Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 6 Issue 1 January 2023

Short Communication

Cross-Education: Evidence and Perspectives on Rehabilitation

Venicius de Paula Silva*

Physical Activity Sciences Laboratory, School of Arts, Sciences and Humanities, University of São Paulo, São Paulo, Brazil

***Corresponding Author:** Venicius de Paula Silva, Physical Activity Sciences Laboratory University of São Paulo, Sao Paulo, Brazil.

Received: November 25, 2022

Published: December 13, 2022

Keywords: Unilateral strength training; Rehabilitation; Muscle strength gain.

Cross-education is defined as the increase in the muscle force generation capacity of the untrained contralateral limb after unilateral strength training [1,2].

This cross-education effect was first described by Scripture., et al. in 1894, at the Yale Laboratory of Physiology [3]. From its discovery, several studies have reported implementing cross-education as a possible rehabilitation strategy during orthopedic limb immobilization [4-6], as a treatment option in stroke rehabilitation [7,8] or after reconstruction of the anterior cruciate ligament [9]. In addition, study demonstrated that unilateral strength training can induce an increase in muscle strength in the untrained contralateral limb of 18% in young adults, 17% in the elderly and 29% in patients with neuromuscular disorders [10].

The effects of cross-education have been proven in men and women [11], both in the upper and lower limbs, as well as in the dominant and non-dominant [12], in response to different types of muscle action (concentric, eccentric or isometric) [13] and in large or small muscle groups [14].

According to Ruddy and Carson, the transfer of force to the untrained contralateral limb is mediated by neural adaptations, since studies have not shown changes in the cross-sectional area of the muscle in the untrained limb as a result of cross-education [16-18].

To the healthy subjects, there is no obvious relevance to application of unilateral strength training, as they generally strive to improve function and strength in both limbs, concurrently. From a rehabilitation point of view, however, the relevance of cross-education emerges as a way to benefit the recovery of strength after unilateral orthopedic injury [7]. In a study by Farthing., et al. cross-education was proven to have positive impact after immobilization period. In this study, the objective was to determine if strength training the free limb during a 3-week period of unilateral immobilization attenuates strength loss in the immobilized limb through cross-education. Participants were assigned to three groups. One group wore a cast and trained the free arm. A second group wore a cast and did not train. A third group received no treatment. The results showed an increase in strength (24%) in the trained limb of the immobilization and training group, while there was no significant increase in strength (2.2%) in the contralateral immobilized limb. However, for the immobilization group without training, a significant decrease in the strength production of the immobilized limb was observed (15%). In addition, via ultrasonography, the researches verified that there was no significant chance in muscle size (-1.1) of the immobilized limb in the immobilization and training group, while in the immobilization without training group there was a significant decrease in muscle size (4,3%).

In another study, Magnus at al., used electromyography, dynamometry and ultrasonography to observe the effects on strength, muscle thickness and muscle electrical activity over 4-week of immobilization of the non-dominant limb to verify cross-education in the untrained limb. The results showed that the electrical muscle activity of the immobilized limb did not present a significant difference, but even without changes in the EMG, an increase in strength and maintenance of muscle thickness of the immobilized limb was observed. These results suggest that cross-education has great application potential, since strength training of the free limb can prevent the decrease in strength and muscle size of the immobilized limb.

Based on these findings, the beneficial effects of unilateral strength training in relation to immobilization in healthy subjects were evidenced. In addition, Voskuil., et al. reported that unilateral strength training can be applied as a starting point as a rehabilitation strategy.

Bibliography

1. Farthing PJ., *et al*. "Cross-education of arm muscular strength is unidirectional in right-handed individuals". *Medicine and Science in Sports and Exercises* 37.9 (2005): 1594-1600.
2. Carroll TJ., *et al*. "Contralateral effects of unilateral strength training: evidence and possible mechanisms". *Journal of Applied Physiology* 101.5 (2006): 1514-1522.
3. Scripture EW., *et al*. "On the education of muscular control and power". Studies from the Yale Psychological Laboratory 2 (1894): 114-119.
4. Andrushko JW., *et al*. "Unilateral strength training leads to muscle-specific sparing effects during opposite homologous limb immobilization". *Journal of Applied Physiology* 124.4 (2018): 866-876.
5. Farthing PJ., *et al*. "Strength training the free limb attenuates strength loss during unilateral immobilization". *Journal of Applied Physiology* 106.3 (2009): 830-836.
6. Magnus CR., *et al*. "Effects of cross-education on the muscle after a period of unilateral limp immobilization using a shoulder sling and swathe". *Journal of Applied Physiology* 109.6 (2010): 1887-1894.
7. Ehrensberger M., *et al*. "Cross-education of strength has a positive impact on post-stroke rehabilitation: a systematic literature review". *Topics in Stroke Rehabilitation* 23.2 (2016): 126-135.
8. Sun Y., *et al*. "Unilateral wrist extension training after stroke improves strength and neural plasticity in both arms". *Experimental Brain Research* 236.7 (2018): 2009-2021.
9. Papandreou M., *et al.* "Cross-exercise on quadriceps deficit after ACL reconstruction". *The Journal Knee Surgery* 26.1 (2013): 51-58.
10. Green LA and Gabriel DA. "The effect of unilateral training on contralateral limb strength in young, older, and patient populations: a meta-analysis of cross education". *Physical Therapy Reviews* 23.4 (2018): 238-249.
11. Kannus P., *et al*. "Effects of one-legged exercise on the strength, power and endurance of the contralateral leg. A randomized, controlled study using isometric and concentric isokinetic training". *European Journal of Applied Physiology and Occupation Physiology* 62. 2 (1992): 117-126.
12. Panzer S., *et al*. "Cross-education and contralateral irradiation". *Journal of Human Kinetics* 27.1 (2011): 66-79.
13. Hortobágyi T., *et al*. "Great cross-education following training with muscle lengthening than shortening". *Medicine and Science in Sports and Exercises* 29.1 (1997): 107-112.
14. Zhou S. "Chronic neural adaptations to unilateral exercise: mechanisms of cross education". *Exercise and Sport Sciences Reviews* 28.4 (2000): 177-184.
15. Ruddy KL and Carson RG. "Neural pathways mediating cross education of motor functional". *Frontiers in Human Neuroscience* 7.397 (2013): 1-22.
16. Bezerra P., *et al*. "Effects of unilateral electromyostimulation superimposed on voluntary training on strength and cross-sectional area". *Muscle and Nerve* 40.3 (2009): 430-437.
17. Tseng Wei-Chin., *et al*. "Contralateral effects by unilateral eccentric versus concentric resistance training". *Medicine and Science in Sports and Exercises* 52.2 (2019): 474-483.
18. Magnus CR., *et al*. "At-home resistance tubing strength training increases shoulder strength in the trained and untrained limb". *Medicine and Science in Sports and Exercises* 24.3 (2014): 586-596.