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ARE LONG-DISTANCE RUNNERS SYMMETRIC FOR KNEE ISOKINETIC PERFORMANCE?

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SUMMARY

Leg asymmetries have been suggested as an injury risk for athletes, especially considering landings tasks. It has been suggested that muscular imbalances between legs would contribute to poor movement control and lead to premature fatigue. Here we evaluated the isokinetic performance of knee flexors and extensors in experienced runners.

INTRODUCTION

The relationship of limb asymmetries with injury and performance still are unclear. Asymmetries have been found in the peak isokinetic torque of the knee flexor and extensor muscles of runners [1]. Furthermore, kinematics asymmetries in frontal plane may increase injury risk among runners, as well as asymmetries decreased with changes in running speed and training experience [2]. For landing tasks, both kinetics and kinematics asymmetries are suggested as predictors for injuries such as anterior cruciate ligament (ACL) tear [3,4].

Factors leading to lower extremity asymmetry in runners can include muscle weakness, impaired muscular coordination and muscle strength unbalances [1]. Additionally, asymmetries in flexor to extensor torque ratio were suggested as risk factor for lower limb injury [5,6]. However, this evaluation requires a complete isokinetic assessment of both limbs and for movements of flexion and extension. It involves hours of laboratory testing for the athlete. No previous study discussed the agreement between asymmetries in flexor to extensor torque ratio and asymmetries for peak torque. Flexor and extensor peak torque are possible to test in shorter protocols not requiring long sessions. The purpose of this study was to evaluate asymmetries in knee flexor and extensor isokinetic torque and torque rations in long distance runners.

METHODS

The knee flexor and extensor torque, work and power were obtained bilaterally during isokinetic contractions by means of an isokinetic dynamometer (CYBEX NORM, Ronkonkoma, NY, USA). Asymmetries were investigated by comparing preferred and non-preferred limbs. All tests were performed in one day. Participants were informed of the study protocol and all risks and possible harms as described in the consent form. Ethics approval for this research was obtained from the local Institutional Ethics Research Committee.

Twenty-three male long-distance runners volunteered to participate in this study (mean ± standard deviation for age 18.0 ± 0.9 years old; height 1.73 ± 0.05 m; body mass 64.3 ± 7.9 kg; body mass index 21.38 ± 1.80 kg/m², and body fat of 11.63 ± 2.87%). All runners were healthy and free of injury or symptoms at the time of the experiment. Average training patterns were six days per week, and 70 km of training distance per week.

After warming up on a treadmill (5 min at self-selected pace) they were positioned seated with their hips and thighs firmly strapped to the seat of the dynamometer, with the hip angle at 85°. Dynamometer arm axis was visually aligned with anatomical axis of the knee joint. Gravity-correction procedure was performed according to manufacturer instructions. The range of motion at the knee was about 110° (0° for knee fully extended).

The testing protocol consisted of open-chain isokinetic movements with concentric quadriceps and hamstring contractions (3 repetitions at $60°\cdot s^{-1}$ and 5 repetitions at $240°\cdot s^{-1}$). Three submaximal repetitions were performed for familiarization. The variables analyzed were: peak torque (PT), total work, power, hamstrings/quadriceps ratio, and asymmetric index at $60°\cdot s^{-1}$ and $240°\cdot s^{-1}$. Peak torque, total work and power were normalized for the body mass (%BM) [5]. An asymmetry index (AI%) describing the relative bilateral asymmetry was calculated by the ratio between preferred (P) and non-preferred (NP) limb [5].

Data normality was verified using Shapiro-Wilk test. Data are expressed as mean and standard-deviation (SD). Limbs and angular velocities were compared by using independent t-test. The significance level was set at 0.05 for all comparisons using a commercial statistical package.

RESULTS AND DISCUSSION

Table 1 shows the mean peak torque, total work, and power, and the relationship between flexor and extensor muscle; all variables were comparing preferred and non-preferred limbs at $60°\cdot s^{-1}$ and $240°\cdot s^{-1}$ angular velocities.

Our results showed significant difference between preferred and non-preferred limbs power for knee flexors at 240°·s^{-1}, with preferred limb producing higher values. Therefore, as angular velocity increases, males increase their hamstring to quadriceps peak torque output in order to stabilize the joint and protect the ACL [7]. On the other hand, a previous study with runners found significant difference in the power produced by extensors, where the non-preferred limb achieved larger values [8]. These differences may be related to the lower limb specialization for locomotion. Particularly for overground locomotion, it has been theorized that most right-handed persons and almost all left-handed persons may use non-preferred limb for propulsion, and that mediolateral balance would primarily be controlled by the preferred limb. As a result preferred limb would receive higher mechanical loading, thus becoming stronger [1,9].

Decreased hamstring to the quadriceps (H/Q) ratio is a potential mechanism for lower extremity injuries [10]. A review study suggested that H/Q torque ratio between 50 and 70% increase injury risk [7], results that agree with the present study. In general, bilateral differences in peak torque and torque rations were similar.

Table 1. Mean±standard-deviation values of peak torque (PT), total work (Work), knee flexors and extensors power and the flexor to extensor torque ratio (Flex/Ext) for preferred (P) and non-preferred (NP) limb in the different conditions (60°·s^{-1} and 240°·s^{-1}).

	60°·s^{-1}		**240°·s^{-1}**	
	P	**NP**	**P**	**NP**
Flexors				
PT (%BM)	183.2±30.5	172.9±23.8	115.6±20.4	104.6±18.9
Work (%BM)	208.5±38.4	200.5±31.5	125.1±23.7	112.9±22.7
Power(%BM)	----	----	237.0±45.2*	205.4±53.6
Extensors				
PT (%BM)	301.3±36.0	283.7±36.8	174.8±21.3	169.6±24.2
Work (%BM)	325.3±45.1	306.5±42.9	196.6±24.8	187.5±26.1
Power(%BM)	----	----	351.1±62.9	351.7±50.2
Flex/Ext				
PT (%)	60.7±7.7	61.3±7.5	66.1±8.8	61.6±6.4
Work (%)	63.9±8.4	65.6±7.5	63.8±10.5	60.1±8.1

* Statistical difference ($p<0.05$).

The angular velocity did not influence the asymmetry indexes for PT and total work (Table 2). However, asymmetry index for flexor power was higher at 240°·s^{-1} speed. Overall, previous experimental studies seem to indicate that strength asymmetries of as high as 10% can be common in long distance runners [1]. Furthermore, strength asymmetries found in athletes are most likely observed in modalities involving systematic unilateral movements, which may elicit asymmetric neuromuscular adaptation. That would results, for instance, from asymmetrical distribution of fast and slow motor units or asymmetric motor unit activation in homologous muscle groups [1]. However, strength asymmetries observed in athletes who are systematically involved in symmetric sports activities, such as swimming, cycling, sprinting and distance running, cannot be easily interpreted [1,11].

The knee joint is the most common injured in male runners [12]. Thus, asymmetries between lower limbs increases the risk of knee injury, the affected limb may show motor, neural and structural deficit [13]. Our results suggest that at higher velocities, the hamstring non-preferred limb may presented higher risk injury, which may also increase risk of knee injury.

Table 2. Asymmetry index for flexor and extensor peak torque (PT), total work and power. A negative value means direction of asymmetry to the non-preferred leg.

	AI% Flexion		**AI% Extension**	
	60°·s^{-1}	**240°·s^{-1}**	**60°·s^{-1}**	**240°·s^{-1}**
PT (Nm)	4.16	8.99	5.58	2.95
Work (J)	2.06	8.94	5.18	4.50
Power (W)	2.21	13.1*	2.97	-3.06

* Statistical difference ($p<0.05$).

CONCLUSIONS

Runners presented limb asymmetry for flexors power at 240°·s^{-1}. This observation may have important implication for long distance runners, where at higher speeds may increase the risk of injury.

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