KINEMATIC ANALYSIS OF THE BALL RELEASE PHASE FOR THREE POINT SHOOT IN BASKETBALL

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Abstract
This research was conducted with twenty elite basketball players from the following Kosovo Super League teams: K.B. Prishtina, K.B. Kerasani and K.B. Lipjani. Shooting measurements and video recordings were conducted in Kosovo during the 2018 training season in the cities of Pristina and Lipjan. The purpose of this study was kinematic analysis of the ball release phase, for the three- point shoot in basketball. Video recordings of the shooting performance techniques are done with three Canon HD cameras, set at 90 degree angles, which can reproduce sixty pictures per second. 10 variables were selected for kinematic analysis. For analysis, only one successful shot was taken from each player. All subsequent phases are done through the Kinematic Analysis System (APAS), producing the required results and values of the kinematic indicators. The data collected were processed by IBM SPSS Statistics 20 statistical software and statistical parameters were determined using the methods: arithmetic mean, standard deviation, minimum score, maximum score, skewness and kurtosis. At the results of the Pearson correlation coefficients of the kinematic analysis of the ball release phase, for the three-point jump shooting, variables that showed high correlations with statistical significance at the level (p = 0.01) are: The distance between center of gravity and ball in final position (DCGFP), and the height of the balls realase (HBR), with correlation coefficients in the value of (0.84); the trajectory of the ball movement (horizontal displacement) (THD), and the trajectory of the ball movement (vertical displacement) (TVD), with correlation coefficients in thevalue of (0.81)

***Key words: basketball**, kinematic, trajectory, three points shooting, Pearson's correlation.*

Introduction

The sport of basketball is quite popular and is experiencing tremendous development. Okazaki et al., (2005) described basketball as a very dynamic sport, where players during a match, realize multiple shots, from different distances, towards the basket. The authors' studies (Sanchez, 1982; Burns, 1990; Malone, 1999) explained that talented shooters are not born capable, but can be developed with proper training and using the scientific approach. For an accurate jump shot, a proper shooting pattern plays a very important role, according to the authors (Varghesea & Shelvam, 2014). Most coaches consider shooting for three points as the most important skill in the game of basketball (Kai, 2011). Shooting for three points represents 16 percent of the points scored in a game and in very frequent cases determines the final result in the last seconds of the match, (Guo et al., 2004). Basketball has changed in recent decades and this is mainly due to scientific innovations in the application of biomechanical principles, improving optimal performance, especially in shooting. Authors Adegbesan & Ekpo (2004) concluded that the use of technology in various sports has helped coaches to give their athletes the best opportunities to achieve maximum performance. One of the kinematic parameters of shooting is also the trajectory of the ball (Satti, 2004). The analysis of the ball trajectory in shooting for three points in basketball has been an interesting topic, but also important for many researchers around the world. Authors like Miller and Bartlett (1993) in their study showed that the angle of entry of the ball is determined by three factors such as: (a) vertical displacement, (b) horizontal displacement and (c) velocity. While according to the author Blazevich (2010), trajectory is influenced by projection speed, projection angle and relative projection height. The kinematic is a science that interest in study the outside discretion for the time and place of movements without the powers (Luay & Ghanim, 1987). However, strength, speed and accuracy are the basic requirements interact with technical for an effective layup, and the kinematic analysis is a type of biomechanics analysis that care of descript the movement and its have three kinds of analysis: quantitative, specific, and educational (Resan & Nejah, 2002). Kinematics is not concerned with the forces which cause the object or the body to move, but with the type of motion that is made from what position, displacement, velocity, acceleration and time of the movement (Wells & Luthegens, 1993; Adrian & Cooper, 1995). Relationships among displacement, velocity, acceleration and time may be expressed in equations of motion (Hall, 1999). The purpose of this study was kinematic analysis of the ball release

phase, for the three-point shoot in basketball. The evaluation of the main kinematic indicators in qualitative basketball players, provides accurate information on the technical level and the possibilities of improving the technique.

Material and methods

This research includes a total of twenty professional Kosovo Super League basketball players (players from basketball clubs: K.B. Prishtina, K.B. Kerasani, and K.B. Lipjani. Filming of the shootings for measurements were conducted during the 2018 training season. For analysis, only one successful shot was taken from each player. Description of the ball release phase includes the moment from the release of the ball from the hands, the trajectory of the movement of the ball, till the entry of the ball into the basket. 10 variables were selected for kinematic analysis such as: distance between center of gravity and ball at starting position (DCGSP), distance between center of gravity and ball in final position (DCGFP), height of the balls realase (HBR), the trajectory of the ball movement (horizontal displacement) (THD), the trajectory of the ball movement (vertical displacement) (TVD), angle of the ball's release (ABR), angle of the ball's entrance (ABE), ball movement speed (BMS), ball movement time (BMT), totale time (TT).

Methods of data collection and processing

The filming of the basketball shooting performance techniques is done with three Canon cameras, set at optimal angles, which can reproduce 60 frames per second. Kinematic analysis of the shootings in basketball has been carried out by many researchers using the same cameras as in this study, namely 60 Hz video cameras, (Hudson, 1982; Miller, Bartlett, 1996; Tang & Shung, 2005; Satti, 2004). At first, the calibration frame was filmed at the place where the techniques were performed. The dimensions of the frame were 200cm x 200cm x 200cm. The camera's alignment has been positioned so that all points of reference of the athlete's body are under the camera lens and visible. Analysis is done according to the performance of the Kinematic Analysis System (APAS), outputting the required results and values of the kinematic indicator.

Statistical processing methods
data collected were processed by statistical analysis software "IBM SPSS 20", and statistical parameters were determined using the methods: arithmetic mean, standard deviation, minimum score, maximum score, skewness, and kurtosis. The confirmation of the mutual influence of the variables was done by the Pearson's coefficients correlation method.

Results and discussion

Table 1 presents the results of the basic statistical parameters of the 10 kinematic variables analysis of the ball release phase, for the three-point shoot in basketball.

Results of the arithmetic means and standard deviation in variables distance between center of gravity and ball at starting position (DCGSP) has shown these results (58.85 ± 7.53 cm). Results of the arithmetic means and standard deviation in variables distance between center of gravity and ball in final position (DCGFP) has shown these results (131.25 ± 9.46 cm). Results of arithmetic mean and standard deviation in variables height of the balls realase (HBR) has shown these results (252.80 ± 13.67 °). Results of the arithmetic means and standard deviation in variable the trajectory of the ball movement (horizontal displacement) (THD) has shown these results (521.40 ± 52.03 °). Results of the arithmetic means and standard deviation in variables the trajectory of the ball movement (vertical displacement) (TVD) has shown these results (187.20 ± 37.78 °). The author Tsaroucha et al., (1988) shows that for the success of accurate shots, the point of ball release must be increased (the vertical displacement of the ball).

Results of the arithmetic means and standard deviation in variable angle of the ball's release (ABR), has shown these results (39.50. 4.03 °). According to the literature of different authors, the right angle should be between (42° and 48°) Dobovičnik et al., (2015) results that are similar to the findings of this study in jump shooting for three points. Hassan et al., (2018) in the study on the kinematics of shooting for three points and on the variable of the angle of release of the ball found these results (44.87 ± 6.29 °), which are consistent with the findings of this study. Ball release variables have been identified as determinants of 3PS performance in basketball (Okazaki et al., 2015). Findings of the author Ranjith & Kumar (2014) in their research, found that the accuracy in three-point jump throws has significant relationship with angle of ball release. Gablonsky & Lang (2005) commented that some players shoot wrongly because they are shooting the ball at the wrong angle. Results of arithmetic mean and standard deviation in variable angle of the ball's entrance (ABE), has shown these results (41.10 ± 8,340).

According to the study by author Hay (1994) the optimal angles of the entry of the ball in the basket, were found to be between 38 and 45 degrees, which corresponds to the findings of this study. Results of the Arithmetic means and standard deviation in variables ball movement speed (BMS), has shown these results (10.73 ± 1.31 m / s).

The findings of this study, in the release of the ball, in the variable: the initial velocity of the release of the ball, are higher compared to those of other authors. Authors such as Chen et al., (2005) show that the main factors that determine the flight of the ball during a jump shooting, in addition to the distance from where the shooting take place, are also: release speed, release angle and height in which the ball is released. In studies conducted by the authors (Satern, 1993; Okazaki, 2012), with a group of basketball players, they have proven that the speed of throwing the ball increases with increasing distance.

Authors Hassan & Mahdi in their study in the year (2018), speed and angle of release, have a positive and direct relationship with the angle at which the ball enters the basket, in the successful three-points jump shooting. Knudson (1993) indicated that velocity of the ball at release phase may be the significant factor determining successful shot. Results of arithmetic mean and standard deviation in variable ball movement time (BMT), has shown these results (1.31 ± 0.16 sec). Results of arithmetic means and standard deviation in variable total time (TT) has shown these results (1.63 ± 0.14 sec).

Table 1. Results of basic statistical parameters of the kinematic analysis of the ball release phase for three-point shoot in basketball.

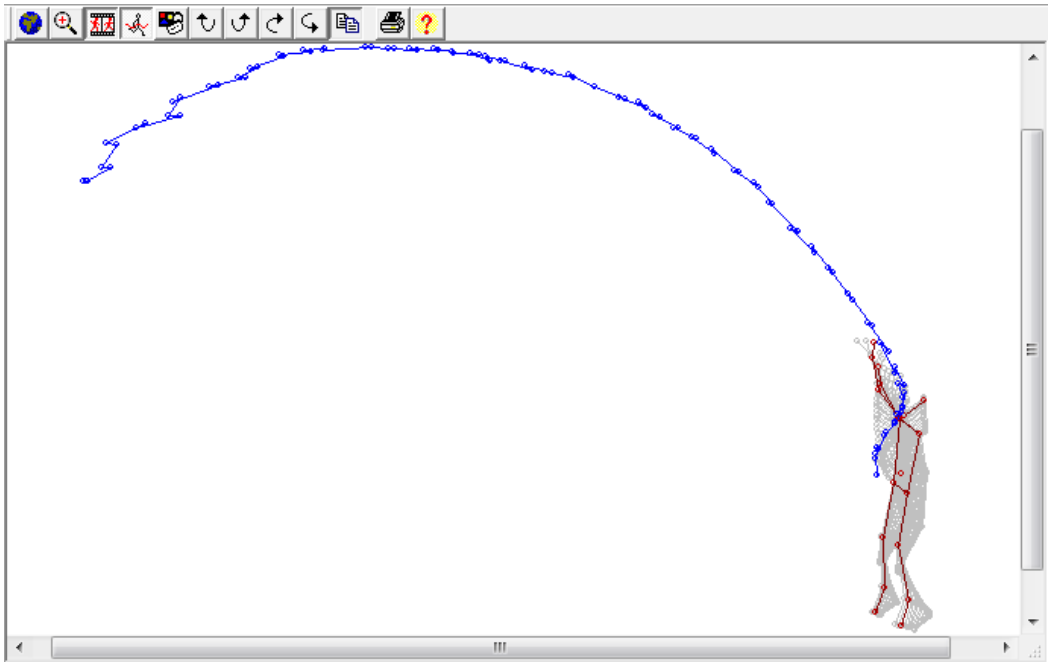
	Minimum	Maximum	Mean	Std. Dev.	Skewness	Kurtosis
DCGSP (cm)	44,00	74,00	58,85	7,53	0,19	-0,29
DCGFP (cm)	105,00	145,00	131,25	9,46	-0,95	1,84
HBR (^{0})	227,00	276,00	252,80	13,67	-0,08	-0,91
THD (^{0})	450,00	621,00	521,40	52,03	0,62	-0,69
TVD (^{0})	131,00	249,00	187,20	37,78	0,24	-1,28
ABR (^{0})	32,00	47,00	39,50	4,03	0,06	-0,85
ABE (^{0})	27,00	58,00	41,10	8,34	0,63	-0,13
BMS (m/s)	7,56	12,96	10,73	1,31	-0,46	0,37
BMT (sec)	1,14	1,81	1,31	0,16	1,87	4,21
TT (sec)	1,41	1,98	1,63	0,14	1,42	2,75

Table 2. Results of the Pearson coefficients correlation of the ball release phase for three-point shoot in basketball.

	DCGSP (cm)	DCGFP (cm)	HBR 0	THD 0	TVD 0	ABR 0	ABE 0	BMS (m/s)	BMT (sec)	TT (sec)
DCGSP (cm)	1,00	-0,04	0,12	0,42	0,24	-0,56**	0,04	0,06	0,39	0,33
DCGFP (cm)	-0,04	1,00	0,84**	-0,49*	-0,56**	-0,36	-0,12	-0,16	-0,42	-0,30
HBR(^{0})	0,12	0,84**	1,00	-0,30	-0,50*	-0,58**	-0,17	-0,10	-0,35	-0,10
THD (^{0})	0,42	-0,49*	-0,30	1,00	0,81**	-0,04	-0,03	0,14	0,70**	0,39
TVD (^{0})	0,24	-0,56**	-0,50*	0,81**	1,00	0,15	-0,14	0,29	0,75**	0,35
ABR (^{0})	-0,56**	-0,36	-0,58**	-0,04	0,15	1,00	-0,02	0,21	-0,15	-0,35
ABE (^{0})	0,04	-0,12	-0,17	-0,03	-0,14	-0,02	1,00	0,20	-0,17	-0,23
BMS(m/s)	0,06	-0,16	-0,10	0,14	0,29	0,21	0,20	1,00	-0,15	-0,27
BMT(sec)	0,39	-0,42	-0,35	0,70**	0,75**	-0,15	-0,17	-0,15	1,00	0,79**
TT(sec)	0,33	-0,30	-0,10	0,39	0,35	-0,35	-0,23	-0,27	0,79**	1,00

The kinematic variables which have shown high correlation with statistical significance at the level (p = 0.01) are:

- The distance between center of gravity and ball in final position (DCGFP), and the height of the balls realase (HBR), with correlation coefficients in the value of (0.84);
- The trajectory of the ball movement (horizontal displacement) (THD), and the trajectory of the ball movement (vertical displacement) (TVD), with correlation coefficients in the value of (0.81); The trajectory of the ball movement (horizontal displacement) (THD), and ball movement time (BMT), with correlation coefficients in the value of (0.70);
- The trajectory of the ball movement (vertical displacement) (TVD), and ball movement time (BMT),with correlation coefficients in the value of (0.75);
- Ball movement time (BMT), and totale time (TT), with correlation coefficients in the value of (0.79).



Contourogram 1. The trajectory of the ball movement (blue line): preparatory phase, ball release,and trajectory of the ball movement, for three point shoot in basketball.

Conclusion

The correct methodology in the teaching process for the technical elements of the shots, the proper trajectory of the ball, especially from the farthest distances, for basketball experts and lecturers will always be of great interest. Successful shots in basketball and perfecting them is at the same time one of the easiest, but also the most difficult task in training, in the initial stage with young basketball players. The results of this study on the release phase of the ball, the trajectory of horizontal, vertical movement, the angle of launch, the flight time and the total time, are very significant indicators for the shooting for three points and a very important guide for experts in this field. According to the author Perse et al., (2009) the ball trajectory in the game of basketball provides useful information for providing effective tactics and strategies of the training process. The results of this research enrich the space of scientific knowledge for the kinematic analysis of the trajectory of the ball for three-point shoot in basketball.

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