THE LATEST UNDERSTANDING ON SOCCER KICKING MECHANICS

[1] Hiroyuki Nunome

[1]Reserach Centre of Health, Physical Fitness & Sports Nagoya University;
email: nunome@htc.nagoya-u.ac.jp

INTRODUCTION

Many attempts have been made to explore "kicking mechanics" for soccer maximal kicking and most of them consistently showed reducing angular and/or linear velocity of the distal segement of kicking leg immediately before ball impact. The descending nature of the kicking leg motion has been interpreted as a motor control strategy for "enhancing accuracy" (Teixeira,1999). However, this strategy seems inconsistent with coach's instruction and thus emphasises a considerable gap between practical instruction and scientific knowledge.

Recently, our research group succeeded in illustrating representative kinematics of soccer instep kicking using advanced technology. The nature of the shank angular kinematics immediately before impact was very different than those reported previously (Nunome, Lake et al., 2006a).

Once the movement characteristics of the swing leg had been clarified, its background dynamics must then be re-considered. Our research group again demonstrated representative kinetics of soccer instep kicking (Nunome, Ikegami et al., 2006b; Apriantono, Nunome et al., 2006).

These new kinematic and kinetic nature of soccer instep kicking will be summarized in this paper.

METHODS

Kinematics:

Studies that have documented kicking motion have typically captured limb movements at sample rates between 100 and 400 Hz and then filtered the displacement using recursive digital low-pass filtering with a cut-off frequency of 6 to 18 Hz. Although these methods were appropriate for describing the swing phase kinematics, it was assumed that they are inadequate to describe transient movement characteristics of the kicking leg motion through ball impact which includes a systematic and drastic change in the data's frequency content. To overcome these issues, high sampling rate (1000 Hz) and a new filtering procedure (time-frequency filtering) were used to report representative kinematics

Kinetics:

Putnam (1991) was the first study which revealed the substantial influence of the 'motion-dependent' moment on several typical proximal-to-distal sequences of limb segment motions, including soccer punt kicking. Her model was applied to demonstrate the detailed time-series changes of both joint and motion-dependent moments in the instep kicking. As the change of the moments near ball impact is very sensitive to data treatments, the non-smoothed moment data were extrapolated using a polynomial regression. The additional extrapolated data avoided the end point distortion produced by filtering artifacts. After these extrapolations, all parameters were smoothed by a fourth-order Butterworth filter and then the extrapolated region was removed.

RESULTS AND DISCUSSION

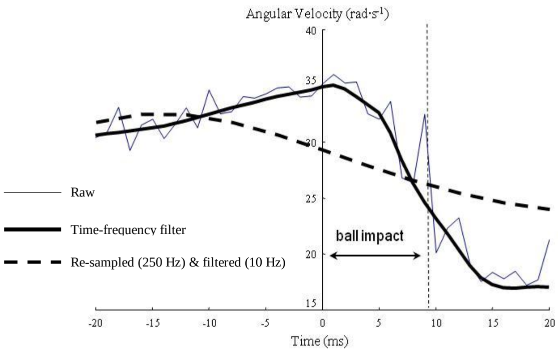

Figure 1: The shank angular velocity changes through ball impact in three different filtering and sampling techniques.

The nature of the shank angular kinematics immediately before impact was very different than those reported previously; specifically the shank was still accelerating until ball impact (Figure 1). In contrast, a typical descending change was reproduced by down-sampling of the data (to 250 Hz) and applying the conventional filter with low and constant cut-off frequency (at 10 Hz).

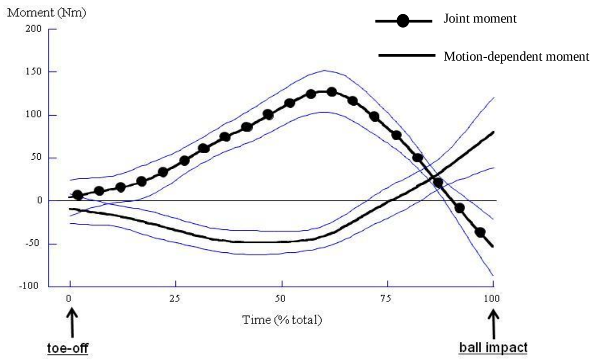

Figure 2: Changes in joint and motion-dependent moment at knee joint during leg swing of soccer instep kicking.

The knee extension moment rapidly decreased and began to exhibit a reverse (flexion) moment immediately before ball impact, while the motion-dependent moment rapidly increased to exhibit an extension moment to ball impact (Figure 2). It can be suggested that the motion-dependent moment helps to compensate for the inhibition of the muscle moment, thereby serving to increase the angular velocity during the final phase of kicking. Moreover, the effective action was obscured when muscle fatigue was induced.

CONCLUSIONS

The latest knowledge that presented in this paper would help to renovate our understandings for soccer kicking and would be applicable for understanding other impact sports. These new evidences strongly support the practical instruction by coaches from a biomechanical perspective thereby helping to fill the gap between coaching practice and biomechanical research.