©Journal of Sports Science and Medicine (2012) **11**, 773-774
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Letter to editor

Repeated bout effect and cross-transfer: Evidence of dominance influence

Dear Editor-in-Chief

Resistance exercise often leads to exercise-induced muscle damage (EIMD). Muscle oedema, muscle soreness, increase in serum creatine kinase (CK) activity, restricted range of motion and strength loss are markers of EIMD. It is well documented that symptoms of EIMD are reduced following a repeated bout of similar exercise, this occurrence has been referred to as the repeated bout effect (RBE) (McHugh, 2003).

Cross-transfer or cross-education is a phenomenon related to increases in the strength of the contralateral (untrained) limb following training in the ipsilateral (trained) limb (Connolly et al., 2002; Howatson and Van Someren, 2007) and is explained primarily by neural adaptations (Hortobágyi et al., 1997). As applicable to the strength gains, the cross-transfer effect have been proposed as plausible for the protection against muscle damage after a first bout of damaging exercise to a contralateral muscle. Connolly et al. (2002) were the first to examine whether the protective effects of a prior bout of eccentric exercise could transfer to the contralateral limb. They submitted subjects to two bouts of lower limb damaging exercise and reported no evidence of a cross-transfer effect. However, Howatson and Van Someren (2007) and Starbuck and Eston (2012) provided evidence that the protective effect of a prior episode of EIMD was cross transferred in the elbow flexors and also related this effect to a neural adaptations.

Interestingly, there is evidence of different motor control strategies employed by dominant and non-dominant arms during motor tasks (Pereira et al. 2012), which could influence the neural adaptations associated with the cross-transfer effect. Presently, however, there have been no studies conducted to investigate the influence of limb dominance on the cross-transfer effect related to RBE.

We submitted 21 volunteers (19.0 ± 1.7 yr; 66.4 ± 8.5 kg; 1.76 ± 0.07 m), healthy and non-active men, to two bouts of upper limb damaging exercise. The volunteers were randomly divided into 3 groups: N-N (n = 7) that carried out 2 exercise bouts with non-dominant arm (control); N-D (n = 7) that carried out the first bout with non-dominant and the second with dominant arm; and D-N (n = 7) with dominant followed to non-dominant arm. All exercise sessions were carried out with 5 maximum sets with load equivalent to 10 RM. Exercise bouts were two weeks apart. We measured muscle soreness, through visual analog scale (VAS), and serum CK activity before and 48, 96 h after each exercise bout. Arm dominance was determined by the hand used to write.

Relative to results, the N-N control group display well documented serum CK activity and muscle soreness patterns; i.e., elevations after first bout followed by attenuation after the second bout (Table 1). The N-D and D-N groups (experimental cross-transfer groups) did not display significant reductions in serum CK activity, but the muscle soreness was lower in D-N ($p < 0.05$).

These findings support there is a cross-transfer effect on perceived muscle soreness after a damaging exercise bout is influenced by the order of arm dominance usage, without having an effect on muscle damage marker.

Cellular, mechanical, and neural adaptations (McHugh, 2003) have collectively been postulated as possible mechanisms to explain the RBE. It is known that neural adaptations may partially explain why a prior bout of eccentric exercise provides protection to the extent of EIMD following a repeated bout of eccentric exercise (McHugh 2003; Starbuck and Eston, 2012). Interestingly, cross-transfer phenomenon as a means for protection against EIMD and has been associated to neural adaptations (Howatson and Van Someren, 2007; Starbuck and Eston, 2012).

Specifically, Starbuck and Eston (2012) provided evidence that the neural adaptations mediate the protection against EIMD in the contralateral arm. In their study subjects were divided into 2 groups and submitted to 2 bouts damaging exercises for elbow flexors, separated by 2 weeks. One group carried out both exercise bouts with the same arm, while other carried bout first exercise bout with one arm and second bout with contralateral arm. In

Table 1. Serum CK activity and muscle soreness responses in N-N (n = 7), N-D (n = 7) and D-N (n = 7) groups. Values are means (±SD).

		Serum CK activity ($U.L^{-1}$)			Muscle Soreness (mm)		
		N-N	N-D	D-N	N-N	N-D	D-N
1st Bout	PRE	128 (48)	185 (37)	190 (126)	0	0	0
	POST	-	-	-	35 (17)	40 (31) *	33 (24) *
	48h	499 (524) *	599 (214) *	757 (666) *	33 (21)	33 (22) *	18 (21) *
	96h	197 (528)	340 (178)	230 (171)	19 (23)	8 (8)	6 (9)
2nd Bout	PRE	262 (74)	161 (48)	175 (85)	1 (1)	0	0
	POST	-	-	-	5 (6)	28 (19) *	8 (7) *[a]
	48h	244 (211)	705 (287) *	560 (138) *	5 (8)	16 (16) *	9 (11) *
	96h	189 (49)	297 (240)	226 (76)	1 (1)	5 (8)	2 (2)

(*) represents significant difference between PRE ($p < 0.05$); ([a]) represents significant differences between groups ($p < 0.05$).

Received: 02 November 2012 / Accepted: 05 November 2012 / Published (online): 01 December 2012

the cited study participants were randomly assigned to perform the initial bout of eccentric exercise in either their dominant or non-dominant arm. Then, the possible influence of arm dominance on cross-transfer phenomenon was not considered, albeit there is evidence of different motor control strategies employed by dominant and non-dominant arms during motor tasks (Pereira et al., 2012).

Our results corroborates with the findings of Starbuck and Eston (2012) about the cross-transfer effect. Additionally, serum CK activity increases after a damaging exercise depends on cellular and mechanical mechanisms, while muscle soreness perception could involve neural mechanisms. Together, results from serum CK activity and perceived muscle soreness may also indicate that the neural mechanisms should be involved in this cross-transfer event, which also corroborate and expand the postulated from Starbuck and Eston (2012).

A limitation of the present study is that changes in muscle strength and range of motion (two other accepted EIMD markers) were not measured and future studies should include these variables. Additionally, the electromyographic data would have helped to improve the comprehension about the intricate relationship among neural adaptations, cross-transfer effect and RBE for dominant and non-dominant limbs. Nonetheless, even with these limitations the finding indicate the cross-transfer effect on perceived muscle soreness after a damaging exercise bout is influenced by the order of arm dominance usage.

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