SEGMENATAL DYNAMICS OF SOCCER INSTEP KICKING

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INTRODUCTION

An open kinetic chain model generally used for the detailed biomechanical analysis of the kicking leg motion allowed the moment due to muscular force input and other sources to be computed separately. Putman (1991) illustrated the actions of the resultant joint moment and motion-dependent interactive moment simultaneously during punt kicking. The procedure was applied by Dörge et al., (2002) to soccer instep kicking. However, as the integrated parameters was solely reported in their study, the time-series changes of the resultant joint moment and motion-dependent interactive moment during soccer instep kicking were still concealed.

The purpose of this study, therefore, was to reveal the detailed time-series actions of the resultant joint moment and motion-dependent interactive moment during soccer instep kicking

METHODS

The kicking motions of five highly skilled club players (age: = 16.8 ± 0.4 yrs; height: = 176.2 ± 6.1 cm; mass: = 70.6 ± 7.2 kg) were captured using a three-dimensional cinematographic technique at 200 Hz. The resultant joint moment (muscle moment) and the motion-dependent interactive moment (interactive moment) were computed using a two link kinetic chain composed of the thigh and lower leg (including shank and foot).

To avoid a systematic distortion of the data caused by ball impact, the moments were computed from unsmoothed coordinates until three frames before ball impact and then extrapolated for fifteen points by a linear regression line. The regression line was defined for each change. To resemble the final change of the data, the final eight to twelve data points were fitted to the linear regression line. For angular velocities, a quadric regression line was fitted to the unsmoothed data in the same manner. After these extrapolations, all parameters were digitally smoothed by a fourth-order Butterworth filter at 12.5 Hz, and then the extrapolated regions after ball impact were removed.

RESULTS AND DISCUSSION

During the final phase of kicking, though the forward hip muscle moment rapidly decreased, its backward moment was rarely seen toward ball impact. This indicated that the backward hip muscle moment had no substantial influence to decelerate the thigh during kicking. As shown in Figure 1, it is obvious that the deceleration of the thigh was initiated by the reaction knee muscle moment as Nunome et al., (2002) argued, and this motion was later emphasized by the interactive moment due to the distal end force.

For the lower leg motion, as shown, the knee muscle moment dominates the lower leg motion until the final phase of kicking.

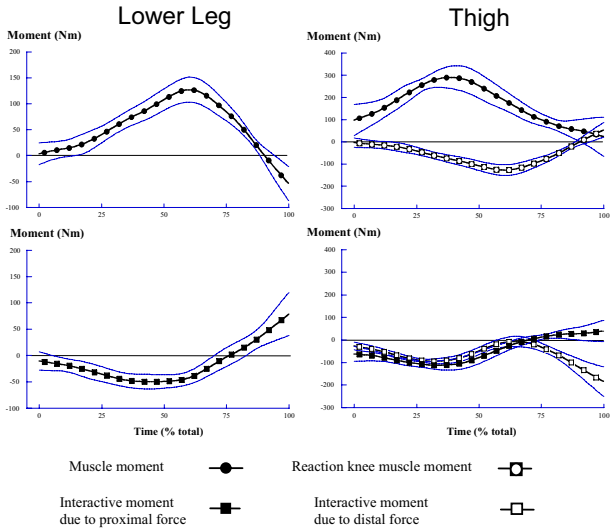

Figure 1: The average (±SD) changes of muscle moment and motion-dependent interactive moment acting on the lower leg and thigh.

After this, the knee muscle moment was rapidly inhibited. It is assumed that as the angular velocity of the lower leg exceeded the inherent force-velocity limitation of muscles immediately before ball impact, the muscular system related to the lower leg motion became incapable of generating any concentric force. Thus, it can be speculated that the backward knee muscle moment was mainly due to the resistance of the muscular system when it was forced to be stretched.

In contrast to the inhibition of the knee muscle moment, the interactive moment began to dominate the accelerative motion of the lower leg immediately before ball impact.

CONCLUSIONS

Detailed time-series data of the muscle moment and interactive moment during soccer instep kicking was clearly illustrated. The deceleration of the thigh was initiated by the reaction knee muscle moment and was later emphasized by the interactive moment due to the distal end force.

The acceleration of the lower leg immediately before ball impact was dominated by the interactive moment due to the proximal end force.

REFERENCES

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