THE KINEMATIC ANALYSIS of BASKETBALL THREE POINT SHOOT AFTER HIGH INTENSITY PROGRAM

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The purpose of this study was to analyze kinetic and kinematic characteristics of three points shooting by high speed camera. Basketball players have to finish the high intensity program which was designed from simulative basketball games. The high intensity testing program includes dribbling, sprint, slide, jump shooting and three points shooting. The results of the experiments indicated that elbow, wrist, hip and ankle joints angle velocities would decrease, except the knee joint, after the high intensity program. The knee angle of take-off would also increase. It indicated that the upper limb joints angular velocity would decrease and players had to increase knee joint angular velocity to maintain original power. The time from take-off to ball release also decreased which means that there was a change in the coordinates in knee joint and elbow joint. After high intensity program the elbow and knee joints extension were closed to produce more power for the shot.

KEY WORDS: basketball, fatigue, three-points shooting.

INTRODUCTION: Basketball is a popular sport in the world. This is evident from the audience level of NBA. Not only a complete organization, but also technical needs, tactic, agreement, experience and the potential for contest is shown in a game (Chiou, 2001). The ratio of aerobic to anaerobic in basketball is 1:9; this shows that basketball is an anaerobic and high intensity exercise (Lin, 1997). Because of the high intensity and anaerobic property of basketball, one has to perform the players' best performance within the short period of the game. These performances include the shooting action, jump shooting and defense. When the coach trains athletes they need to improve basketball players' power, muscle endurance and cardiovascular endurance to adapt to the high intensity exercise.

Shooting is the basic way to get score in basketball and for this reason it is the most frequently used technical action (Hey, 1994). The jump shot is distinguished as the most important of all the shooting actions (Hess, 1980). Miller (1996) has discussed the relationship between basketball shooting kinematics, distance and playing position. Chin (2002) also analyzed the basketball shooting of different distances and movements. In 2002 the International Basketball Federation (FIBA) decided to decrease the shot clock violation to 24 seconds so that players have to improve their fitness to avoid fatigue.

When a sport player feels tired it has influence on performance and leads to injury easily. If there is enough time slow contractions can modify ago-ant control strategies which will minimize the error of target setting. The increase of random error could not be adjusted by ago-ant muscle control after fatigue (Huang, 2003). In order to enhance performance in sports the aim of this study is to discuss the relationship of high intensity action and three points shooting.

METHOD:

Subjects: The subjects were 6 male participants who volunteered for the study. They were active university basketball team players. All participants were right-handed and specialised in mid- and long-distance shooting. The mean age was 22.3 (±2.7) years with mean height of 180 cm (±0.11) and 78 kg (±13) body weight. The mean years of basketball playing experience of the participants was 8.5 (±3.5) years.

Data collection: One high speed camera (Fastcam Co.) was used at 250 Hz to record the performance of the shots. Shutter speed was 1/1000 seconds. It was placed at an orientation of 90° to the direction of the shoots. The camera was started approximately 3 second prior to the beginning of each shot and was not switched off until the ball passed through the hoop to

ensure the recording of a sufficient portion of the performance to permit an analysis of the release variables. There were eight markers on the right hand side at the middle finger, wrist, elbow, shoulder, hip, knee, ankle and toe.
After warm-up, each participant participated in two pretests. Each pretest consisted of ten times three-points shooting which was recorded by camera simultaneously. The three times three-points shooting was collected in this study after participating in the high intensity proram.

High intensity program:This program was designed to simulate the skills and recruited muscle in a real game. There are four marked points: foul line (5.8m), mid-line (14m), back court foul line (22.2m) and backcourt end line (28m). This program includes the dribbling, sprint, slide, jump shooting and three points shooting. There are four stages in this testing program:

(i) Player ran and dribbled along a line to foul line, then back to line up (figure 1).
(ii) Player ran and dribbled along a line to mid-line, then back to foul line to jump shot. And sprinted to the front court end line (figure 2).
(iii) Player ran and dribbled along a line to backcourt end line, and then back to three points line to jump shot. And sprinted to the frontcourt end line (figure 3).
(iv) After slid to the backcourt end line, player sprinted back to the frontcourt end line (figure 3).

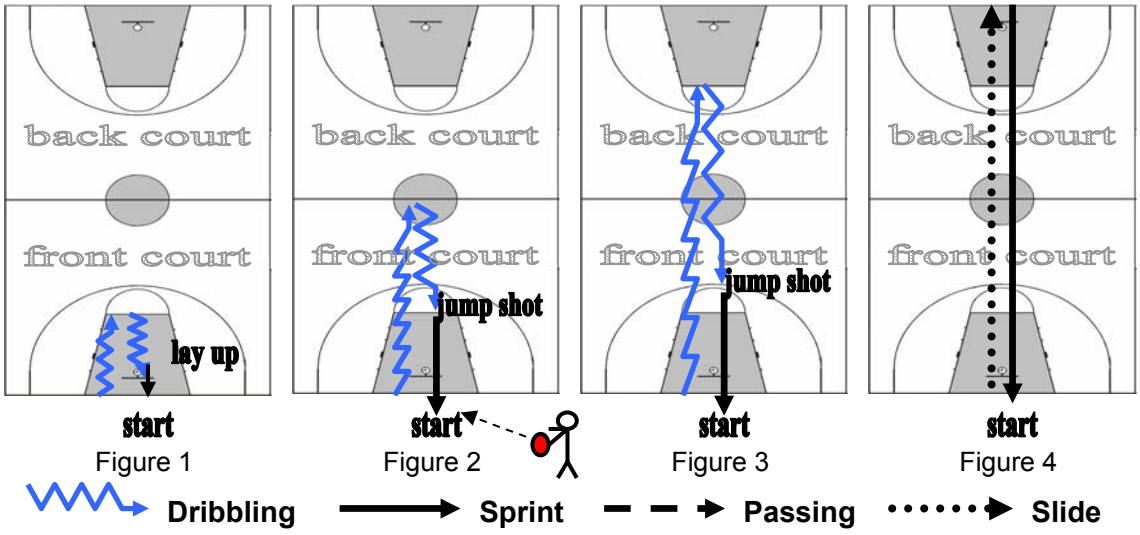

Figure 1 Figure 2 Figure 3 Figure 4

The players had to do these four stages in ten trials. During the first trial, the players need to do their best and record their seconds. This data was their maximal performance. Every player must finish the four stages within 90% of the maximal performance (seconds). The resting time was the same as their best record at each trial.

Data analysis: Thirteen shots by each player (ten pretests and three post-test). The SIMI Motion Analysis System was used to calculate the angles and velocity of each joint. Including the joint of wrist, elbow, shoulder, hip, knee and ankle. Not only was the velocity of the ball from its lowest vertical point analyzed, but also the total time data.

The aim of this study was to examine the effect of paired-sample t test analysis of variance. The statistics value of $P<0.05$ was used to indicate significance. Product variables which determine the final result of the action. It was corresponding to the angular and velocity of the release of the ball and based on the mechanical relationships of projectile motions which were illustrated in figure 5.

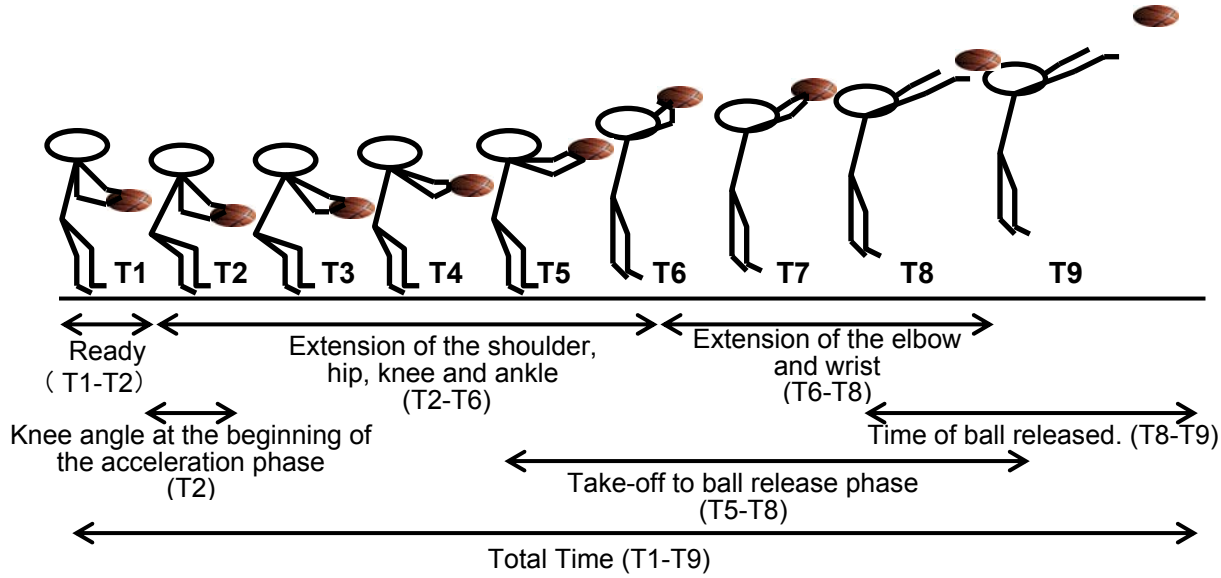

Figure 5：Typical stick figure sequences for long-range shots.

RESULTS:

Angular velocity

The angular velocities of upper extremity joints had all decreased. The mean elbow angular velocity had decreased by 1.5419% as shown in table1. And the mean wrist angle velocity had decreased by 4.8909%. The exception here that had resulted in an increase of 0.0833% was the shoulder angular velocity. The mean hip and ankle angular velocity had decreased by 3.0459% and 1.6583%. Notice another significant increase of 9.4653%. ($p<.05$) was the mean knee joint angular velocity.

The velocity of ball release

There was no statistic significant difference between the pretest and the post-test, but an increase of 0.906016%.

Time of take-off to ball-released

The mean time decreased by 11.2128%. It showed that players moved quicker in post-tests (Table 2).

Knee joint angle at take-off moment

The knee joint angle decreased by 2.8287° and 2.798081%(Table 3).

Table 1 Mean joints angular velocity (rad s-1)

Limb	Pretest	Posttest	Difference %
Shoulder	307.5122	307.7684	0.0833
Elbow	786.5325	774.4052	-1.5419
Wrist	1870.079	1778.615	-4.8909
Hip	182.4433	176.8863	-3.0459
Knee	279.7346	306.2122	9.4653
ankle	564.7742	555.4083	-1.6583

Table 2 Time from take off to ball released (sec)

Time of take-off to ball-released	Pretest	Posttest	Difference %
	0.220002	0.195333	11.2128

Table 3 The knee joint angle of the ball released (degrees)

Knee joint angle at take-off moment	Pretest	Posttest	Difference %
	101.0611	103.8889	2.798081

DISCUSSION: The ball release from finger was a key factor, the kinematics chain was from the shank, thigh, trunk, upper arm and fore arm segments which also influences release height (Chung et al., 2004). So the joints flexion and extension were an important rule in shooting. In addition to the fore arm segments, the ball flying tautochrone and stability was dependent on it (Wang, 1984). The result of this study was that after players finished the high intensity testing program they could feel fatigue and the angular velocity of elbow, wrist, hip and ankle joints were slowed down. The error of force generation would increase in muscle contractions after fatigue (Huang, 2003). Since the body felt fatigue and made joint moments to slow down it changed the body moving control.

Especially in the knee angular velocity which increased in posttest, and the same as in the angle of take-off. Although, these two variables were not significantly different, it was probable that the upper limb joints angular velocity would decrease and players had to increase knee joint angular velocity to maintain original power. The results agreed with the findings of Stuart et al(1993) who reported that as the shooting distance increased so did the knee joint angular velocities. In the posttest, knee joint angle of take-off had increased by 2.798081%. It probably was because of the knee joint flexion-extension which had increased the take-off velocity to improve the ball release velocity (Stuart et al.1993). The decrease in the time from take-off to ball release means that the coordinates in knee joint and elbow joint had changed. After high intensity program, the elbow and knee joint extension were closed to produce more power to shot.

CONCLUSION: In conclusion, to know how the high intensity program affects the basketball player was very important. Because the high intensity program was designed from basketball games, we could find body coordination in lower limb to change after high intensity program. The current findings may also support the notion of training all players to delay the feeling of fatigue. In future, a more elaborated research applies to testing intensity training programs and player positions of shooting.

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