IMPACT OF FLEXIBILITY ON MUSCULAR PERFORMANCE OF THE KNEE

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INTRODUCTION

Despite the popularity of stretching programs for sport rehabilitation, little it is known about the relationships between gains in flexibility and changes in muscular performance. This aim of this study was to investigate the impact of static stretching on flexibility of the hamstrings and muscular performance of knee flexor and extensor muscles.

METHODS

Thirty subjects (19 women and 11 men; aged:22.8 ± 4.9 years) with shortened hamstrings (60 legs), operationally defined as the loss of knee extension greater than 30°, took part in the study. Measures of flexibility were obtained with a goniometer and the amount of applied force was controlled by a manual dynamometer. Muscular performance measures on the isokinetic dynamometer at 60° and 300°/s were obtained before and immediately after the intervention. The intervention program consisted of 30 sessions of static stretching, performed bilaterally five times a week for six weeks. Measures of flexibility were reassessed six weeks after the cessation of the intervention (follow-up). Descriptive statistics and tests for normality (Shapiro-Wilk) were calculated for all outcome measures. The impact of the intervention was investigated using parametric and non-parametric analyses, depending on data distribution (α<0.05).

RESULTS AND DISCUSSION

As presented in Table 1, after the intervention, there were significant gains in measures of flexibility (*p*=0.000) and muscular performance for the following parameters: angle of peak torque for hamstrings at 60°/s and 300°/s (*p*<0.0001 and 0.018); for work normalized by body weight at 60°/s and 300°/s for knee flexors (*p*=0.012 and 0.005); for knee extensors (*p*<0.0001). Of the 10 subjects who comprised the follow-up group, repeated measures ANOVA revealed that gains in flexibility obtained with the intervention, were maintained (p= 0.183).

The observed gains of flexibility corroborated previous findings [1,2]. Considering evidence of stretching-induced sarcomerogenesis [2,3], it is possible to infer that after the intervention, the number of sarcomers in series in the hamstrings increased, and thus, improved their capacity to vary length, which may explain changes of angle of peak torque in the direction of knee extension.

It is possible to speculate that the hamstrings became more capable of moving the leg over a larger angular distance during the same time interval. Increases in the number of sarcomers in series represent a larger capacity of the muscle-tendon unit to vary its length in a certain time interval [4], which can be translated by increases of angular velocity. Therefore, the slope of the curve is increased until the segment reaches the isokinetic programmed speed, generating a larger area below the curve, and thus increasing the generated work.

The observed increases in work generated by knee extensors after the intervention can be related to smaller passive resistance imposed by the knee flexors [2,3], once the range of motion used during tests was the same.

The retention of gains in flexibility can be explained by the fact that the stretching exercises were performed bilaterally and may have allowed the subjects to incorporate these gains in their daily lives, thus, attenuating the detraining effects.

CONCLUSIONS

These findings indicated that the intervention resulted in gains in measures of flexibility and muscular performance and suggest that these gains had a positive impact on various parameters of muscular performance.

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Table 1: Means (± SD) of Outcome Measures over Time

Variable		Pre	Post
Flexibility (°)		142.6 ± 5.9	157.1 ± 11.2
Angle of peak torque (°)	60°	59.2 ± 8.4	55.3 ± 8.4
	300°	88.6 ± 12.9	85.2 ± 15.6
Work of Knee flexors (J/kg)	60°	121.3 ± 27.4	125.6 ± 28.5
	300°	61.2 ± 16.4	63.5 ± 18.5
Work of knee extensors (J/Kg)	60°	240.7 ± 48.0	248.6 ± 53.0
	300°	116.0 ± 27.7	119.3 ± 28.0