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Original article

Unilateral intramuscular needling can improve ankle dorsiflexor strength and muscle activation in both legs

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Abstract

Background/Objective: The aim of this study was to determine whether unilateral manual needling at nonacupoints could result in bilateral strength gain similar to that found in electroacupuncture at specific acupoints.
Methods: Fifty healthy male volunteers with an age range of 19–27 years were recruited and randomly allocated into five groups: (1) manual acupuncture and (2) electroacupuncture at two acupoints (ST-36 and ST-39); (3) manual acupuncture and (4) electroacupuncture at two non-acupoints on the tibialis anterior muscle; and (5) control group. The intervention groups received needling in each session on the right leg for 15 minutes in Week 1, 20 minutes in Week 2, and 30 minutes in Weeks 3–8, three sessions per week. The maximal isometric ankle dorsiflexion strength and muscle activation (as determined by twitch interpolation) of both legs were assessed pre, post, 2 weeks post, and 3 weeks post the experimental period.
Results: Mixed models (linear) with repeated-measures analysis identified significant strength gains ($p < 0.01$) after the intervention period in both limbs, while no significant differences were detected between the intervention groups and between the two legs, and no change was found in the control group. A significant improvement in muscle activation ($p < 0.01$) was also observed in both legs in the intervention groups.
Conclusion: It was concluded that both unilateral manual and electric needling caused significant bilateral strength gain, and this effect was not specific to the selected acupoints or electric stimulation. The strength gain was sustained for at least 3 weeks after the 8-week intervention.

Keywords: Acupuncture; Detraining; Muscle activation; Muscle strength

Introduction

It has been repeatedly reported in the literature that single-limb resistance exercise can affect muscle strength in both the muscle under training and the homologous muscle in the contralateral limb, a phenomenon known as cross education or cross transfer.[1,2] Furthermore, unilateral electromyo stimulation has also been shown to increase strength in both limbs, possibly related to the influence of sensory inputs.[3,4] Interestingly, there have been recent reports that unilateral electroacupuncture and manual acupuncture at selected acupoints can also induce a crossover effect on the expression of strength in the contralateral limb, with the magnitude being similar to that found in resistance training or transcutaneous electromyostimulation.[5,6] These findings may have potential implications in the practice of physical conditioning and rehabilitation, as well as in advancement of our understanding

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of cross education, because most of the previous reports on cross education were based on voluntary resistance training.[7–9] In this paper, we refer to "acupuncture" as applying needles at known acupoints following the practice in traditional Chinese medicine, and "needling" as applying needles at sham points (points not identified in traditional Chinese medicine); in addition, we use "cross education" for the effects of voluntary training and "cross transfer" for the effects of electromyostimulation training or needling.

Regarding the bilateral effect of unilateral electroacupuncture on muscle strength,[5] it can be argued that the effect can be caused by either acupuncture at certain acupoints,[10] or electric stimulation applied through needles. It has been speculated that the strength gain could be related to the sensory inputs associated with electric stimulation.[3,4] The effect may not necessarily be caused by stimulation at specific acupoints, as reported in some investigations where intramuscular needling was not used or electric needling was applied to sham points.[6] Furthermore, it has been reported that manual acupuncture at selected acupoints can also induce cross-transfer effect similar to that induced by electroacupuncture.[6] It would be interesting to find whether manual needling at sham points can induce a similar effect. Such evidence would be essential in understanding whether it is necessary to stimulate certain acupoints and use electric stimulation to cause cross transfer. If manual needling at sham points could induce similar bilateral strength gain, it would support the speculation that sensory input is a common and critical factor in manifesting cross transfer. In addition to the implications in therapy or rehabilitation, there have been increased interests in the field of sport science on the effect of acupuncture (or needling) as an ergogenic aid to neuromuscular function and sport performance; however, the published work in this area is still very limited.[11–13]

Therefore, the main aim of this study was to determine whether unilateral manual needling at sham points could induce similar bilateral changes in muscle strength to that induced by electroacupuncture or manual acupuncture. A null hypothesis was proposed that there would be no difference between the cross-transfer effects induced by manual needling on sham points and that induced by acupuncture at specific acupoints. This study also investigated whether the changes in muscle strength could be maintained after the intervention period, which had not been determined previously. Such evidence would assist practitioners in selecting an appropriate method of intervention, aiming to improve muscle strength.

It has been suggested that the phenomenon of cross education or cross transfer is mainly due to an adaptation in the nervous system, because no evidence of muscle hypertrophy has been reported.[1,2,4,14] To determine adaptations to training in the nervous system, twitch interpolation technique is frequently used for assessment of individual's capacity in activating muscles.[15,16] The second aim of this study was to determine whether the capacity of muscle activation could be improved by acupuncture or needling. A null hypothesis was proposed that there would be no difference between muscle activation induced by manual needling on sham points and that induced by acupuncture at specific acupoints.

Methods

Participants

Fifty healthy men with a mean age of 22.3 years (range 19–27 years) volunteered for the study. The participants were first given an individual registration number and then randomly allocated into five groups ($n = 10$ in each group) according to a random number table. The five groups were as follows: manual acupuncture at acupoints (MAcu); electroacupuncture at acupoints (EAcu); manual needling on sham points (MSham); electric needling on sham points (ESham); and control (CON).

The participants were university students who were physically active but not athletes. The inclusion criteria for participation were that the participants had no musculoskeletal or neurological disorders, had not been involved in regular strength training or structured sport training during the 6 months prior to the study, and had no previous experience with acupuncture or electric stimulation. All participants were right-foot dominant, as identified using an established questionnaire.[17] The experimental procedures were approved by the Human Research Ethics Committee of Southern Cross University and conducted in compliance with the Declaration of Helsinki. Consent was obtained from all participants prior to the commencement of the study.

The sample size was determined by *a priori* estimation, using the G*Power 3 program (version 3.0.3).[18] The predicted minimum number of participants for analysis of variance with repeated measures was 25 (5 in each of the 5 groups), with the assumptions of an effect size of 0.4, a power of 0.80, and an alpha level of 0.05. Therefore, 10 participants in each group were thought to have sufficient statistical power to determine the effect and could accommodate potential dropout in the present study. Physical characteristics of the participants who completed the study (there were 5 dropouts) are summarized in Table 1. *Post hoc* calculation based on the results of this study indicated that the effect size was higher than 0.57 in all experimental groups and the statistical power was 1.0.

Procedures

The dorsiflexion muscle group was chosen as the subject in this study because its function is essential to normal gait, and

Table 1
Physical characteristics of participants.

		MAcu	MSham	EAcu	ESham	CON	Total
	N	9	8	10	8	10	45
Age (y)	Mean	21.6	20.9	22.5	22.1	24.2	22.3
	SD	1.7	1.8	2.5	2.2	1.5	2.2
Mass (kg)	Mean	62.3	74.8	67.4	69.5	66.3	67.8
	SD	8.5	12.3	8.9	7.1	7.1	9.4
Height (cm)	Mean	171.3	175.4	172.7	176.1	173.7	173.7
	SD	6.1	5.7	6.2	4.7	7.2	6.1

CON = control; EAcu = electroacupuncture on acupoints; ESham = needling with electric stimulation on sham points; MAcu = manual acupuncture on acupoints; MSham = manual needling on sham points; SD = standard deviation.