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Analysing the action techniques of basketball players' shooting training using calculus method

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Abstract

This article uses the calculus method and three-dimensional analysis system to photograph and analyse the action techniques of China's famous basketball players' shooting training. Combining with the action technical parameters of outstanding male basketball players at home and abroad, this article analyses several main basketball players' shooting training actions. Quantitative analysis of the calculus method was carried out in the technical link, and the problems existing in the basketball player's movement technology were found. Further, from the comparison of the physical fitness of excellent athletes, the reasons for the gap between the level of basketball in China and the world were discovered, and the physical quality of excellent male basketball players was established. Level evaluation models and standards provide a reliable guarantee for accurately grasping the development of athletes' physical fitness, clarifying the status of each physical fitness in training, optimally controlling the basketball training process, and achieving scientific basketball training.

Keywords: basketball technical analysis, shooting training, calculus method, evaluation model, kinematic parameters, physical fitness
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1 Introduction

To a certain extent, the competition of modern sports is a competition of science and technology. Due to the intervention of modern technology and its wide application in sports, the functional potential of the human body has been maximised and fully tapped, and modern technology is updated. To improve the quality of sports, modern scientific and technological aspects are used to engage in scientific sports training; it is extremely important for improving athletes' sports skills, improving the level of various special sports, improving the

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effects of sports training, and creating excellent sports results in a short time. profound impact. The three-dimensional analysis method of sports biomechanics is used to test the shooting skills of the outstanding Chinese male basketball players to obtain various kinematics and dynamics parameters when the athletes are shooting a basketball and to make quantitative analyses and analyse several main links of the shooting technology in time. An evaluation is done based on sports' technical characteristics and action elements that are conducive to enhancing the performance of the event, helping athletes to establish an understanding of their own shooting techniques, optimising the understanding of the technique mode, and improving effective sports training methods and sports training effects.

The basketball event is one of the most technically complex events in track and field. The complete basketball shooting technique includes four parts: pre-swing, rotation, final exertion and shot. Among them, the rotation technique occupies a very important position in the complete basketball shooting technique. Studies have shown that the speed of the basketball running at the end of the rotation can reach about the speed of the final shot. Studies have shown that basketball spinning technique is the primary factor that affects the performance of outstanding male basketball players in my country. With the development of basketball shooting skills, athletes must make three or four turns with the ball before the final exertion. During the spinning process, on the one hand, it is necessary to overcome the centrifugal force generated by the high-speed basketball running, and on the other hand, to maintain the correctness of technology and direction. Therefore, in the complete basketball shooting technique, rotation is the most complicated technical link. According to literature reports, the development of high-level basketball players' spin technology in the world today is high spin speed, fast action rhythm, short spin time in each circle, and the time of single support stage is shorter than double support stage [1].

2 Research objects and methods

2.1 Research object

This article mainly focuses on the shooting and image analysis of basketball players' six shooting techniques on the year, month and day, and selects more reference objects as a comparison to find the reasons from the physical fitness and special ability.

2.2 Research methods

The main idea of this paper is to quantitatively calculate the impact of hand speed, shooting angle, and shooting height on the basketball shooting height, to determine the focus of the subsequent kinematic parameter analysis, that is, shooting speed. A three-dimensional photography is used to shoot and analyse the technical movements of basketball players. The method of comparative analysis explores the gap between basketball players and excellent athletes at home and abroad in terms of the factors that affect the shooting speed. The technical gap is largely derived from physical fitness and special ability. This article has conducted a detailed analysis and has targeted to establish the main index system, evaluation model and implementation plan of basketball player training [2].

Two panasonic high-speed sync cameras made in Japan were used to film the six shots of the outstanding basketball players in Jiangxi Province. Both cameras are equipped with a sync signal generator device and an external recognition sync device voice baton. Before shooting, the body is fixed, and the positions of the two cameras are shown in Figure 1. It is particularly pointed out that we lacked experience in camera installation at the time of shooting, and so it caused us a lot of trouble in analysis. The correct installation should be done in the shooting. At the back of the direction, the other one is erected on the left side of the shooting direction. The main optical axis of the two cameras is 90° facing the basketball shooting circle, which can reduce the workload during analysis. The height of the camera is 1.20 m, and the distance between the two cameras and the centre of the shooting circle is 15 cm. When shooting, the actual shooting frequency is calculated by the internal time scale to be 25 frames, and the exposure time is 1/250 s. The shooting action is from the start of the pre-swing to

the shot. The whole process. There were 8 effective shots on the scene, including six male basketball players, all of which were successful. When parsing, one frame is divided into two fields, so the time of each field is $1/50$ s.

Fig. 1 Schematic diagram of basketball shooting technique.

At the same time, the image analysis of the basketball shooting technique of players was carried out on the original American Ariel3D analysis system introduced by the Sports Biomechanics Laboratory of Hubei University. During the analysis of the system, 25 joint points of the human body plus instrument points and a static reference point were measured for a total of 27 points. In this paper, digital low-pass filtering and smoothing is performed on the raw data of each joint and equipment, and the required research data and indicators such as related angle and line are calculated. Using frame-by-frame analysis, the motion analysis starts from the pre-swing to the whole process. On average, 118 frames are analysed per shot.

The biomechanical evaluation of movement techniques mainly reveals the basic laws of motion and assesses the pros and cons of movement techniques. The evaluation is usually carried out based on three aspects – compare and analyse the test results of the research object with the movement technical parameters of outstanding athletes to find out the technical existence gap, analyze the main reasons for the gap, and solve it in sports practice. For the test results, statistical methods are used for statistical calculations, and the characteristics, laws and technical standards of the technology are obtained. Using the relevant principles of sports biomechanics, combined with the specific form of the action and kinematic parameters, the rationality and actual effect of the action are explained. Through the Ariel 3D image analysis system to analyse the three-dimensional image of the basketball player's shooting action, the selected technical diagnostic indicators mainly include the final shot parameters, the shot speed, angle and height. Through the three-dimensional analysis of the basketball shot time, the basketball shot speed, angle and height are obtained. The time parameters of single, double support phases and ratio time parameters are obtained by counting the number of image frames in each action phase and multiplying the number of image frames with the time of each image taken, and the product is the action time. The time taken for each image to be taken is the inverse of the shooting frequency [3].

3 Research results and analysis

3.1 The basic theories of the biomechanics of basketball shooting techniques

3.1.1 The basic principles of basketball

The main task of basketball shooting is to make the basketball get a spinning speed through the rotation of the players, and throw the basketball along the tangential direction in the final force stage. Athletes who want to achieve the maximum height must be required to create the best conditions for the basketball's force during the entire shooting process so that the basketball can obtain the maximum shooting speed [4]. The distance of basketball movement mainly includes the distance before the shot and the distance after the shot. The basic elements are shown in Figure 2.

Fig. 2 Schematic diagram of distance factors affecting basketball.

After the basketball is shot, it is only affected by gravity when flying in the air, so it makes a projectile motion. In the parabolic motion, the object moves in a straight line at a constant speed in the horizontal direction and a vertical throwing motion in the vertical direction. The basic motion law is as follows.

$$\begin{cases} x = v_{0x}t = v_0 \cos \theta t \\ y = v_{0y}t - \frac{1}{2}gt^2 = v_0 \sin \theta t - \frac{1}{2}gt^2 \end{cases} \quad (1)$$

The equation that can be solved by Eq. (2) is substituted into Eq. (1), and the calculation formula for height can be obtained

$$x = \frac{v_0^2 \sin \theta \cos \theta}{g} + \frac{v_0 \cos \theta (v_0^2 \sin^2 \theta + 2gh)^{1/2}}{g} \quad (2)$$

3.1.2 The main influencing factors of basketball performance

Basketball performance mainly depends on the distance after the shot. From the height calculation formula, it can be seen that the factors that affect the height of the basketball are mainly shot speed, shot angle and shot height. The order of the degree of influence of each influencing factor on the height is that the shot speed is the first influencing factor, followed by the shot angle, and then the shot height. To be able to determine how much influence each influencing factor has on the height from a numerical point of view, we will calculate the influence of the hand speed, the influence of the shooting angle and the influence of the shooting angle respectively [5].

3.1.3 Impact of shot speed

When the shooting angle is 41 and the shooting height is 1.5 m, the corresponding basketball flying height. From the calculation results, the speed of the shot has a great influence on sports performance. When the shooting speed is 15 m/s, the shooting height is only >24 m. The actual shooting speed of an excellent basketball player is between 26 m/s and 30 m/s. When the shooting speed is 26 m/s, the shooting height can reach about 70 m, and the shooting speed is 28 m/s. The shooting height can reach about 81 m when the shooting speed is 30 m/s, and the shooting height can reach about 93 m. Therefore, the key to improving athletic performance is to increase the speed of basketball shots. So with the increase of shooting speed, what is the change of basketball shooting height? In Excel, we make a diagram of the relationship between shooting speed and shooting height. Among them, the X coordinate represents the speed change, and the Y coordinate represents the height change. We can see that the change of height and the change of shooting speed are nonlinear. With the increase of shooting speed, the height shows an accelerating trend. This further proves the importance of athletes to improve shooting speed in basketball as shown in Figure 3.

Fig. 3 The change curve of height with shot speed.

The increase in the initial speed of the shot depends to a large extent on the acceleration of the athlete's rotation speed, and people can only spin the ball faster. At present, the world's outstanding basketball players' basketball shots spin faster and faster, and even some athletes lose a certain amount of rotation in exchange for an increase in speed. A survey of track and field competitions in the Eighth National Games group shows that most basketball players in my country have relatively standardised skills, but the rotation speed is low, the rhythm is slow, and there is no sense of acceleration [6]. On the other hand, when the world's elite basketball players shoot, the rotation speed of four laps is faster than one lap, and the acceleration is particularly obvious, as shown in Table 1.

Table 1 Training results of some Chinese athletes.

Athlete	Grade (m)
A	2.5
B	2.1
C	2.6
D	2.4
E	2.5
F	2.3
G	2.4
H	2.7
AVG	2.4375

3.2 Impact of shot angle

When the shooting speed and shooting height are fixed, the trajectory of the parabolic flight is different for different shooting angles, and the basketball flying height is also quite different. Figure 4 shows the parabola trajectory of different shooting angles and the relationship between the shooting angle and the basketball flying height.

Fig. 4 Parabolic trajectories at different shooting angles.

From the calculation results, the shooting angle also has a certain impact on sports performance. When the shooting speed is 30° , the shooting height is about 67 m. The actual shooting speed of an excellent basketball player is between 38 and 44 when the shooting angle is 38° . The hourly shooting height can reach about 74 m, when the shooting angle is 40° , the shooting height can reach about 75 m, and when the shooting angle is 44° , the shooting height can reach 76 m. When the shooting angle increased from 38° to 44° , the height only increased from 74 m to >75 m, and the difference was <2 m. Therefore, the impact of shooting angle on height is much smaller than the impact of shooting speed on height. At the same time, it can be seen that 45° means that the altitude has dropped. There is no need to continue to calculate downwards. After 45° , with the increase of the angle, the flight altitude has dropped significantly. Therefore, athletes must control the shooting angle at 45° during the shooting process, which is more powerful. Therefore, athletes must control the shooting angle within ‘in the process of shooting [7]. It can be seen from the above table that at 30–44, as the shooting angle increases, the shooting height increases, so whether 44° is the maximum Good shot angle. The following uses mathematics to further discuss the method of function extremum:

Fig. 5 The relationship between shooting angle and basketball flying height.

From Figure 5 above, it can be seen that when θ is too small or too large, the maximum height of the projectile cannot be obtained. Only when θ is a certain angle can X be maximised, and the corresponding angle θ is the best projection angle.

3.3 Obtaining the best throw angle

The first problem is to find the objective function. Generally, if the throw point is high, V_0, H is certain, and the objective function is to seek the maximum height According to

$$x = \frac{v_0^2 \sin \theta \cos \theta}{g} + \frac{v_0 \cos \theta (v_0^2 \sin^2 \theta + 2gh)^{1/2}}{g}.$$

This is a formula whose independent variable is X and θ function is X . If you want the largest X , then find $dx/d\theta$ and make it equal to 0, then

$$\frac{\partial}{\partial \theta} \left[\frac{v_0^2 \sin \theta \cos \theta}{g} + \frac{v_0 \cos \theta (v_0^2 \sin^2 \theta + 2gh)^{1/2}}{g} \right] = 0 \quad (3)$$

This is a very complicated equation about θ , and the dichotomy method is used here.

$$Q(\theta) = \frac{\partial}{\partial \theta} \left[\frac{v_0^2 \sin \theta \cos \theta}{g} + \frac{v_0 \cos \theta (v_0^2 \sin^2 \theta + 2gh)^{1/2}}{g} \right] \quad (4)$$

Take the value of $[0, 45, 90]$ calculation, Q_1 , Q_2 , and Q_3 respectively, then θ is in the $[0, 45]$ area or the $[45, 90]$ area. We respectively judge whether Q_1 , Q_2 are different signs and Q_2 , Q_3 are different signs, then θ is in the interval where the product of the two Q s is negative. For example, the first calculation in this problem can determine that θ is in $[0, 45]$ and then take $\theta = 22.5$ degrees to determine the values of Q_1 , Q_2 , and Q_3 of $[0, 22.545]$, to further determine the area where you are, and proceed to find the accuracy value.

3.4 The impact of degrees

Taking the following is the effect of the shooting height on the shooting height, assuming the shooting speed is 27 m/s and the shooting angle is 44, the shooting height corresponding to 1.2–2.2 m is calculated. The above results show that as the shooting height increases, the basketball shooting height is increased. The increase in the basketball shooting height is mainly through increasing the shooting angle. The above calculation shows that increasing the shooting angle has a good effect on increasing the shooting height. For this reason, we recommend sports practice. Based on the existing ‘left and right shot angles, the angle of shots is appropriately increased, and the angle of shots depends on the inclination of the swivel slope in the last lap of the basketball. It is necessary to study the inclination of the swivel slope in basketball. The effect of the height of the shot on the height of the basketball shot is relatively small [8].

4 Establishment of body motion trajectory model

The ultimate goal of research on basketball skills and athletes’ physical conditions, physical fitness, and special abilities is to help coaches find problems in sports training so that they can be solved in sports practice and improve athletes’ sports performance. The establishment of evaluation models and evaluation standards of test indicators can effectively grasp the development speed and range of athletes’ sports performance, which can make our sports training more targeted and improve the scientific nature of sports training. Therefore, conducting this part of the research is very meaningful work [9].

4.1 Establishment of evaluation model

Establishing an evaluation model can not only predict the sports performance that athletes should achieve based on the main physical fitness indicators of the athletes in each training stage, but also check and evaluate the physical fitness development status of the athletes based on the sports performance, and comprehensively and systematically evaluate the main physical fitness Diagnosis of quality, clarify which indicators have met the requirements, which indicators need to be improved, so as to regulate the training process and improve the training effect. The establishment of a physical fitness development level evaluation model can also evaluate the athlete’s technical level. If the result calculated by the model is higher than the competition result, it indicates that the athlete’s technical level is basically adapted to the level of physical fitness development. If the estimated result is lower than the competition result, the athlete’s technical level is good [10].

First, establish the evaluation model of the multiple regression equation. Take basketball performance as the dependent variable (Y), and use the above 6 indicators as independent variables ($x_1, x_2, x_3, x_4, x_5, x_6$) to establish a multiple regression model. The basic expression of the equation is

$$Y = 19.0779 + 0.6771x_1 + 0.1299x_2 + 0.1299x_3 + 0.9489x_4 - 12.928x_5 - 0.3109x_6 \quad (5)$$

Secondly, verify the significance of the regression equation. Calculated variance $F = 6.3105$, significance $F < 0.05$, indicating that the establishment of the multiple regression equation has significant significance. S_y is the standard error of the equation and reflects the prediction accuracy of the equation. The smaller the value, the higher the prediction accuracy. In this article $S_y = 2.58$ m the height of basketball is generally between 60 m and 90 m, and the fluctuation range of basketball performance is feasible. Therefore, the prediction accuracy of the equation is higher. In addition, the back-generation experiment proves that its prediction accuracy is about 97.67%. The average value of the correlation coefficient between the various physical fitness indicators and basketball performance of the selected equation is $R = 0.712$. From a statistical point of view, it is appropriate to use them as the evaluation indicators of basketball players’ performance.

4.2 Establishment of evaluation scale

To predict sports performance more conveniently, we convert various indicators into corresponding scores and develop evaluation scales. First of all, the number of indicators is infinitely rigid, and the standard score method is used to formulate a scoring scale to comprehensively evaluate the physical fitness of the athletes and calculate their performance. The scoring scale is formulated with the average value of each indicator as the reference value, and the interval of 1/2 standard deviation is used to establish the grades of each indicator, a total of 20 grades, and the grades of each indicator correspond to 1–20 standard points, and the evaluation mode is established. Chart [11].

4.3 Establishment of evaluation standards and prediction of sports performance

First, check the corresponding evaluation scale according to the evaluation index data of each athlete in the sample, and get the corresponding standard score, and then calculate the average value M of each standard score according to the formula, and then calculate the average and standard deviation of the M value. Determine the standard score interval value of each evaluation grade according to the method of mean standard deviation. To predict sports performance, after checking the standard score M_i of each evaluation index from the evaluation table, take the average of the standard scores of the 6 indicators, and the calculation formula is as follows

$$M = (M_1 + M_2 + M_3 + M_4 + M_5 + M_6) / 6 \quad (6)$$

The sports performance is also divided into 20 grades. The theoretical prediction of each person's performance is to use the average of his 6 index standard scores to infer sports performance.

4.4 Evaluation of the balance of physical fitness

Various physical qualities promote each other and restrict each other. Excessive development of a certain power quality must suppress the development of other power qualities, and the most effective connection between various power qualities will also be destroyed. Therefore, maintaining a balanced and coordinated development of various strength qualities is very important for improving the overall effect of strength training. To assess the balance of the strength of basketball players, we use the extremely poor method proposed by the former Soviet Union Krisel to test and evaluate. Range calculation formula. In the evaluation, the value is smaller or tends to 0, indicating that the athlete's physical fitness development level is more balanced, and there is no obvious weakness. The larger the value, indicating that the development of various physical fitness is more uneven, and training should focus on improving the level of weaknesses to effectively improve the overall level of physical fitness.

5 Conclusion

Starting from the basic motion law of the projectile, this article uses mathematical methods to calculate the impact of the shooting speed, shooting angle, and shooting height on the basketball flying height. The mathematical calculation results are consistent with the practical results. The research results show that the shooting speed affects the basketball movement. The key factor of performance, so improving the shooting speed of basketball should be the focus of this research. The theoretical calculation of the best shooting angle of basketball is about 44, while the actual shooting angle of the athletes is 41°. The height of the left and right shots has little effect on basketball performance.

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