

THE CHANGES IN SPRINT RUNNING MOTION IN THE ACCELERATION PHASE OF 100 METRE RACE

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INTRODUCTION

The 100 metre sprint has been frequently divided into 1) acceleration phase, 2) maximal velocity phase, and 3) deceleration phase. Some investigations indicate that the maximal velocity is a most important factor for an excellent record of the 100 metre race. However, many sprinters and coaches have frequently pointed out there must be some switching between the first acceleration phase in which a sprinter increases his velocity quickly from a start and the second acceleration phase where he is gradually reaching the maximal velocity in spite of a small increase in velocity. However, there was less information and evidences to support their feeling of the second acceleration, and if so, it is significant to investigate what motion changes occur during this phase because the information will help sprinters and coaches to design a technical training to increase the maximal velocity.

METHODS

Nine male sprinters (100m P.B., 10.71 ± 0.16 s) were videotaped from the start to the 59m marks in the official 100m races with ten high-speed cameras (250 fps) which were positioned at the 2, 8, 14, 20, 26, 32, 38, 44, 50 and 56m marks from the start line for two-dimensional motion analysis. The sprinters ran in the third lane were analyzed, without sprinter in the first and second lanes. The coordinates of the twenty-three segment endpoints of the body were obtained by digitizing at 125Hz. The coordinate data from each race were combined to a series of data from the start to the 59m marks.

The combined coordinate data were filtered with a Butterworth low-path digital filter cutting off at 5-10Hz for the X coordinate and 7.5-12.5Hz for the Y coordinate, the optimal cut-off frequencies decided by a residual method.

Linear and angular kinematics of the joints and body segments, and the whole body center of gravity (CG) were calculated. Joint kinetics of the swing leg in each cycle of running were also calculated by an inverse dynamics.

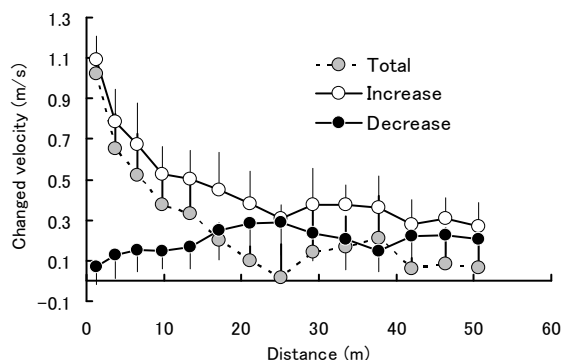


Figure 1: Changes in the increased and decreased CG horizontal velocities during the support phase from the start to the 59m mark.

RESULTS AND DISCUSSION

Average and S.D. of the race time, maximal velocity and distance from the start to the point of the maximal velocity were 11.20 ± 0.31 s, 10.23 ± 0.40 m/s, 52.83 ± 8.85 m, respectively.

Figure 1 shows the changes in the increased, decreased and total changed CG horizontal velocities during the support phases. In the support phase, the CG horizontal velocity usually decreases at the first half and increases in the second half. The whole velocity change is a total of the decrease and increase velocities. The velocity decrease in the support phase gradually grew from the 1st cycle to the 8th cycle, and then decreased from the 25m mark. The velocity increase in the support phase rose quickly at the 1st cycle and acutely decreased to the 8th cycle, followed by an increase beginning at the 25m mark. As a result of these changes, the total velocity change became close to zero at the 8th cycle, and then increased a little bit.

Figure 2 shows the changes in the angular velocities of the support leg, shank and thigh at the support leg touchdown. The thigh angular velocity did not change remarkably during the acceleration phase with a slight decreasing from the 30m mark. The shank angular velocity increased largely throughout the acceleration phase. As a result of these changes, the support leg angular velocity increased throughout the acceleration phase. The shank angular velocity became faster than that of the thigh angular velocity after the 8th cycle. This means that the support knee joint at the touchdown tended to be flexed.

The changes in the CG horizontal velocity and leg motion occurred at the same cycle in the acceleration phase. These results imply that some switching of the sprint running motion took place around the 8th cycle, 25m mark, and that this point can functionally divide the acceleration phase of the 100m race.

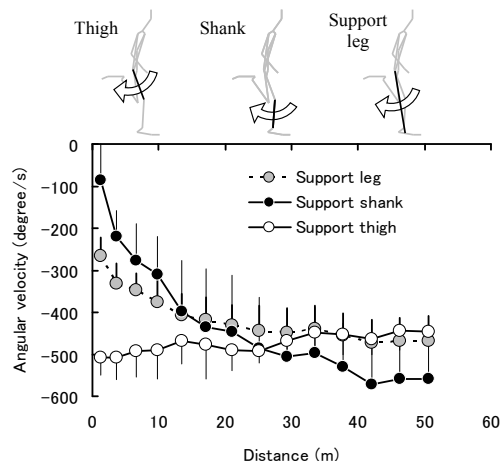


Figure 2: Changes in the angular velocities of the support leg, shank and thigh at support leg touchdown.