

## VARIANCE OF LOWER LIMB KINEMATICS DURING RUNNING ON TREADMILL

Hidetaka Okada and Ryoya Ozaki

The University of Electro-Communications, Tokyo, Japan

**KEY WORDS:** variance, treadmill running, lower limb kinematics

**INTRODUCTION:** It is empirically known that the less variance of motion is one of the reflectors of skillfulness in sports. There are some investigations which show that the small variance in movement indicates the high repeatability of that motion (Winter, 1983; Ferrario *et al.*, 1995). However, very little information has been obtained about the variance of kinematics during long distance running. The purpose of this study was to clarify the effect of endurance running training and running speed on the intra-individual variance of lower limb kinematics during running in order to investigate the relationship between repeatability of motion and running skill in long distance running at various speeds.

**METHOD:** Ten young adults who read and signed an informed consent were subjects. Five of them were distance runners who usually run long distance (Distance group) and another five were not distance runners (Control group). Subjects were instructed to run on treadmill at four paces (1.67m/s, 2.33m/s, 3.00m/s and 3.67m/s). Each pace session was 2 minutes long and no rest was taken between each session. Reflective markers were attached at subject's toe, fifth metatarsal, heel, ankle joint, knee joint, great trochanter of right leg, cervicale and suprasternale. A digital video camera was set at right angle to the sagittal plane of subject to measure their running motion at 60 fields per second. For 30 running cycles which starts at half point of each pace session, two dimensional coordinates of each marker were obtained by using video digitizing system (Frame-Dias II, DKH Inc.) and auto-tracking algorithm. After coordinates of the markers were filtered with Butterworth low-pass digital filter, stride length, stride frequency and joint angles of ankle, knee and hip during 30 running cycles were calculated from the filtered coordinates of the markers. For each subject, mean, standard deviation (SD) and coefficient of variance (CV) of 30 running cycles were calculated for each variable. Two-way ANOVA was done in order to test the significant effect of endurance training and running speed on each variable's mean, SD and CV. Multiple comparison with Scheffe's test was done if there were significant main effects of endurance training and/or running speed and significant interaction of them.

**RESULTS AND DISCUSSION:** Figure 1 shows variance of joint angles during 30 running cycles. Subject L (Control group) shows larger variance of joint angles than Subject Q (Distance group). From the results of statistical analysis, CV of maximal ankle dorsi-flexion and maximal hip flexion in stance phase has significant main effect of endurance training and Distance group shows smaller CV of them than Control group. Maximal hip extension and flexion during swing phase shows the same results. These results indicate that usual endurance running training may make the variance of lower limb motion smaller.

This study shows that Distance group has smaller variance of motion than Control group.

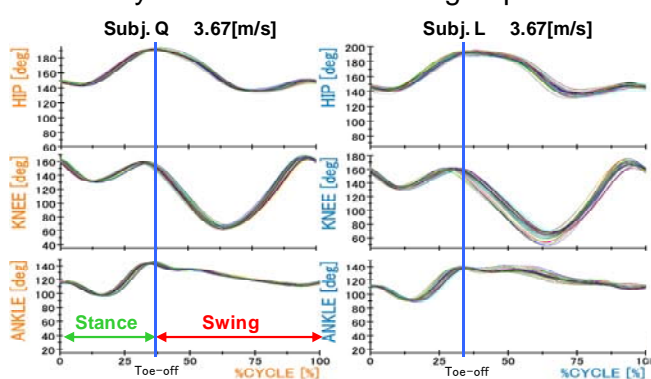


Figure 1 Variance of joint angles (typical examples). Subject Q is a distance runner and Subject L is not a distance runner.

This finding may indicate the possibility that the variance of motion can be used as an index of skillfulness and economy of distance running.

**REFERENCES:**

Ferrario, V.F., *et al.* (1995). Morphological variation analysis: a new method to quantify the repeatability of sport actions. *Coaching and Sport Science*, 1, 29-36.