KINEMATIC AND KINETIC COMPARISON OF ELITE AND WELL-TRAINED SPRINTER DURING SPRINT START

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INTRODUCTION

To reach a higher maximal velocity, the starting block phase and subsequent acceleration phase are two extremely important phases which directly generate the results in a 60 m and 100 m sprint. Many authors have been interested in the biomechanical factors of these two phases in order to explain the key factors of the sprint performance [1-6]. However, little data have been published for elite sprinters.
The purpose of this study was to compare the major kinematic and kinetic parameters of elite and well-trained sprinters during these phases of the sprint start.

METHODS

Six elite sprinters (10.07 to 10.43s / 100 m) and six well-trained sprinters (11.01 to 11.80s / 100 m) equipped with 63 passive reflective markers, realised four maximal 10m sprints start on an indoor track. An opto-electronic Motion Analysis® system consisting of 12 digital cameras (250 Hz) was used to record the 3D marker trajectories. The 3D marker trajectories were computed and then corrected by a low-pass filter (Butterworth, fourth-order, with a cut-off frequency of 8 Hz). Segment kinematics, during the starting block phase and the two first steps of the acceleration phase, were reconstructed from the 3D marker trajectories according to ISB recommendations [8, 9]. Angle values calculated in this study corresponded at the angles of flexion-extension. Moreover, from 3D marker trajectories, the segment mass, position of the centre of mass and inertia tensor were estimated from scaling equations [7].

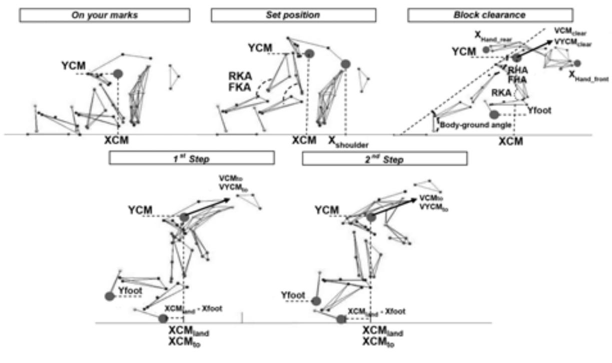

Figure 1: The five critical instants used to analyse the kinematics data.

At the times "On your marks", "Set", "clearing the block", "landing and toe-off of the first and second step" (Figure 1), the horizontal position of the centre of mass (CM), its velocity (XCM and VCM) and the horizontal position of the rear and front hand (XHand_rear and XHand_front) were calculated. During the pushing phase on the starting block and the two first steps, the rate of force development (RFD) and the impulse (Fimpulse) were also calculated.

RESULTS AND DISCUSSION

The main results showed that at each time XCM and VCM were significantly greater in elite sprinters (Figure2).
Moreover, during the pushing phase on the block RFD and Fimpulse were significantly greater in elite sprinters (respectively 15505 ± 5397N.s-1 and 8459 ± 3811N.s-1 for RFD ; 276.2 ± 36.0N.s and 215.4 ± 28.5N.s for Fimpulse, $p \leq 0.05$). Finally, at the block clearing, elite sprinters showed a greater XHand_rear and XHand_front than well-trained sprinters (respectively 0.07± 0.12m and -0.27 ± 0.36m for XHand_rear; 1.00 ± 0.14m and 0.52 ± 0.27m for XHand_front; $p \leq 0.05$).

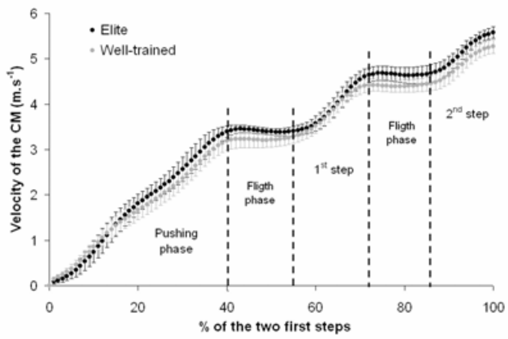

Figure 2: Evolution of the velocity of the (CM) during the pushing phase and the two first steps.

CONCLUSIONS

The present study shows that to start faster, the elite sprinters placed their CM as close as possible to the finish line. It seems that their greater "explosive muscle strength" and better arm coordination allowed them to have a greater RFD and impulse and thus a greater velocity of their centre of mass from the block phase until the toe-off of the second step. Detailed information on starting block phase and on the first metres of the run could be of great importance for coaches in order to understand better the specific movements of both these phases and to develop them.

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