INTRODUCTION

Biomechanical data associated with impact situations involving large accelerations can be prone to error due to inadequate data processing (Knudson and Bahamonde, 2001) and sampling rate. For ball kicking, the movement data at or just before initial ball contact can suffer from such problems, which reduce its usefulness in determining both the quality of the impact and the skill of the player.

The purpose of this study was to describe the true kinematics of lower limb motion during ball impact phase of instep kicking by exploring the influence of both sampling rate and smoothing procedures of the acquired motion data on the resulting movement transients.

METHODS

Nine male footballers (age = 27.6 ± 5.6 yrs; height = 175.1 ± 5.5 cm; mass = 74.5 ± 8.2 kg) participated in this study. Three-dimensional motion of the foot, shank and ball during maximal instep kicking were recorded using a six camera opto-electronic motion analysis system (ProReflex, Qualisys Inc., Sweden) operating at 1000 Hz.

The angular velocity of the leg before, at and during ball contact was determined using the co-ordinate data after different processing approaches. The displacements were smoothed by a 2nd-order dual low-pass Butterworth digital filter at 200 Hz cut-off (BWF) and also processed using a modified version of the time-frequency filtering algorithm (based on the Wigner representation (WGN)) described by Georgakis et al. (2002). Also, the co-ordinates were resampled at 250 Hz but not smoothed (RSR) and finally, the resampled data were filtered by the same Butterworth digital filter using a 10 Hz cut-off (RSF) to resemble typical sampling and processing conditions used in previous studies.

RESULTS AND DISCUSSION

The typical change of shank angular velocity computed using the four different filtering schemes (WGN, BWF, RSR and RSF) are shown in Figure 1. As shown, the angular velocity of shank was increased during the final phase of kicking and reached its peak magnitude just after ball impact. In contrast, a decrease in speed before ball impact has been consistently characterized more accurately.

The new time-frequency filtering approach was found to be successful at smoothing data before and during ball impact. Although the data of the BWF case seemed to trace the rapid change, its pre-contact base line was still noisy (figure 1). This caused a slight but significant over-estimation of the peak shank angular velocity (31.5 ± 5.0 rad/s vs. 31.8 ± 5.1 rad/s). The signal of WGN removed the noise on the base line, yet maintained the peak of the rapid change, thereby showing the advantage of the time frequency filtering technique. The results of the present study clearly show that the conventional Butterworth filtering is insufficient to remove the noise of signal having both high and low frequency components.

SUMMARY

The present study proposes a new time-frequency filtering technique as a better way to smooth signals whose frequency content varies dramatically with time, by which the movement transients during impacts such as ball kicking can be characterized more accurately.

REFERENCES