A change of angular momentum during the approach phase into the curved path in sprint running

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Summary: This research aimed to examine how the angular momentum would influence the inclination phenomenon during the approach phase into the curved path in sprint running. Sprinting during the approach phase into the curved path (radius:38.2 m) was measured using 50 force platforms and a motion capture system. Then, the angular momentum around the center of mass was calculated. It was concluded that an imbalance of the positive and negative anteroposterior angular momentum causes the inclination phenomenon.

Introduction: There is a curved path in sprint events in athletics, such as the 400-m race event. Sprinters incline their body toward the centripetal direction in the curved path [1,3]. This inclination phenomenon could be a critical skill for curved sprinting because the ground reaction force has to act on sprinters toward the centripetal direction each step for the continuous directional change in the curved path. Therefore, this research aimed to examine how the angular momentum would influence the inclination phenomenon during the approach phase into the curved path, which is seen in the 400-m race event.

Method: The objective of the experiment was to obtain kinetic and kinematic parameters during the approach phase into the curved path with a radius of 38.2-m in sprint running. Fifty force platforms (TF-90100, Tec Gihan, Uji, Japan; 500 Hz) and a motion capture system (MAC3D, Raptor-12HS; 250 Hz) were adopted for this experiment. These force platforms were embedded under the track surface, and there was a tiny space (5 mm) between the force platforms. Ten volunteer male collegiate sprinters (mean ± SD: age, 20.9 ± 0.8 y; stature, 1.70 ± 0.04 m; mass, 65.8 ± 4.1 kg; personal best 200-m race time, 22.30 ± 0.51 s; 400-m race time, 50.26 ± 1.06 s) were recruited for this study. The experiment was conducted after being approved by Keio University SFC research ethics committee on June 26th, 2017. The participants, wearing their spiked shoes, performed five approaching runs toward the curved path at their own 90-95% effort. A whole human body was modelled as 15 rigid body-linked segments. The inertial parameters of each segment were calculated using the study of Yokosawa et al. [4]. The angular momentum around the center of mass (CM) was calculated as (1),

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$$\boldsymbol{H}_{CM} = \sum_{i=1}^{15} [(\boldsymbol{r}_i - \boldsymbol{r}_{CM}) \times m_i(\boldsymbol{v}_i - \boldsymbol{v}_{CM}) + I_i\boldsymbol{\omega}_i] \quad (1)$$

where $\boldsymbol{r}_i$, $\boldsymbol{v}_i$ and $\boldsymbol{\omega}_i$ are the position, velocity and angular velocity vectors of the i^{th} segment, $\boldsymbol{r}_{CM}$ and $\boldsymbol{v}_{CM}$ are the position and velocity vectors of the center of mass (CM), and m_i and I_i are the mass and inertia moment of the i^{th} segment [2].

Result & Discussion: The inclination phenomenon in the curved path might be caused by larger negative anteroposterior angular momentum than positive angular momentum. The sum of the positive and negative anteroposterior angular momentum was almost zero during the first cycle (Fig. 1). However, those angular momentums were unbalanced at the second and third cycles (Fig. 1).

Conclusion: This research concluded that the imbalance between the positive and negative anteroposterior angular momentum results in the inclination phenomenon during the approach phase into the curved path.

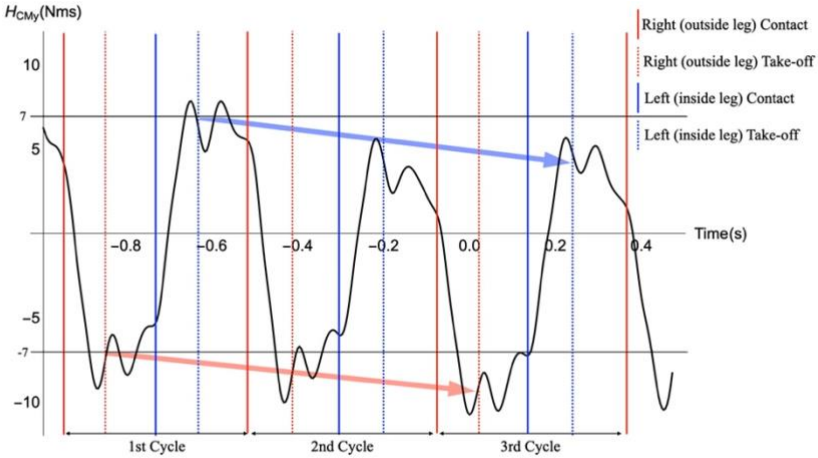

Fig. 1: A typical time series data of the anteroposterior angular momentum (0.0 sec is defined as the timing of the CM position's transition from the straight path to the curved path)

Reference

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