BIOMECHANICAL STUDY ON A BASKETBALL DRIBBLE WITH A CUTTING MOTION

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The purpose of this study was to investigate the kinematics of skilled and non-skilled players in dribbling motion: cross-over and inside-out dribbles, which are frequently-used in basketball games. The subjects were three male skilled varsity players and seven male ordinary collegiate players. They performed dodging poles with four types dribbling motion. The motion of the subjects was videotaped from one step before and after the switching step, step to change running direction. The skilled players could be characterised by the continuous acceleration of the CG throughout the cutting phase and the large approach velocity to the poles. These results imply that the skilled players moved so that a defensive player would be unable to predict the change in the running direction and follow the motion of the skilled player.

KEY WORDS: three-dimensional motion analysis, switching step, direction change angle

INTRODUCTION: In basketball, a dribble motion is one of the most frequently-used techniques to carry a ball and for an offensive player to get a head of a defensive player or to dodge with a cutting motion. Previous biomechanical investigations analysed the dribbling motion on the spot (Iwami and Kizuka, 2011) and investigated the dribbling motion in a straight running (Hirata et al., 2011). Although in real games the dribbling motion varies with conditions such as running speed and direction, defensive players and so on, there seems no enough scientific information on the dribbling motion with change in the running direction or cutting motion to design effective teaching methods for the dribbling motion. Therefore, The purpose of this study was to investigate the kinematics of skilled and non-skilled players in dribbling motion: cross-over and inside-out dribbles, which are frequently-used to get a head of a defensive player by an offensive player.

METHODS: The subjects were three male skilled varsity players (height, 1.76±0.01m; weight, 74.67±1.89kg; point-guard) and seven male ordinary collegiate players (height, 1.73±0.03m; weight, 66.71±5.44kg; point-guard).

Figure 1 shows the experimental set-up of the present study. The subjects performed dodging poles as a model of a defensive player with two types of cross-over dribbling motion (speed cross-over, CS; feint cross-over, CF) and two types of inside-out dribbling motion (speed inside-out, IS; feint inside-out, IF) in three or four times for each condition. The motion of the subjects from one step before and after the change in the direction was videotaped by four high-speed digital cameras, CASIO EXILIM EX-F1 (300Hz). The video images were digitized with Frame DiasⅡ system (DKH Co., Japan). Three dimensional coordinates of twenty-three landmarks attached to the subject's body were reconstracted by using the three-dimensional DLT technique. The coordinates data were smoothed with a Butterworth low-pass digital filter with optimal cut-off frequencies determined by the residual method after Winter (2004).

The motion time, moving distance in x-y plane of the center of gravity (CG) of the subjects, horizontal velocity of the ball and CG direction change angle, and selected biomechanical variables were calculated. The direction change angle was defined as an angle between CG horizontal velocity vectors at the touchdown (On2, Figure2) and toeoff (Off2) of the switching step(Suzuki et al., 2010).

The unpaired t-test was conducted to assess the differences between the two groups. Significance level was ste at 0.05 percent.

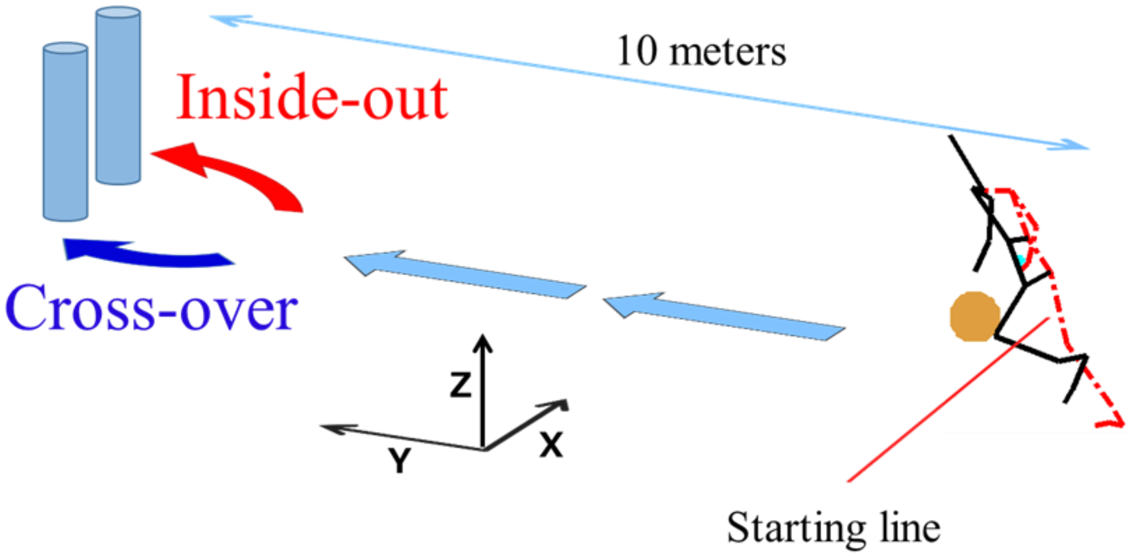

Figure 1. An illustration of the experimental set-up for the dribbling motion with the change in the direction.

RESULTS AND DISCUSSION: Figure 2 shows examples of the stick pictures of two kinds of the dribbling motion. Figure 3 shows the motion time, moving distance of the CG and average speed in the cross-over and inside-out dribbles for the skilled and ordinary players. For the cross-over speed dribble (Figure 3,②), there were no significant differences in the motion time, movig distance and average speed between two groups. On the other hand in the inside-out speed dribble (Figure 3,①), the skilled players moved in the shorter motion time and moving distance than those of the ordinary players, despite that there was no difference in the average speed. The compact motion, short time and small motion, of the skilled players is likely to be helpful so that a defensive player is unable to predict the change in the direction and follow an offensive player.

For the dribbles with the feint, the inside-out feint cross-over feint (Figure 3,③ and ④), the average speed in the skilled players was significantly larger than that of the ordinary players, though the average speed of the dribbles with the feint was smaller than the case of the speed dribbles. The motion time in the skilled players was shorter than the ordinary players, that there was no difference in the moving distance.

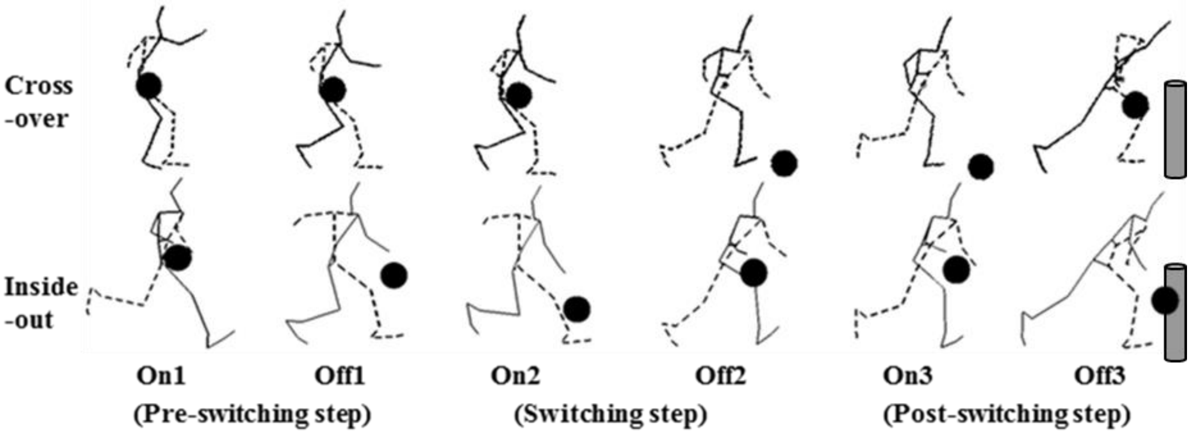

Figure 2. The cross-over (upper) and inside-out (lower) dribbling motions. The black circle is a basketball. The "On1" and "Off1" are the instants of the touchdown and the toeoff of the pre-switching step, the "On2" and "Off2" are for the switching step, the "On3" and "Off3" are for the post-switching step. The column on the right of the figure indicates the position of poles as a defender.

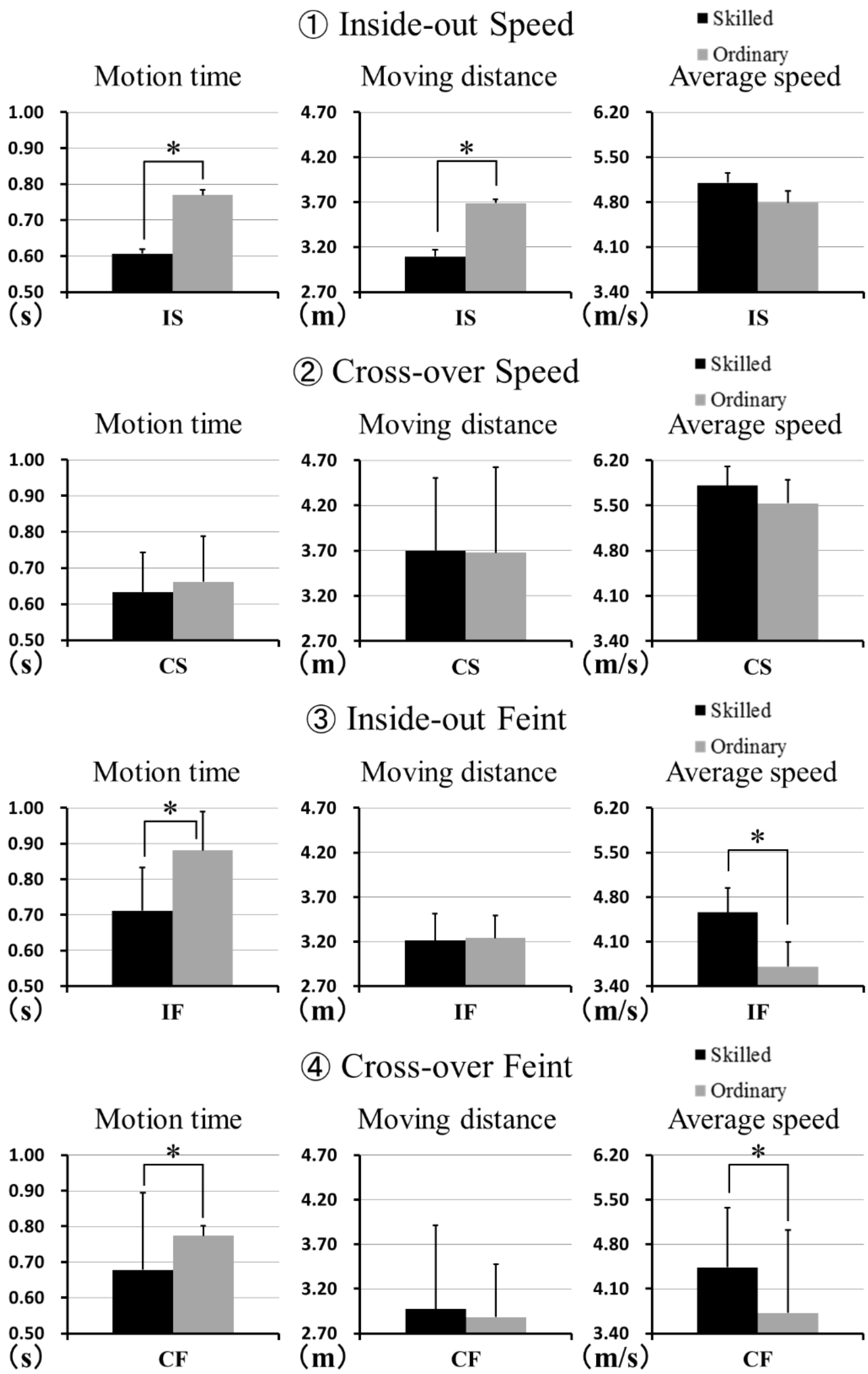

Figure 3. The motion time, the moving distance and the average speed for the skilled and ordinary players in the cross-over and inside-out dribbles.

Figure 4 shows the changes in the CG velocity at the touchdown and the toeoff during the CS dribbling for the skilled and ordinary players. Although the CG velocity in the CS for the skilled players was slightly smaller at the On1 than that of ordinary players, at the other instants the CG velocity for the skilled was significantly larger than that of the ordinary players. These results revealed that the skilled players accelerated their body from the pre-switching step until the post- switching step. On the other hand the ordinary players decelerated their speed from the pre-switching step to the instant of the touchdown of the post-switching step, and then slightly increased their speed during the support phase of the post-switching step.

No significant difference was found in the average speed of the cross-over speed between two groups(Figure 3,②). However, the change in the CG velocity, as show in Figure 4, revealed that the skilled players could be characterised by the continuous acceleration of the CG throughout the cutting phase. As a consequence, the skilled players were able to move in a large speed as they approached the poles. Despite no difference in the moving distance in cross-over speed between two groups, the step length at the switching step of the ordinary players tended to be shorter in the forward direction but wider in the sideward than that of the skilled players. This may be one of the reasons why the ordinary players were unable to accelerate at the switching step.

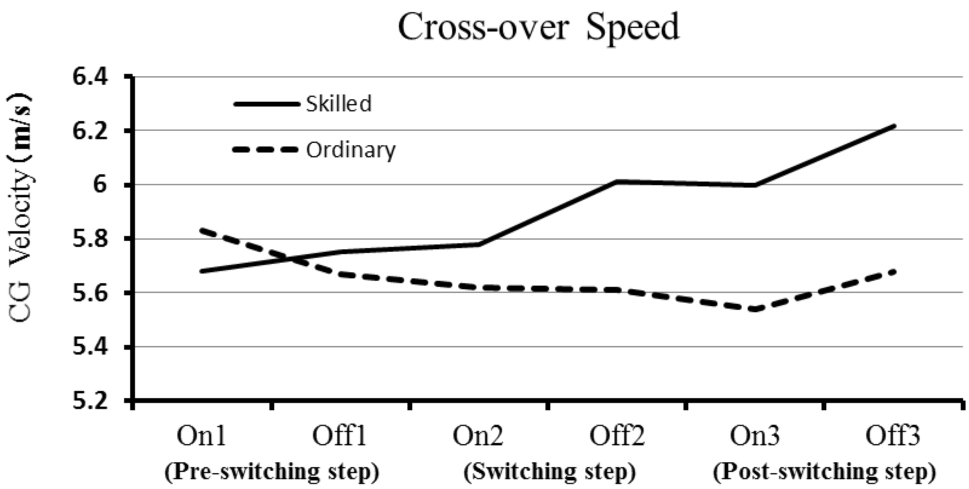

Figure 4. The changes in the CG velocity at the touchdown and toeoff for the skilled players and ordinary players. The instants are same as Figure 2.

These results implied that the skilled players got a head of a defensive player quickly because of an appropriate step length in the horizontal direction and stepping forward stronger to the traveling direction at the switching step.

CONCLUSION: The skilled players could be characterised by the continuous acceleration of the CG throughout the cutting phase. The results in the present study imply that the skilled player may move so that a defensive player would be unable to predict the change in the direction and follow the motion of the skilled player.
Therefore, for teaching the dribble, it is helpful for ordinary players to step forward stronger in the horizontal direction at the switching step.

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