Effect of static stretching of ankle plantar flexors on quasi-stiffness of the ankle joint during sprint start

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Summary

This study aimed to examine the effect of ankle dorsiflexion static stretching on ankle quasi-stiffness during the starting phase of sprint running. Two sprinters performed a sprint start from starting block and an isometric ankle plantarflexion test before and after static stretching. Ground reaction forces and kinematics data were recorded during the sprinting. The displacement of the muscle tendon junction (MTJ) of the medial gastrocnemius medialis was measured with the ultrasound apparatus during the isometric plantarflexion development of the ankle on the ankle dynamometer. A decrease in ankle quasi-stiffness coincided with a maximal decrease in plantarflexion torque, hysteresis and tendon-stiffness were observed after static stretching. No change was observed in the ground contact time of the first step, although a greater displacement of the MTJ was also observed after static stretching.

Introduction

Many athletes include static stretching as a part of their warm-up routine to prevent injury and improve performance. However, some reports have suggested that static stretching does not improve muscular strength [1] and jumping performance [2]. Increased joint flexibility as a result of stretching may reduce not only the stiffness of the muscle-tendon unit in the plantar flexors, but also the quasi-stiffness in the ankle during foot contact in the initial phase of the sprint start. Therefore, the aim of the present study was to examine the effect of ankle dorsiflexion static stretching on ankle quasi-stiffness during the sprint start phase.

Methods

The participants were a well-trained male sprinter and a well-trained female sprinter. They performed the ankle plantarflexion test on the isometric dynamometer and one sprint start from starting block before and after 4 sets of ankle dorsiflexion static stretching for 30 seconds each. The muscle tendon junction (MTJ) of the medial gastrocnemius was imaged with an ultrasound apparatus during isometric test. Hysteresis and tendon-stiffness were calculated from the obtained MTJ displacement and plantarflexion torque. During the sprinting trial, ground reaction forces were measured using three force platforms. The sprint starting motion was recorded by a three-dimensional motion capture system. Ankle joint quasi-stiffness was calculated from ground reaction forces and ankle joint angle in the first step. The ROM displacement was calculated from the coordinates of the three points of the knee, ankle, and MTP joints obtained from the three-dimensional motion capture system, and was the difference between the initial angle and maximum dorsiflexion angle.

Results and Discussion

Decreased maximal plantarflexion torque, tendon-stiffness, hysteresis, and ankle joint quasi-stiffness were observed after static stretching. In contrast, the MTJ and ROM displacement increased, but ground contact time that associated with sprint performance [3] did not significantly change (Table 1).

Table 1: Results of before and after static stretching

	A		B	
	Before	After	Before	After
Maximal plantarflexion torque (Nm)	69.72	67.5	114.98	104.08
⊿FL (mm)	11.91	12.51	11.04	13.82
Tendon-stiffness (Nm/mm)	7.46	6.90	9.32	8.20
⊿ROM in isometric (deg)	2.26	2.21	2.03	2.23
Hysteresis (%)	22.24	19.59	17.22	16.64
Quasi-stiffness (Nm/deg)	10.44	9.41	10.98	9.18
⊿ROM in starting (deg)	13.56	13.66	23.57	24.19
Contact time (sec)	0.21	0.20	0.20	0.21

These findings suggest that ankle plantarflexion static stretching may affect factors such as the maximal plantarflexion torque, hysteresis, and stiffness, but not acceleration performance in sprinting. It was possible that gender differences may be related to the trends in the before and after stretching changes of the two participants.

Conclusions

Static stretching decreased achilles tendon-stiffness during isometric ankle plantar flexion and ankle quasi-stiffness during the sprint starting.

References

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