KINEMATICAL CHARACTERISTICS OF BICYCLE KICK AND SIDE VOLLEY IN SOCCER

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INTRODUCTION: There exist various techniques for successfully gaining goals: maximal instep kick, bicycling kick and/or side volley. However, due to test constraints, difficulty in multi-dimensional signal exploration and the complexity of total body control, there is hardly any scientific study that describes bicycle kick and side volley (Shan & Westerhoff, 2005). The current study tried to address this deficiency by 1) providing 3D kinematical characteristics of these two techniques using a 15-segmental full body model and 2) exploring possible parameters for quantitative evaluations of the kick quality.

METHODS: The study involved the synchronization of 3 measuring systems – motion capture (VICON v8i, 12 cameras, 120 Hz, accuracy < 1.5 mm), video recorder, and sound capture – as well as biomechanical modelling. The VICON system tracked 42 reflective markers (12 mm) on the subjects' body and 3 on the soccer ball. The captured data was used to create 3D reconstructions of the movements and served as inputs to a 15-segment model in order to calculate range of motion of joints and other parameters. Video and sound capture permitted a traditional external view of motion analysis.

To evaluate the kicks, 5 male college team players (<26 yrs, over ten-years of experience) were tested. The kicks were conducted on a 2 cm thick wrestling mat (to mimic the grass of a soccer field). A damping curtain of 5X7 m^2 was used to reduce rebound of the kicked ball, preventing equipment damage. Each subject completed three good kicks using his dominant foot.

RESULTS AND DISCUSSION: The 3D kinematics revealed the following features.

Bicycle kick: 1) Just before takeoff, non-kick side (NKS) leg moved toward the athlete's chest, as the trunk reached a horizontal position. The instance angle between the two thighs would determine the kick power. 2) In airborne phase, the kick side (KS) knee remained flexed during the downwards sweeping movement of NKS leg with extended knee. Simultaneously, KS leg moved upwards via flexion of KS hip. Because of the difference between the moments of inertia of flexed and extended legs, the flexion of KS hip was faster than the simultaneous extension of NKS hip. 3) Shortly before ball contact, an explosive extension of KS knee was observed, which formed a powerful whip-like movement of KS leg.

Side volley: 1) Before the volley, athletes' trunk and hips rotated away from the goal. 2) During the takeoff, NKS leg was raised while the trunk and hip reversed rotational directions and came to twist toward the goal; at the same time, the trunk approached a more horizontal position. 3) While airborne, the kicking foot followed a smooth rainbow-like trajectory accompanied by continuous body rolling towards the goal.

The results of this study reveal that the upper body movement contributes notably to soccer kicks, which was hardly revealed by previous studies. First, larger angle between thighs at takeoff and whip-like movement of KS leg creates a more powerful bicycle kick. Second, the twist of trunk and hip before takeoff and the following directionally-reversed body rolling during takeoff and airborne are keys for the quality of side volley. Lastly, timing is the most crucial element for bicycle kick and side volley.

CONCLUSION: soccer kicks represent a full body, multi-joint coordination. 3D motion capture and full-body biomechanical modeling could help us extract the essence of the kicks for better understanding and coaching as well as improving the skill in practice.

REFERENCE:

Shan, G.B., & Westerhoff, P. (2005). Full-body kinematic characteristics of the maximal instep soccer kick by male soccer players and parameters related to kick quality. *Sports Biomechanics*, 4(1): 59-72.

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