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RAPID COMMUNICATION

Acute static muscle stretching improves manual dexterity in young men

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OBJECTIVE: This study aimed to evaluate the influence of acute muscle stretching on manual function.
METHODS: The sample consisted of 10 untrained men in a randomized, four test session cross-over experimental design. Each session was composed of only one of two protocols: a) control, or b) single series of passive static stretching; followed by either Minnesota Hand dexterity test or hand grip strength test with eletromyographical recording of reaction time. For data comparison, the Student T-test with significance level of $p \leq 0.05$ was used.
RESULTS: Manual dexterity increased after stretching for both placing and turning tests, with no changes in hand grip strength or reaction time.
CONCLUSION: The results show that a 30 second static stretch of the hand decreases time to complete the Minnesota Hand Dexterity test without affecting handgrip strength or hand reaction time; thus it improves manual dexterity of young untrained men.

KEYWORDS: Muscle stretching, motor skills, reaction time.

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INTRODUCTION

Stretching exercises are often prescribed for persons with reduced motor skills or range of motion. Several reports describe this exercise technique as a necessary activity for better performance in daily life activities.[1–4] However, muscle stretching seems to evoke neural and mechanical adaptations that reduce strength, reaction time and body balance;[3,5–7] it also affects the responsiveness of relevant afferent structures, such as muscle spindles[8] and Golgi tendon organs,[9] which are important structures in the regulation of motor commands.

Manual dexterity, handgrip strength and reaction time are important components to assess hand function, which relate to better quality of daily life[1,10] and recreational activities;[2,11] they also act as indicators of cognitive and exercise performance[12,13] and are determinant factors in the ability to manipulate objects.[14] Additionally, manual dexterity and handgrip strength are closely interdependent, in an interaction known as strength-dexterity trade-off.[15] Manual dexterity is also related to the central nervous system, since the cortex receives information from several proprioceptors[8,16] to modulate manual motor tasks increasing movement efficiency.[14,17–19] Hence, if muscle stretching does interfere with these factors it could alter the ability to manipulate objects. Because several sports, such as boxing,[20] handball,[21] basketball,[22] and many non-sporting activities such as musical performance[23] require agility and manual dexterity, the assessment of hand function is essential for the development of training techniques and functional rehabilitation of hand movements. However, there is a lack of knowledge about the effect of static stretching on manual dexterity. We hypothesized that muscle stretching would interfere with these factors and consequently alter hand dexterity.

The purpose of this study was to understand the effect of static stretching on manual dexterity, providing evidence for health professionals seeking to prescribe stretching exercises safely and efficiently for athletes and patients who need to improve their manual skills.

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MATERIALS AND METHODS

The present study was approved by the Research Ethics Committee of the Federal Rural University of Rio de Janeiro, under case # 23083.008201/2014-91. The study was carried out with 10 healthy untrained male subjects (age: 22 ± 2 years; weight 72.58 ± 3.5 kg; height: 170 ± 6 cm; body fat percentile: 12.69 ± 3.39 %; BMI: 23.91 ± 1.71) with no present or pre-existent lesions or signs of pain in the arms or hands, no restriction to normal hand movements and no use of medications that could intervene with hand skills such as sedatives, psychotropics or beta blockers. All volunteers read and signed a consent form and were instructed not to participate in physical activities during the week preceding the performance of the experiment. In a previous visit to the laboratory, anthropometric measurements were obtained; subsequently, a familiarization session with the experimental protocols was carried out in order to decrease the influence of learning on results. The experiment had a cross-over randomized design, i.e. the same subjects were used in all experimental groups and compared with themselves; the order in which they performed the experiments was randomized, thus avoiding possible adaptations. The experiments were executed in a week with four testing sessions. Each session consisted of one of two protocols: a) control, in which participants performed no activity; or b) one instance of passive static stretch. After the protocol the participants performed either the Minnesota Hand Dexterity Test or the Hand Grip Test with eletromyographical analysis of hand reaction time. All procedures were carried out in a well-lit and silent environment.

Muscle stretching

Muscle stretching consisted of a single instance of 30 seconds of passive static stretch. The participant sat with the shoulder in orthostatic position, with elbows at an angle of 90° and forearms supported by the table. The wrist was in supine position with fingertips pointing upward. The participant's wrist was passively stretched by the researcher to the limit of pain and held in position for 30s.

Hand Dexterity Test

The subject sits on a chair adequate to his height in front of a table so that he has a complete view of the area and equipment.[4] To ensure the consistency of the procedures and test accuracy, general instructions are given before each session to avoid doubts. The volunteer is instructed to start the test immediately after the command and to proceed as fast as possible. To avoid distractions, the presence of observers during the test was not allowed and access to the areas surrounding the lab restricted. The Minnesota Manual Dexterity Test is performed using a board with holes (matrix) and a set of 60 discs (black/red) that fit into the matrix. Two tests are performed: (a) the placing test, in which all discs must be fitted into the board as fast as possible, using only one hand; (b) the turning test, in which the discs start in the matrix, are removed, turned and refitted on the matrix so that all discs start with the black side up and end with the red side up. In both tests, the time to completion is measured in seconds, and a lower time indicates an increased performance.[11] The performance in this test indicates the capacity to execute a task that requires hand dexterity.[1,4,11]

Hand Grip Strength

Hand grip strength was measured with a hydraulic dynamometer (Jamar, Sammons Preston Rolyan, 4, Bolingbrook, IL) as described elsewhere.[10,24] The participants sat in a comfortable armless chair, with the arm alongside the body, the elbow flexed at 90° and dominant hand parallel to the body holding the dynamometer. The opposite hand rested over the thigh. The participants were then instructed to perform a maximal contraction with the dominant hand for 3s in each of three tries; a rest period of 30s was allowed between tries and the mean values of the three attempts was used for analysis.

Hand Reaction Time

For electromyographical analysis, electric signals were recorded on the skin above the forearm with bipolar electrodes and filtered to EMG Spikerbox (Backyard Brains), as described elsewhere.[25,26] To record the signals and measure the reaction time, we used the open-source audio processing program Audacity (Audacity®, Version 2.1.2). The recording was carried out during the above-described hand grip test and the assessment used the mean of values found in the 3 tries.

Statistical Analysis

Data are displayed as mean ± standard deviation Data analysis was carried out with Prism v6.0 (GraphPad, EUA). Data normality was assessed by the Shapiro-Wilk test. The groups were compared with Student T-test and the adopted level of significance was $p \leq 0.05$.

RESULTS

Muscle stretching significantly improved hand dexterity. Figure 1A shows that the time to complete the placing test was significantly reduced after stretching, from 55.53 ± 1.78 to 53.63 ± 3.23 seconds (p=0.0139). Figure 1B shows that the time to complete the turning test was also significantly reduced after stretching, from 54.20 ± 2.39 vs. 50.35 ± 5.39 seconds (p = 0.0200). Figure 2 shows that static stretch did not affect hand grip strength (33.3 ± 8.84 vs. 33.2 ± 9.61; p = 0.9238, Fig. 2a) or reaction time (200.8 ± 30.08 vs. 199.2 ± 41.56; p = 0.8981, fig 2B)

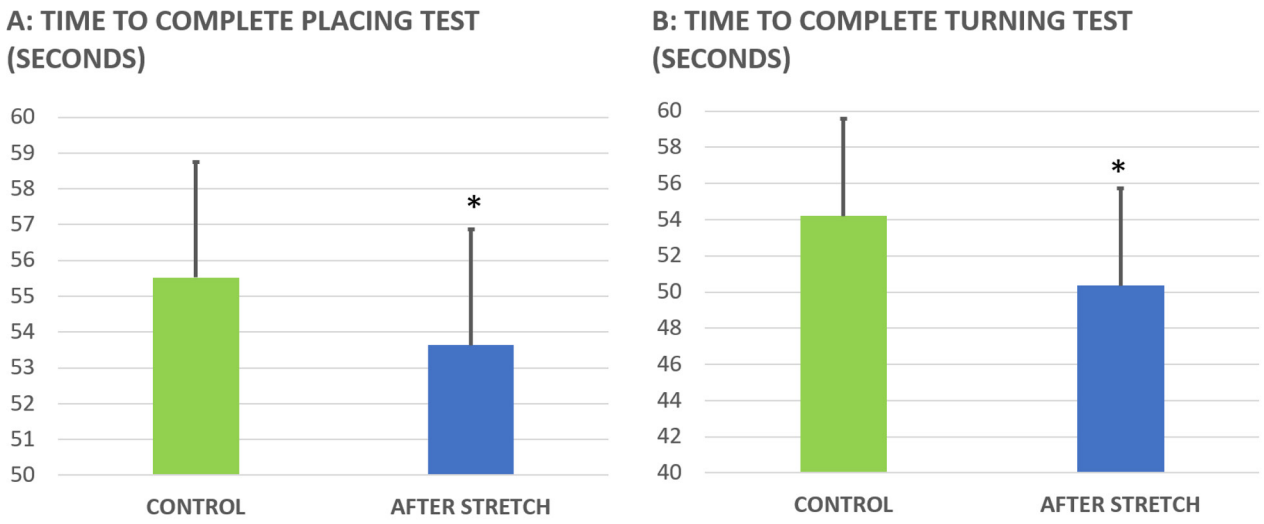

Figure 1: Time to complete the Minnesota Dexterity Test (mean and std dev). Stretching decreased time to complete the placing (A) and turning (B) components of the Minnesota Dexterity Test, showing improved hand dexterity. * $p < 0.05$ vs. CTR.

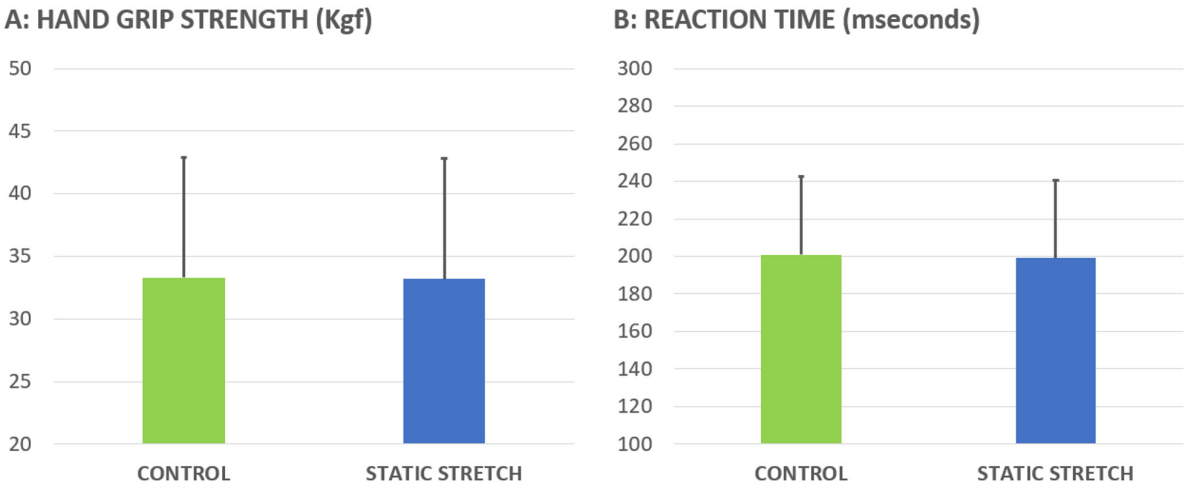

Figure 2: Strength and reaction time (mean and std. dev.). Static muscle stretching did not affect hand grip strength (A) or reaction time (B).

DISCUSSION

This study showed that 30 seconds of static stretching improved manual dexterity, with no change of handgrip strength or hand reaction time. The absence of changes of handgrip strength and hand reaction time after muscle stretching may be due to the moderate volume (1 instance) and intensity (30s) used in our study, because deleterious effects on strength and reaction time are related to greater volume (>2 sets) or intensities (≥45s) of muscle stretching,[5,9,27–29] as a result of a decreased motor unit activation.[9,30] The impact of muscle stretching on these variables relates to the stretching protocol used;[31] in this sense, conflicting results have been reported, in which muscle stretching improved,[32] decreased[5,6,9,27,28] or had no effect on these variables,[33–36] in different stretching protocols. In a study with a similar methodological design Silva *et al.*[6] reported that acute static stretching did not affect strength in men; similar results are found in another study.[37] Decreases in strength after stretching were observed in other groups, such as women[6] or participants experienced in strength training,[38] both of which differ from our sample of untrained male subjects. However, Knudson[29] showed, in a sample similar to ours, an exponential decline of grip strength after stretching that was only significant after 4 sets of 10 seconds of static stretching, which demonstrates that lower intensities and volumes of stretching are not sufficient to induce changes on strength.

Interestingly, our results showed that passive static stretch, performed at an intensity range that does not affect strength, decreased placing and turning test time, which means an improvement of manual dexterity. It is conceivable that stretching induced an increase in cortical excitability, in order to compensate the inhibition of moto-neurons at spinal level, resulting in enhanced descending excitatory drive.[39] Likewise, muscle stretching increases the proprioceptors activity before the onset of movement enabling a basis for motor command programming and organization at central and peripheral level, and thus improved performance.[8,39–41] Additionally, central nervous system and proprioceptors are related to hand dexterity[14,15,17,42] through both spinal reflexes and central connections,[41,43] which ensure the generation of the correct pattern of muscle activity or automatic adjustments of hand movement.[8,39,40] Thus, muscle stretching possibly increased the quality of the information and the capacity of response of the subject, promoting a sequence of muscular activation and modulation of motor command better suited to the task. This increased cortical drive may have influenced the increase in dexterity found in this study. This study has limitations: participants were not controlled for intervenient factors such as hormonal levels, sleep time and feeding patterns, which may have influenced the results found on this study. Only one population was assessed in this study. Future studies should include different populations, such as participants trained in sports or with limitations to hand function.

CONCLUSION

Our results indicate that moderate volume and intensity of static stretching of the hand/forearm muscles may increase manual dexterity with no change in strength and hand reaction time. Therefore, stretching may increase hand dexterity if it is of an intensity that does not induce changes in other components of hand function. Greater volumes or intensities should be recommended with care, to avoid potential disturbances in manual dexterity. Further studies are pivotal to assess and establish a safe muscle stretching volume and intensity.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTION

Study concept and design: CRMC, ALBS. Analysis and interpretation of data: CRMC, RCS, ALBS. Drafting/revision of the manuscript: CRMC, RCS, WVP, WMV, ALBS. Study supervision: ALB. All authors read and approved the final version of the manuscript.

EFEITO AGUDO DO ALONGAMENTO ESTÁTICO SOBRE A DESTREZA MANUAL DE JOVENS DESTREINADOS

OBJETIVO: Este estudo objetivou avaliar a influência do alongamento sobre a função manual.

MÉTODOS: A amostra foi composta por 10 homens destreinados em um delineamento experimental cross-over randomizado, com quatro sessões de testes. Cada sessão foi constituída apenas por um dos protocolos: a) controle ou b) série única de alongamento estático passivo seguidos pelo minnesota Hand Dexterity Test ou pelo Teste de Preensão Manual com analise eletromiográfica do Tempo de Reação Manual. Para as comparações dos dados, o teste T de Student foi usado, com o índice de significância adotado de $p \leq 0,05$.

RESULTADOS: O alongamento aumentou a destreza manual em ambos *Placing* e *Turning Tests*, sem alterar a força de preensão manual ou o tempo de reação.

CONCLUSÃO: Os resultados indicam que o alongamento melhorou a destreza manual de jovens destreinados.

PALAVRAS CHAVE: Alongamento muscular; destreza motora; tempo de reação.

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