this population may be limited by the small active muscle mass of the upper-limb. The combination of voluntary, upper-limb exercise and involuntary, functional electrical stimulation (FES)-evoked lower-limb cycling termed 'hybrid' exercise, may augment the acute myokine response by activating a greater volume of muscle mass than upper-limb exercise alone.

Five community-based individuals with motor complete, thoracic SCI (Age=44±15 years; Body mass=66.6±14.3 kg) and at least 3 months FES-evoked cycling experience volunteered to participate. On separate occasions, each participant performed 30 min of voluntary upper-limb, hand cycling exercise with (HYBRID) and without (ARM only) the addition of FES-evoked lower-limb cycling at a fixed workload. Blood samples were collected at rest, immediately post-exercise, and 1 and 2 h post-exercise. Plasma concentrations of IL-6, IL-10 and IL-1ra were subsequently determined by enzyme linked immunoassay.

Estimated energy expenditure was significantly higher in HYBRID (154±25 kcal) than ARM (132±21 kcal) ($P=0.01$; ES=0.90). Plasma IL-6 concentrations were significantly elevated following HYBRID, with values 1 h and 2 h post-exercise significantly higher than rest and immediately post-exercise ($P<0.04$). A small (~50%) non-significant increase in IL-6 was present 1 h and 2 h post-exercise following ARM, however concentrations were significantly higher in HYBRID than ARM at the same time points ($P<0.02$). Plasma IL-10 concentrations were unaffected by exercise in ARM. Although not attaining statistical significance, there was a tendency for IL-10 concentrations to rise in HYBRID, with an 85% increase in IL-10 concentrations at 2 h post exercise. Plasma IL-1ra was unaffected by exercise in both trials.

Initial findings suggest paralysed skeletal muscle releases the myokine IL-6 in response to electrically evoked contractions. Further, voluntary upper-limb exercise combined with involuntary lower-limb FES-evoked exercise had the tendency to elevate plasma concentrations of the anti-inflammatory cytokine IL-10; this effect was not present when performing arm exercise alone. Hybrid exercise may offer a method of maximising the anti-inflammatory potential of acute exercise in individuals with a SCI. The current findings require verification in a larger cohort.