Changes in running motion of 100 m sprinters with increase in the distance

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INTRODUCTION

Although changes in the velocity, stride length and stride frequency during 100 m sprint have been investigated, there is little information of changes in running motion, joint torque and joint torque power of the lower limb with increase in the distance and change in velocity. The purpose of this study was to investigate the changes in the running motion occurring at every 10 m in 100 m sprint.

METHODS

Nine male and two female sprinters participated in this study. Subjects sprinting 100 m with the maximum effort were videotaped at every 10 m from the start to the 90 m mark with five high-speed cameras (250 Hz) and five normal VTR cameras (60 Hz). Two dimensional coordinates of the body landmarks were obtained by digitizing VTR images over at least one cycle of every 10 m. Performance descriptors, kinematics and kinetics of the lower limb joints such as stride length, stride frequency, joint angles, joint torques, joint torque powers and works were calculated with an inverse dynamics approach. These variables were compared between adjacent marks, every 10 m, to identify the changes with the distance.

RESULTS AND DISCUSSION

The velocity of all the subjects rapidly increased from the start to the 30m mark, increased gradually to the 60 m mark, and then decreased from the 70 m mark to the goal.

Figure 1 shows typical changes in the angular velocity of the hip, knee and ankle joints and the support leg at the 60 m and the 70 m marks. The maximal knee extension velocity and hip extension velocity at 60 m mark were larger than that of the 70 m mark. There was larger difference in the angular velocity in the second half between the support leg and the hip at the 60 m mark, which indicates less effective leg motion during the support phase of sprinting (Ito et al., 1994). In the 70 m mark the leg swing velocity, the hip and the knee extension velocity decreased, but the maximal ankle extension velocity increased.

These kinematic results indicate that the pattern and magnitude of the hip extension velocity and the leg swing velocity do not always coincide if the sprinter depends more on knee extension to increase. The leg swing velocity and the hip extension velocity coincided well at the 70 m mark, the knee extension velocity and the hip extension velocity decreased. To compensate these decreases due to fatigue, he might increase ankle extension velocity. However, his leg swing velocity decreased and the decrease of sprinting velocity occurred as a result.

Figure 2 shows typical patterns of the joint torque power (JTP) at the hip of the swing leg from the 40 m to the 80 m marks. The largest positive JTP was exerted by the hip flexors in the early recovery phase and by the extensors in the late recovery phase at the 60 m mark. Although the joint torque power of the knee was not indicated in Figure 2, the largest negative power was observed at the knee joint flexors in the
late recovery phase at the 60 m mark. Although general patterns of JTP of the hip and knee of the swing leg unchanged with the increase in the distance, the peak JTP in the late recovery phase increased from the start to the 60 m mark, and then decreased gradually to the 80 m mark. Furthermore, although the time of appearance of the peak JTP delayed with the increase in sprinting velocity and because closer to the instant of the foot strike when sprinting velocity decreased.

These results indicate that one of the factors to maintain the velocity in 100 m sprint was JTP exerted by the hip flexors in the early recovery phase and the hip and knee JTP by extensor and knee flexors in the late recovery phase. Moreover, it may suggest that the time of appearance of peak JTP should be paid attention as well as its magnitude to obtain insights into 100 m sprint running.

**Figure 1** Typical patterns of angular velocity changes in the hip, knee, ankle joints and the support leg at the 60 m and 70 m marks.
Figure 2 Typical patterns of changes in the joint torque power at the hip joint of the swing leg from the 40 m to the 80 m mark.

REFERENCES