THE STANDARD MOTION MODEL OF A BASKETBALL SET SHOT FOR TEACHING

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The purpose of this study was to create a standard motion model of a basketball set shot. Twenty-one male collegiate basketball players participated in three-dimensional data collection session (Vicon MX+, 250Hz), and the method proposed by Ae, et al. (2007) was used to create a standard motion model. The set shot motion in the standard motion model started with the shoulder flexion and hip extension in the downward phase, followed by the sequential motions of the knee, ankle, shoulder, elbow and wrist joints in the upward phase. Immediately before the ball release, the elbow and wrist joints were abruptly extended. The motion variation in the wrist, elbow and shoulder joints just before the ball release were small, implying there must be some commonality in these joint motions.

KEYWORDS: Basketball, Teaching, Set shot, Standard motion model, Motion analysis

INTRODUCTION: There are three basketball offense techniques: dribble, pass and shoot (Hay, 2011). Among them, the shoot technique, which is the only means of directly connecting to the score, is said to be the most important technique in basketball (Japan Basketball Association, 2016). The technique of basketball always depends on the physical characteristics of players such as body height, weight, strength and the details of their movements may not be exactly the same. However, for the successful shot, there should be some common elements, and it is said that the elements appear in a technique of a good shooter (Takei, 1984). Ae et al. (2007) and Murata et al. (2008) prepared standard motion models for various sport techniques as the averaged motion of skilled players, considering variation in motion and deviation from the standard motion. In the present study, we intended to prepare the standard motion model of a basketball set shot as one of teaching tools.

METHODS: The task was to throw the ball from a line 4.25 m behind a backboard into a ring (height, 3.05 m).The participants were 21 male basketball players belonging to the men's second division Kanto University Basketball League (height, 1.79 ± 0.08 m, mass, 76.5 ± 9.0 kg, experience years, 11.1 ± 1.7 yrs.). Based on the five-degree introspection rating by players, the trial in which the shoot succeeded and the evaluation rate was 4 or 5 was chosen as an analysis target trial. Three-dimensional coordinates data of 47 reflective markers on the body were collected using 20 cameras of an optical three-dimensional motion capture system (VICON MX+, Vicon Motion System) operating at 250 Hz. The three-dimensional coordinates data of body landmarks during the basketball set shot were smoothed by Butterworth digital filter at a cut off frequencies ranging from 4 to 18 Hz, as determined by the residual method (Winter, 2009). The standard motion model was created from three-dimensional coordinates data by the method of Ae et al. (2007). In this study, joint angles of the shoulder, elbow, wrist, hip, knee, ankle joints were calculated. This study was approved by the Research Ethics Committee of Nippon Sport Science university(No.017- H107).

RESULTS: Figure 1 shows the standard motion model of the set shot. Based on the vertical displacement of the right hip, the downward and upward phases were set at 80% and 20%, respectively. Figure 2 shows changes in averaged joint angles of the standard motion model.

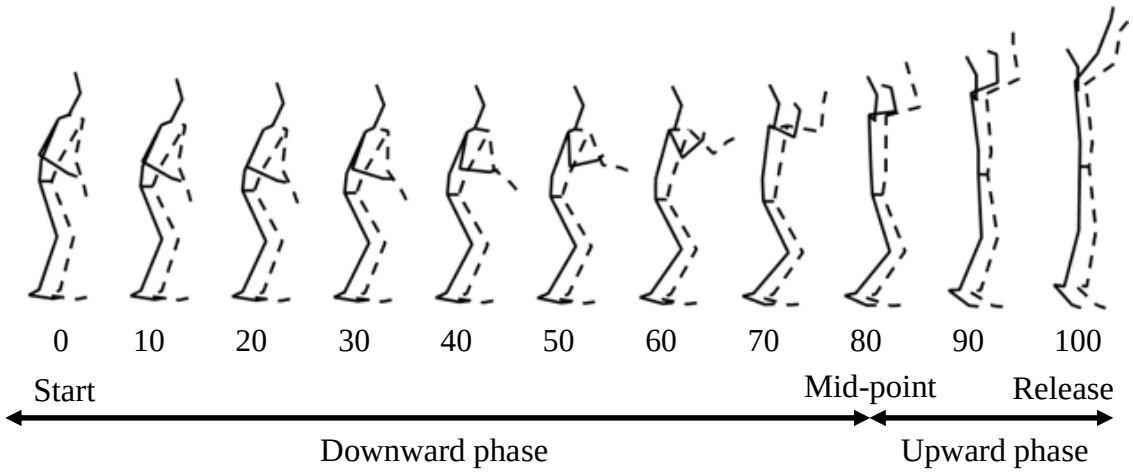

Figure 1 Stick pictures of the standard motion model of set shot (males, n=21).

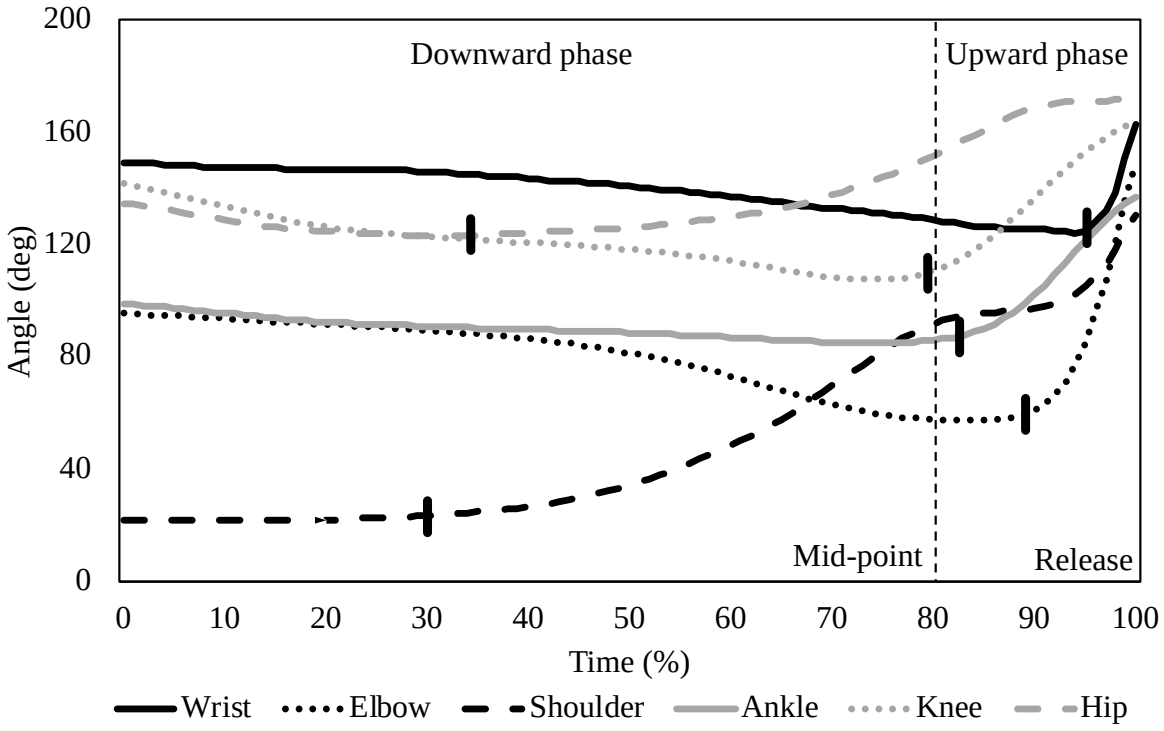

Figure 2 Changes in joint angles of the standard motion model of the set shot.

The marks shown in Figure 2 show the instant when the joint was switched from flexion / extension to extension / flexion. In the standard motion model of the set shot, the hip, knee and elbow joints were flexed first in the downward phase, but the shoulder flexion and hip extension began from about 30 % time and prepared for raising the upper arm and the ball. The knee and ankle joints extended around the onset of the upward phase. The elbow and wrist joints abruptly extended to release the ball when the 90 % time passed. In the middle of the upward phase, the shoulder joint stagnated its flexion.

Figure 3 shows the changes in coefficient of variation (CV) of the joint angles in the standard motion model of the set shot. As for the set shot as a whole, the largest CV of the shoulder joint angle was in the downward phase, indicating that individual differences were observed in the motion to raise the upper arms and ball. As can be seen in Figures 3 and 4 the variation in the downward phase tended to be large in the wrist, elbow, shoulder and hip joints, but the variation of these joints tended to be small in the upward phase, especially just before the ball release (Figure 4).

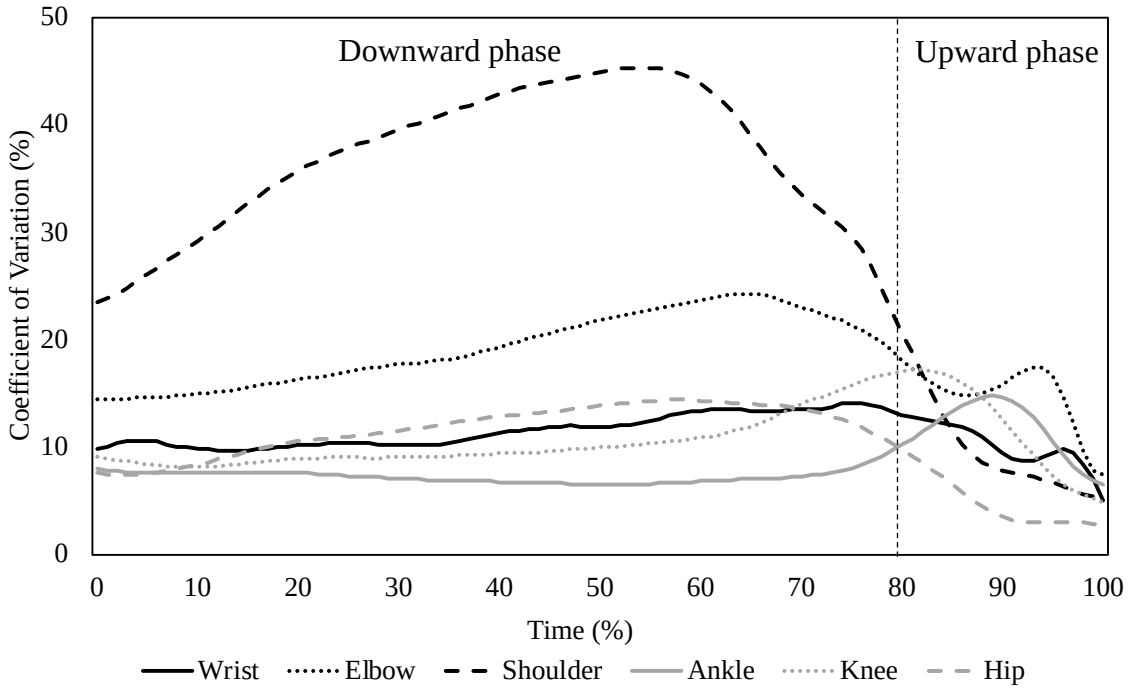

Figure 3 Changes in the coefficient of variations of the joint angles in the standard motion model of the set shot.

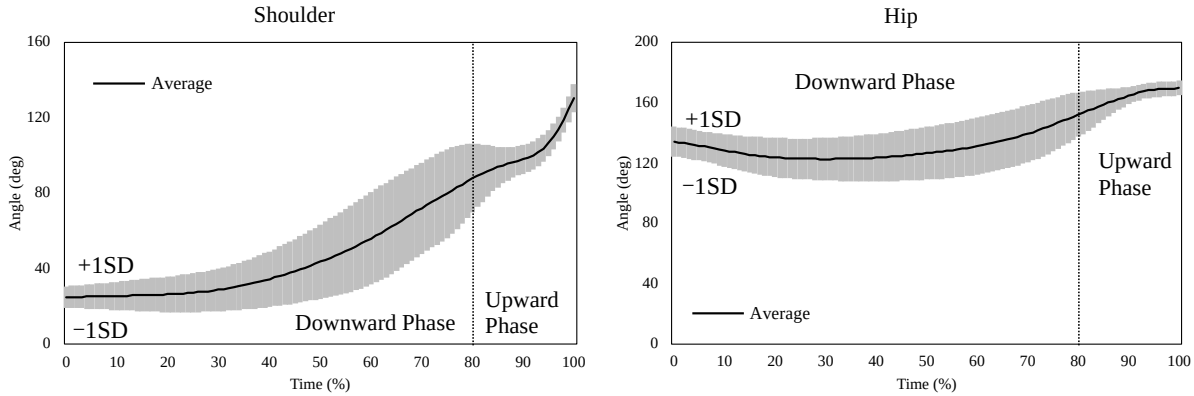

Figure 4 The average and standard deviation of the shoulder and hip joint angles (n=21).

DISCUSSION: In the set shot motion represented as the standard motion model, the flexion of the shoulder and hip joints started in the downward phase, and the knee, ankle, elbow and wrist joints started to extend a little later than the onset of the upward phase. Before the ball release, the elbow and wrist joints were rapidly extended and the shoulder joint showed the second quick flexion from 93 % time, which followed the first flexion and the stagnated portion. The stagnated flexion of the shoulder joint may have partially occurred due to the reaction force resulted from the beginning of the elbow end ankle extensions. Many of the studies on the set shot motion for experts highlighted the sequential nature of the upper limbs toward the ball release in the upward phase. However, in the set shot motion model created in this study, it obvious that preparation for the shot of the upper body was done in the downward phase, and this should be noted in teaching the set shot motion. The sequential behaviour of the standard motion model seems to support the study of Rikukawa et al. (2005) that the upper limb joint and the lower limb joint moved in a sequential manner although the flexion of the shoulder joint passed through the stagnated portion, despite it had begun in the downward phase. In broad sense, it can also be seen that the set shot was conducted from the proximal to the distal segments as well as in the throwing motion (Knudson, 2003). In shoot motion of basketball unnecessary movement such as too much bending legs or moving the ball too much: lead to increased chance for error (Filippi, 2011), but this trend was not seen in the

standard motion model in the present study. Therefore, it's considered to be appropriate as an motion model to be used for teaching.
The motion variation between the subjects was large at the shoulder joint angle. In the downward phase, which was considered to indicate that individual differences were seen in the motion to raise the upper arm. As mentioned above, the flexion of the shoulder joint in the downward phase was considered to be one of the points to be noted in teaching, but the fact that the variation in the shoulder joint was large was attributable to the fact that the motion to raise the upper arm and its timing in individual differences were considered to be meaningful. In the wrist, elbow, shoulder and hip joints, since the motion variation became smaller in the upward phase, especially after 90 %, the individual difference was small among experts at the release. Therefore, it can be said that in the instruction of the set shot motion, it is useful to present the release of such a standard motion model as a desirable motion. The fact that the motion variation in the joints of the lower limbs in the downward phase was smaller than that in the upper limbs suggests that the flexion of the knee joint and the flexion and extension of the hip joint in the downward phase would be important actions in instructing unskilled players. In the standard motion model of the set shot motion, the motion variation in the upper limbs was large in the downward phase, while was small that of the lower limbs, the upward phase. The motion variation in the upper limb became small before the ball release. These results were obtained from skilled university male basketball players. In the evaluation and diagnosis of the techniques of unskilled players, it is useful to observe and focus on actions and phases in which these motion variations were small.

CONCLUSION: In the standard motion model of set shot motion, flexion of the shoulder and hip joints began in the downward phase, and the extension was occurred in the order of the knee and ankle joints, with a slight delay, the elbow and wrist joints in the upward phase. The motion variation among subjects was large at the shoulder joint angle. In the downward phase, individual differences were seen in raising the upper arm. However, in the upward phase, especially before release, the motion variation of the wrist, elbow, shoulder and hip joints was small, implying a high commonality. The standard motion model suggests that we need to pay attention to the preparatory movement of the shoulder joint in the downward phase, which has not been mentioned so much in the previous studies and instruction books. In the teaching of novice players, it is necessary to pay attention to the downward phase and preparatory movements.

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