THE EFFECT OF FATIGUE CAUSED BY RUNNING TIME ON THE KINEMATIC PARAMETERS OF THE LOWER EXTREMITY

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INTRODUCTION

The risk of sustaining an injury during running depends on a number of extrinsic factors such as velocity, training frequency, equipment, and the surface. In addition, intrinsic factors, such as the individual's physical and personality traits, can also influence the individual's likelihood of injury(Clanton, 1992). Among these intrinsic factors, fatigue have frequently been associated with injury and pain(Moretto & Bislaux, 1999). Thus, it is important thing to find biomechanical abnormality in a condition of fatigue induced by running time during a prolonged run for predicting the cause of injury. During a prolonged run for 2 hours which is completely fatigue, the kinematic parameters of the lower limb have not been specifically investigated. The goal of the present study was to determine the effect of fatigue caused by the amount of running time on the kinematic parameters of the lower limb during a prolonged run.

METHODS

Fourteen young males served as subjects in this study. (mean age 26±4.6yrs., mean height 170±3.0cm, and mean mass 68±5.1kg). Reflective markers (3 per segment) were placed on the foot, shank, thigh for the purpose of obtaining three dimensional data. All subjects wore the same type of running shoes. Each subject ran up to 2 hours at each preference running speed (mean running speed 3.0±0.4m/s.) on a treadmill. Kinematic data were collected using a 4-camera high speed (200Hz) 3-dimensional motion analysis system at 5, 30, 60, 90, and 120 minutes of running time. The joint and segment angles were calculated using a Joint Coordinate System approach during the stance phase. The angle of the joint to be used for calibration measured during standing for 3 seconds prior to running and averaged it. Each angles for the different running times were compared using a ANOVA test ($p<0.05$).

RESULTS

Table1 summarize all of the maximal values for each running time.

DISCUSSION AND CONCLUSIONS

In this study, the three dimensional angles of the ankle and knee joint which included maximum flexion/extension, inversion/eversion, adduction/abduction, internal/external rotation at stance period were no difference between running times. The maximum pronation of Achilles angle, indicative of injury, was apparently increased after 90 minutes running, which was same to the findings reported by Bruggemann & Arndt(1994).

The maximum pronation angle of the rear foot increased significantly after 90 minutes running in this study. It was speculated that its change caused by running time effected on the external rotation of the tibia with coupling system(Stefanyshyn et al, 1999). This findings supported the results that maximum supination/pronation of the rear foot was increased with increasing fatigue(Bruggemann et al, 1991; Nigg et al, 1986).

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Table 1. Mean & SD of joint and segment angles selected during stance phase(♣:$p<.05$)

Running Time(min.) / Variables / Joint & Segment		5	30	60	90	120
Ankle	Max.	+	+	+	+	+
	Max. Dorsiflexion	+	+	+	+	+
	Max. Inversion	+	+	+	+	+
	Max. Eversion	+	+	+	+	+
	Max. Internal Rotation	+	+	+	+	+
Knee	Max. Flexion	+	+	+	+	+
	Max. Abduction	+	+	+	+	+
	Max. Adduction	+	+	+	+	+
	Max. External Rotation	+	+	+	+	+
Achilles	Max. Supination	9.5±3.7	9.6±2.8	11.0±3.3	10.6±3.3	9.7±4.3
	Max. Pronation	13.9±1.2	13.9±1.4	14.3±0.7	15.2±1.4	16.8±1.3
Rear foot	Max. Supination	8.8±2.5	7.6±1.9	9.5±2.4	7.4±0.6	7.5±1.7
	Max. Pronation	5.2±1.1	5.5±1.1	5.7±0.4	6.4±1.0	7.0±0.9♣
Tibia	Max. Ext. Rotation	3.5±1.2	4.3±1.0	3.7±2.2	6.4±1.3	7.0±0.6♣
	Max. Int. Rotation	9.3±1.4	5.2±1.8	7.4±1.5	6.0±1.2	4.8±2.9