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The Effectiveness of Self-Administered Contract Relax Agonist Contract (CRAC) Stretching on Performance of Hamstring Curls to Fatigue in Elderly Population

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ABSTRACT

Active lifestyle is important for all age groups, especially essential among older adults to counter balance the deleterious effects of aging. Scientific literature is scarce about the effect of Proprioceptive Neuromuscular Facilitatio (PNF) stretching on older adults. Therefore, the purpose of this study is to find out the effect of self-administered CRAC stretching on the performance of hamstring curls to fatigue in older adults. We used the same subject repeated measure experimental crossover design, where subjects were randomly allocated into two groups and both the groups were given the Self-Administered CRAC stretching in alternate session to overcome the order effect. The result of this present study demonstrated that there was a significant between-group effect ($t = -2.06$, $p=0.0484$) seen. The participants getting CRAC stretching performed 37% and 44% less hamstring curls to fatigue in the respective sessions. In summary, our primary findings indicated enhanced flexibility with an accompanying decrease in the number of hamstring curls performance in response to self-administered CRAC stretching. These findings are unique in that, to our knowledge, no other authors have examined the effects of CRAC stretching on isolated muscle performance with a repeated measures design. Regarding the mechanisms underlying the stretching-induced performance deficit, the decreases in no of hamstring curls we observed in our study tentatively support the hypothesis that stretching may alter the length-tension relationship and the hypothesis that stretching may reduce muscle activation, respectively. CRAC stretching can be made part of a full warm-up routine because of its positive impact on flexibility and musculotendinous injury occurrence in the physically active older population.

KEY WORDS: CRACS-CONTRACT RELAX AGONIST CONTRACT, N-NUMBER, NHC- NUMBERS OF HAMSTRING CURLS, S1-SESSION 1, AND S2-SESSION 2.

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INTRODUCTION

Regular physical activities and exercise provide protection against many cardiovascular and lifestyle associated diseases, improve flexibility, and enhance the overall performance as well. Despite the rewards that physical activity and exercise bring, for the aging population, the compliance with this activity is quite low (Witvrouw et al 2004, Boulton et. al. 2018, Dazau et al 2019).

The age-related decrease in strength and flexibility negatively affects the activity level and exercise in the older population (Behm and Chaouachi, 2011 Behm et al 2015, Musich et al 2017 and Sato et al 2020). Due to decreased strength, flexibility, and comorbidities the physical activity and exercise carry the risk for injuries leading to disability in the older population (Rae et al 2020 Angulo et al 2020).

Studies comparing the effect of different stretching techniques have found to be effective in improving joint flexibility (Behm et al 2011). Samson et al (2012) demonstrated that, in comparison to dynamic stretching, passive stretching is more effective in improving the joint range of motion at rest. Proprioceptive Neuromuscular Facilitation (PNF) stretching has been reported to be superior to passive stretching in improving flexibility (Caplan et al 2009). Proprioceptive Neuromuscular Facilitation (PNF) techniques utilizing a specific sequence of passive stretching and isometric contractions provide a distinct improvement in muscle flexibility and power(Sharman et al 2006 Dzau et al 2019). PNF techniques require assistance, thereby making it difficult to perform. Two of the most used PNF techniques are the contract-relax (CR) and the contract-relax-antagonist-contract, popularly called as CRAC, (Dent et al 2019).

Maddigan et al (2012) have demonstrated that unaided PNF stretching with the help of a strap is equally effective in the normal population. Later, Burgess et al (2019) have shown that CRAC is a safe and effective method of improving hamstring flexibility. Even though the literature is scarce about the effect of PNF stretching on older adults it is often used to improving flexibility associated with physical activity and exercises. Given the contentious nature of research that has assessed the link between hamstring performance, flexibility, and injury. In addition to this, till date, no study has assessed the impact of self-administered CRAC stretching on the performance of hamstring curls to fatigue in the older adults. Therefore, the purpose of this study is to determine the effect of self-administered CRAC stretching on the performance of hamstring curls to fatigue in the older adults.

MATERIAL AND METHODS

Active older adults aged between 50 to 70 years, with no restriction in hip, knee, and ankle joint with grade 5 muscle strength on manual muscle testing scale, were included in the study. Participants having any musculoskeletal injuries, neurologic, cardiovascular, or any other disease affecting lower-limb, or any sensory-motor deficit were excluded from the study. Participants with cognitive deficit or non-compliant participants were excluded from the study. Informed written consent was taken from the subjects after explaining the risk factors, purpose, and procedure of the study, and participants were informed that they had the right to withdraw from the study at any stage. The same subjects were repeated with measure experimental crossover design. The participants were randomly allocated into two groups by lottery method and both the groups were given the Self-Administered CRAC stretching in alternate sessions to overcome the order effect. To achieve this in the first session Self-Administered CRAC stretching was given to the first group and in the second session subjects from the second group got self-administered CRAC stretching. The outcome variable was the maximum number of hamstring curls performed after the stretching. All the measurement was collected during a single session. Both the groups had fifteen subjects and were matched for age, sex, and body mass, to get a uniform sample.

Participants' maximal voluntary isometric contraction was established by strain gauge method before any intervention (Dara et. al. 2007). The subject was rested for 10 minutes and then performed submaximal warm-up exercises on the cycle ergometer. After the warmup, the subjects from the experimental group performed Self-Administered CRAC Stretching based on the protocol given by Maddigan et. al. (2012). The stretching was performed with the subjects lying supine on the couch with the contralateral leg secured to the couch with a strap placed over the upper thigh. The participants raised their legs straight up with a belt placed around the sole. Holding on both the ends of the belt the leg was pulled towards the torso until a mild stretch is felt in the hamstring. This position was maintained for seven seconds then the participants, isometrically contracted the hamstring and held it for seven seconds by attempting to push the leg back toward the table against the resistance of the belt by holding it tight and not letting the leg move. Maintaining this position, they relaxed the muscle for five seconds and stretched it again for seven seconds. The sequence they followed was 7 seconds of stretch, 5 seconds of isometric contraction, 5 seconds relax, and finally, seven seconds of stretch again, which was repeated five times on each subject. Subsequently, they performed as many hamstring curls as they can at a load of 70% of maximal voluntary isometric contraction, (Maddigan et al 2012, Huygaerts et al 2020).

The participants in the control group did not perform stretching instead after the rest period they performed as many hamstring curls as they can at 70% of maximal voluntary isometric contraction load. After 5-7 days of the gap, readings for the second session were collected while reversing the order of giving the Self-Administered CRAC stretching to the second group and then measuring the number of hamstring curls to fatigue. The first group performed hamstring curls to fatigue without Self-Administered CRAC stretching. The maximum numbers of hamstring curl were noted for both groups and in both test sessions.

RESULTS AND DISCUSSION

All the data were tabulated and analyzed using SPSS version 20. Demographic data of subjects including sex, age, height, and weight were descriptively summarized. To find the Self-Administered CRAC stretching on hamstring curls to fatigue performance, t-test was used keeping

the value of α=<0.05. In this study, we have taken 30 subjects with a mean age of 59.3+3.1 ranging from 50 to 68 years, average weight of 64.1+6.2 kilograms, and with a mean height of 164.1+4.9 centimeters. Required statistical test were performed to find out the effect of the experiment on the dependent variables, these findings are mentioned below. In the first session the participants who received CRAC stretching (M = 8.5, SD = 1.9) compared to the participants in the control group (M = 10.7, SD = 1.8) demonstrated significantly more hamstring curls to fatigue, t = 3.412, p = 0.002. A similar pattern was observed in the second session as well, where the number hamstring curls to fatigue, performed by the subjects getting CRAC stretching were less (M = 10.2, SD = 2) compared to the participants of control group (M = 12.9, SD = 2.4), which was a statistically significant t =3.356, p = 0.002 (Table 1).

A reduction of 21% and 20% hamstring curls were observed in the participants getting CRAC stretching respectively, in the first and second session. The results from the first session (M = 8.5, SD = 1.9) and second session (M = 10.2, SD = 2) on the performance of hamstring curls to fatigue showed an improvement, t = 2.229, p = 0.043 in the participants getting CRAC stretching (Table 1).There was a significant increase in the number of hamstring curls to fatigue performed by the participants in the control group between the first (M = 10.7, SD = 1.8) and second session (M = 12.7, SD = 2.4), t = 3.090, p = 0.008 (Table 1).

Table 1. Effect of CRAC stretching on hamstring curls to fatigue during two different sessions

	CRAC Stretching N=15		Control N=15		t-test	
	Mean	Std. Deviation	Mean	Std. Deviation	t	Sig. (2-tailed)
NHC_S1	8.5	1.9	10.7	1.8	3.412	.002
NHC_S2	10.2	2.0	12.7	2.4	3.156	.004
Paired t-Test	T	2.229	3.090			
	P	0.043	0.008			

In our study, we have used a self-administered contract-relax-antagonist-contract (CRAC) stretching technique. A single session of CRAC stretching has demonstrated a reduction in performance during hamstring curls to fatigue in the subjects. The result of our study is consistent with previous reports of a transitory decline in muscle performance after stretching. Behm et. al. (2015) have reported that the decline in muscle performance is mainly due to a decrease in motor unit activity and suggested it to be protective in nature as it prevents extreme fatigue of the muscle fiber by decreasing the frequency of the action potential. In a similar study, Davis et al. (2005) showed improved flexibility after a contract-relax agonist PNF stretching protocol but it was not found to be better than static or active-controlled stretching. However, the most likely factor for the difference between our studies is the fact that our participants belonged to the older adults, which might have affected their ability to be flexible. O'Hora et al. (2011) study also demonstrated a similar finding of enhanced flexibility due to agonist contract-relax PNF when compared with static stretching on hamstring length.

Recently, Caldwell et al. (2019) in their study, examined the effects of stretching on quadriceps muscle and showed a substantial reduction in the strength, but contrary to this, Palmer et al. (2019) observed a decline in muscle power only after stretching for longer duration. In another study Kay and Blazevich (2008), they demonstrated that sustained stretching of the muscle resulted in decreased muscle performance, but brief stretching does not adversely affect it. Another study by Reid et al. (2018) demonstrated an improvement in the knee flexibility and range of motion in response to stretching on the knee, they further elaborated that the stretching duration of ≤60 does not affect the maximum isometric power but with increased duration, there was a clear reduction in the muscle power.

The result of the study by Blazevich et al. (2018) was also similar as it showed no negative effect of short duration stretching exercised on muscle power. Bengtsson et al. (2018) examined the effect of sport-specific exercises on peak torque of the knee extensors and showed that stretching does not hamper muscle performance. Blazevich et al. (2018) also reported a beneficial effect of stretching on motivation due to the participant's belief that it can enhance their performance irrespective of type and duration of stretching. These findings contradict the widespread opinion that stretching inhibits performance and emphasizes the role of stretching duration on muscle power and performance (Pulverenti et al., 2019).

As our findings indicated as well as previous studies have shown that an acute bout of muscle stretching can improve flexibility but adversely affect the force output and performance. However, in a community or clinical setting, the mild to moderate decrease in muscle performance may not be relevant as the main objective of stretching in these settings are to achieve

a pain-free function for an active lifestyle. During the rehabilitation period, regaining functional range of motion is more important than maximal muscle-force production. Therefore, it is safe to recommend the use of short duration stretching as an integral part of the pre-exercise warm-up routine due to its positive psychological effect and its potential to lower the risk of sustaining musculotendinous injuries.

Limitations: The result of this study should be interpreted with caution as the relatively small sample size is going to influence generalization. Further study with proper follow up could be conducted to find out the long-term effects of CRAC stretching.

CONCLUSION

The findings of our study have suggested that enhanced flexibility could be observed with an accompanying decrease in the number of hamstring curls performance in response to self-administered CRAC stretching. These findings are unique in that, to our knowledge, no other authors have examined the effects of CRAC stretching on isolated muscle performance with a repeated measures design. Regarding the mechanisms underlying the stretching-induced performance deficit, the decreases in no of hamstring curls we observed in our study tentatively support the hypothesis that stretching may alter the length-tension relationship and the hypothesis that stretching may reduce muscle activation, respectively. CRAC stretching can be made part of a full warm-up routine because of its positive impact on flexibility and musculotendinous injury occurrence in the physically active older population.

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