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Kinetic Analysis of Instep and Side-foot Kick in Female and Male Soccer Players

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Abstract

The purpose of this study was to identify the kinetics of instep and side-foot kicks for female and male soccer players to understand the common and different mechanics underlying the two kicks. 6 female and 6 male soccer players performed maximal instep and side-foot kicks. Their motions and ground reaction forces were recorded by a motion capture system (250 Hz) and a force platform (1000 Hz). The ball velocity of the instep kick (22.5 ± 1.0 m/s for female players, 27.9 ± 1.3 m/s for male players) was significantly higher than that of the side-foot kick (21.5 ± 1.0 m/s for female players, 26.9 ± 1.3 m/s for male players). Significant differences were also observed between the two kicks of female players for the value of hip flexion/extension torque. Moreover, significant differences were also observed between the female and male players for the value of hip adduction/abduction torque for side-foot kick. These results indicated that to enhance such hip torques is one of the technical elements that could be improved to increase ball velocity of side-foot kick in female players.

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Keywords: Female soccer players, Instep kick, Side-foot kick;

1. Introduction

Recently, the competition level of female soccer has increased with the increasing player population. The game is also becoming more sophisticated, with demands for stronger shooting and faster passing. Therefore, a kicking technique for increasing the ball velocity is suggested to have become extremely important for achieving a high performance from female soccer players. The ball velocity of female players is considered to be slower than that of male players (Tant et al.,1991; Barfield et al., 2002). Physical factors such as the body frame or muscle strength can be cited as primary reasons for the slower ball velocity of female players, but other than that, we suggested that technical factors such as the swinging technique, ball impact technique, and others may be influencing the ball velocity. Many previous studies have been conducted on the kicking techniques of male players (Lees et al.,1998; Nunome et al., 2002), and only a very few studies have been performed using female players as participants (Shan, 2009; Orloff et al., 2008). However, no study has focused on the three-dimensional kinetics of these kicking techniques for female players. Thus, the kinetics of the instep and side-foot kicks have not been quantified appropriately. The joint torque for the swinging technique and kinetic chain technique are considered to be the most fundamental elements of the kicking technique. We suggest that comparing such technical elements between female and male players is critically important for revealing the characteristics and issues of the kicking technique of female players to improve their soccer performance.

This study examined the technical characteristics related to the swinging motions of female players by focusing on the instep kicking motions of university male and female soccer players.

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2. Methods

2.1. Participants and Experimental Procedure

The participants were 12 players specializing in soccer at a university with a department of physical education (6 females, 158.7 ± 6.7 cm in height and 58.0 ± 5.7 kg in weight; 6 males, 175.0 ± 5.8 cm in height and 66.4 ± 6.8 kg in weight). Informed written consent was obtained from all the participants prior participation in this study. All procedures undertaken in this study were approved by the Ethics Committee for the Institute of Health and Sport Sciences, University of Tsukuba, Japan. The experimental task was to execute a kicking motion in which the ball is caught at the instep (Fig. 1a) and side-foot kicks (Fig. 1b). Each participant was asked to warm up, and then, with an ad libitum running start, to kick a soccer ball that had been set down towards a goal 10 m away, using the dominant leg at full force. Imaging was performed using 10 infrared cameras (Vicon Motion Systems, Oxford, UK); three-dimensional (3D) coordinate data for each body part (16 anthropometric points with reflective markers attached) during the kicking motion were collected at 250 Hz. The stationary coordinate system was defined as a right-handed system in which the x-axis is the direction orthogonal to the horizontal kicking direction at the start of the task, the y-axis is the horizontal kick direction at the start of the task, and the z-axis is the vertical direction. The data, including the extrapolated points, were smoothed using a fourth-order phase-shift-free Butterworth digital filter to determine the optimum cut-off frequency (20 Hz) (Winter, 2004). A force platform (Kistler,Winterthur, Switzerland, Type 9287) was installed beside the ball, and the ground reaction force at the point of contact with the supporting leg was measured at a sampling frequency of 1000 Hz.

Fig. 1. Typical of kicks (a) instep kick ; (b) side-foot kick.

3. Results and Discussion

3.1. Average Velocities of Ball and Centre of Gravity of Foot

The average ball velocity for female players was 22.5 ± 1.0 m/s for instep kicks and 21.5 ± 1.0 m/s for side-foot kicks (Fig. 2a). In comparison, the average ball velocity for male players was 27.9 ± 1.3 m/s for instep kicks, 26.9 ± 1.3 m/s for side-foot kicks. Thus, the average ball velocities for two types of kicks were lower for female players than for male players, and the differences were statistically significant ($p < 0.05$). The average ball velocity of instep kick for female players (22.5 ± 1.0 m/s) was almost identical to the that reported in Orloff et al. (2008) (21.9 ± 3.5 m/s). Furthermore, the average ball velocity of instep kick for male players (27.9 ± 1.3 m/s) was higher than that for male players in Orloff et al. (2008) (22.7 ± 3.1 m/s). The average ball velocity of side-foot kick for male players (26.9 ± 1.3 m/s) was higher than that for male players in Nunome et al. (2002) (23.4 ± 1.7 m/s) and Levanon and Dapena (1998) (22.5 ± 1.8 m/s) (Fig. 2b). Various factors affect the ball velocity (e.g. foot velocity, place of impact, stiffness of the foot at point of impact, and mass of the kicking leg). Foot velocity in particular is considered to have the greatest impact on ball velocity. To increase ball velocity, techniques to increase the swing velocity before impact are considered to be important.