Mechanics Research and Analysis of the Impact on the Basketball Shooting Average

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Abstract — Objective: Modern basketball is developing in the direction of high speed, high altitude advantage and exquisite skill. The research on the influence of the theory of mechanics on the percentage of the field has become a key point in the field of basketball. Methods: In this paper, the literature data method, expert interview evaluation method and logical analysis method were used. Process: This paper first introduced the characteristics of contemporary basketball, led to the study of the guidance of the mechanical analysis, then introduced the research methods and mechanics theory, and analyzed the force of basketball in the air, touch frame and contact plate. Finally, this paper made a detailed analysis of the technical movements of the shot, and the experimental of shooting training and test. Conclusion: The stress situation of the basketball in the contact box and the contact plate, and the players' shooting position are the key to the shooting average.

Keywords - Shooting average; Shooting posture; Mechanics analysis

I. INTRODUCTION

Modern basketball is developing towards the direction of high speed, high altitude, and superb skill. Shooting is that the player uses the correct technique with the ball as the ball from the basket above into action by basket method, the cumulative number of shooting scores decide the game. The attacking team use various techniques and tactics to create more and better shots, and try to shoot the ball. The defensive team is active defense, which is in order to prevent the other side of the basket. Therefore, the shooting has become the focus of attack and defense, which is the most important basic technology of basketball [1].

With the development of basketball, the shape and function of the athletes are improved, which makes the technology of the shot to be developed from the low to high, and the speed is slow to fast. The shooting method is more and more, the shooting rate is increasing, and the evolution of the shooting technique is a sign of the basketball movement from one stage to another. With the continuous development of basketball, as an offensive and defensive combat, basketball match focusing shooting also appears some new trends and characteristics, sums up as fast, high and far, and all six words. Shooting is one of the most important techniques in basketball. It is the only way to score. It is the most important technology in basketball technology, and it is also the core of basketball tactics. No matter what kind of attack tactics are ultimately to be attributed to the shooting score, while the purpose of defense is to limit the opponent's shot, so as to create more scoring opportunities. So in a sense, basketball is a sport that limits the opponent's score. Therefore, the shooting rate is a critical technical indicator [2].

If we can make use of the principle of sports biomechanics to analyze the factors affecting the shooting rate and improve the feasibility and effectiveness of this analysis to explore the effective way to improve the shooting rate, we can enrich the existing basketball training theory and method to improve the athletes' understanding of the shooting process, guide the basketball training and improve the shooting rate to guide the basketball teaching and training [3].

II. RESEARCH METHODS AND THEORETICAL BASIS

A. Research Method

(1) Literature data method.

This article has consulted for the past twenty years, the basketball shooting skill movement and the movement skill study paper many, and the book rest. Through access to foreign language information to understand the current situation and the lack of basketball, the accumulation of a large number of data [4].

(2) Expert interview evaluation method

Through the research on Basketball Teaching and training of basketball teaching and training for many years,
we have a deep research on Basketball Teaching and training [5].

(3) Logical analysis method
To obtain the data and the research analysis result to carry on the comparison, the analysis, the induction and so on [6].

B. Theoretical Basis

(1) Analysis of Sports Biomechanics
Using the principle of sports biomechanics, sports biomechanics analysis of the technical movement of the shot, the sport biomechanics of the basketball shooting technique is obtained. In particular, the action process of the upper and lower limbs of the body is analyzed [7].

(2) Basic research on mechanics theory
On the basis of mechanics theory of basketball shot after the flight trajectory calculation and analysis, and the hollow frame, touch the basket into the basket, and a frame in different situations were analyzed using the mechanics principle. The effects of different mechanical factors on different shooting results, and the analysis of the steps and the points of the case [8].

III. MECHANICS THEORY ANALYSIS OF THE ACTION OF SHOOTING TECHNIQUE

It is difficult to grasp the skill of shooting, and it is difficult to grasp. So the research on the technology of basketball is one of the key research. Many papers on the teaching and training of shooting and training, the focus of the research is mainly on the technical movements of the specifications and technical analysis, technical action teaching method, the psychological training of shooting and shooting techniques, and so on. And the factors affecting the rate of shooting in addition to the correct ball movement, shooting techniques, there are many factors such as mechanics, the force on the ball, the ball in the air direction, trajectory, i.e. hand speed, release height, angle and ball rotation and air resistance etc. These factors are different with the body condition, body quality and shooting position.

Mainly in the following aspects:

A. The Rotation and the Air Resistance of Basketball

(1) Basketball rotation type
The rotation of the ball in the basket has two types, namely, the front and the back. The pre - or post - spin of the ball is determined by the index finger of the player's shot. And the rotation of the ball type depends on shooting action, which mainly occurred in March before the spin cast hollow ball and moving under low cast cricket. After the rotation occurs mainly in the long-range shooting with hook shot and moving master cast hollow ball, cricket [9].

(2) The function and mechanics analysis of the post rotation in the basket
Generally speaking, basketball is carried out indoors, so basketball is playing a role in the air, which is a kind of force in the air. Since the latter two forces are less than the gravity, it can be considered that the basketball is to make an approximate oblique motion, and the motion parameters of the oblique motion are determined by the sum of the various elements of the force exerted by the players in the ball before and in the moment. The act of shooting basketball caused by rotation in the air to form a composite motion, namely in projectile motion and rotation motion in the coronal axis around the ball, so the basketball in the air running track with different projectile motion [10].

Basketball in the air at low speed, the air is applied in the sphere and the friction force is less. There is a small gap between the air flow and the spherical surface of the ball. Because of the existence of spherical layer, the pressure difference between the two parts of the sphere is not significant. That is to say, the flow of air through the spherical surface can be kept stable, which has little influence on the running of the basketball. But in the middle and far distance shooting, the movement speed of basketball, the ball surface and air flow of the friction is greatly increased, the spherical surface is severely damaged, when the air flow through the ball point see figure can produce a large deviation of the flow line, so that the rear area of the ball to produce a large flow area, so that the ball before and after the two parts of the pressure is significantly different, reduce the length and height of the ball flight trajectory, especially not conducive to the long distance shot.

Figure 2 Lift force generated by the rear spin

(3) The function and mechanics analysis of basketball in shooting
The basketball in the air before the spin is mainly due to the shooting, the athlete’s leg strength, waist strength and upper limb strength by means of transfer of human machine chain, through wrist flexion, finger on the lower sphere before finally produced. Mainly in the road between the investment and investment under hollow ball in cricket [11].

B. Mechanical Analysis of Ball in the Air
Set H shooting height, V0 shooting speed, θ shooting angle, α angle of entry and L shooting distance. h=3.05-H. According to the formula, the relationship of the factors can be calculated:
The relationship between the factors in the case of a certain shooting distance. Considering the air resistance, the ball level velocity is:

\[ V_x = V_0 \cos \theta \]  

Vertical velocity in the basket:

\[ V_y = \sqrt{V_0^2 \sin^2 \theta - 2gh} \]

There is:

\[ \tan \alpha = \frac{Lg}{V_0 \cos \theta} - V_0 \sin \theta \]

Therefore, the more far from the shooting range from the need to increase the speed of the shot, the angle should be reduced to increase the level of speed. At the same time, the error caused by the change of V0 and the shooting of 0 of the shooting of the greater the effect.

C. Aiming Point Selection

According to whether the ball can be shot hit the backboard, the aiming point is divided into two categories, namely the basket aiming points and rebounds aiming point.

(1) The mechanics basis of the points of the rebound

The mechanics principle of the point shot with the rebound is the conservation of momentum. If the basketball rebounds and is elastic, ignoring the momentum loss during, before and after the angle of basketball backboard should be approximately equal, plus the basketball area, so the aiming point to allow a certain degree of error, this error depends on the athletes through thousands of practice and the formation of motion perception and precise sense to grasp. Can be found in the experimental observations, the spin and spin orbit after a basketball will be different. Before the ball will have a red sports in a spin, then there will be a press movement. Therefore, in the investment underhand cricket aiming point should be aimed at investment than cricket master point distance slightly far lower rim. Similarly, far too many to rely on the body of the players to adjust the sense to adjust [12].

(2) Aiming at the mechanics basis point ring

Through the investigation of basketball experts and athletes, find the hearts of the people set up a basket aiming point, namely the basket, the basket along the frontier, the nothingness of the ring center, empty ring center point just above and the rim. Here is the most widely accepted aiming point is the basket along the rim [13].
of the ball into the basket, can increase the angle, more conducive to the basket.

Figure 6 Schematic diagram of a positive backward rotation of basketball

**E. Mechanical Analysis of the Touch Ring into the Basket**

After the ball rebounds in touch and in addition to the hollow net basket, there is a touch in the basket after basket. For the convenience of analysis, and the flight path of the ball far side of the basket is called the basket along the flight path of the ball, and a proximal rim called the front rim.

If the ball does not touch the rim in the rotation, after the ball is in the opposite direction with the ball bounce, the ball will be according to the original route. If the ball itself after rotation, in the face of the basket along the rim, not only by the rebound effect, at the same time is caused by the ball rotation of the ring reaction force, the force direction of the two point to the rim, greatly increase the possibility of the ball in the basket. If the spin on the ball hit the basket front, also, will be elastic and anti-reaction force of the ring, the vertical direction of the two force direction and the ring is close, often can cause the ball to bounce over after falling basket. Also, to a certain extent, after the spin down in the ring after the front or both along the rotation speed of the ball faster, the ring counter force of the larger force direction of the sphere stress is close to the vertical direction of the rim, can further increase the possibility of the ball into the box. It can be seen that the rotation speed of the ball is also directly related to the shooting percentage. These cases are described, after the ball can generally increase the ball in the basket, and the ball is also playing a very important role in the rotation speed.

Figure 7 Backward rotation basketball touch the front of the rim rebound diagram

**IV. BIOMECHANICAL ANALYSIS OF THE TECHNICAL MOVEMENTS OF THE SHOT**

Shooting technique refers to the process of coordinating and coordinating the body parts in the body. The polymerization started from shooting the ready position, a leg force, and then along the stretch direction moves to the basket, especially with the spinal stretch of lower limbs, trunk and upper limb inertia to promote coherence, coordination, to all parts of the body muscles strength finally accumulated in the arm, wrist and finger, and to flip shake the arm, wrist flexion extension and finger plucked action ball. Because the shooting technique is composed of multiple action links, in order to let the players as soon as possible to grasp the accurate shooting skills. From the angle of the movement of the technical movement of the shot from the perspective of the sport biomechanics [14].

**A. Shooting the Ball Technique**

The suitable ball technique is a prerequisite to complete shooting action right. For example, one hand shot ball movement should be five fingers apart, wrist back, with the lower part above the root, hold the ball hand out, fingers slightly bent, the bending degree and spherical radian, angle of thumb and little finger is about, the gravity line ball almost fell on the index finger and middle finger the site refers to the root, the elbow drooping naturally, above the ball placement on the same side of the shoulder, before shooting the other hand on the ball in the lower front, shooting ball is evacuated.

**B. Technical Movements of Shoulder, Elbow, Wrist and Finger**

Any of the final form of the shooting is done by the shoulder, elbow, wrist, finger joint activities to achieve. The
difference of shooting style, mainly depending on the shoulder and elbow joint.

When the shot is stretched, it is accompanied by a movement of the elbow. Elbow movement is not only related to the whole body coordination force but also affects the size of the angle of the shot, which affects the ratio of vertical and horizontal velocity of the ball. The vertical velocity and horizontal velocity increases with the increase of the ratio of casually. Therefore, the nearer the shot distance, the more close to the vertical and the long distance shot, it is necessary to move forward. Elbow action also affects the wrist and finger movements, because the elbow, elbow abduction and adduction will affect the correct direction of wrist refers to the direction and size of force to change the ball shot.

When shooting requires hard and soft, straight shooting arm to increase the force distance and time, is conducive to the control of the ball, to avoid the explosive force. According to the lever principle and the function principle, through the extension of the arm to increase the working distance to make the ball to produce a big shot speed. At the same time, it is also beneficial to the synthesis of the whole body, to avoid the premature force of the wrist force, to effectively use the wrist force. Straight shot arm can also improve the shot point, increase the ball's flight arc. Arm straight after you have to pay attention to maintain a period of time to lay down, to ensure that the soft force [15].

The ball is controlled by the wrist. The angle and direction of the shot mainly depend on the wrist movement. Two in addition to force the ball out by gravity but also by direction of the shot mainly depend on the wrist movement. The other is to make the ball rotation, the direction and the tangent ball.

C. Rotation Problem in Shooting

The rotation of the shot is mainly the application of the two theorems. The first is the momentum moment theorem, and the two is the law of conservation of momentum moment.

1) Application of momentum moment theorem in basketball shooting technique

The momentum theorem is brought into the law of rotation.

\[ M = I \beta = \frac{I(\omega_2 - \omega_1)}{t} \]  
(5)

On both sides by T:

\[ Mt = I(\omega_2 - \omega_1) \]  
(6)

In sports, whether the rotation of the device, or the body parts of the body or the whole body rotation, the effect of the external force can be reflected by the moment of momentum, can be described by the momentum of the rotating state, and can be used to calculate the moment of momentum. Because the body and the rigid body is different, in the movement process, the human body's rotational inertia is the change, if uses I1 to express the human body to one axis original rotational inertia, in the t time, the human body to the same axis rotational inertia is I2, in this kind of circumstance, the moment of momentum:

\[ Mt = I_2\omega_2 - I_1\omega_1 \]  
(7)

Using the rotation theorem and the theorem of moment of momentum, it can make a simple analysis of the movement of the human body and the rotation of the body as a whole.

D. Body Posture and Coordination and Coherence in Shooting

The body condition of the athlete is to keep the balance of the body, and the necessary condition for the coordination of the shot. The correct body posture is feet after standing, shooting the same side in front feet, two knees bent, chest and abdomen, the body center of gravity falls in between the legs, upper body slightly forward, holding hands in the chest, holding that the formation of basic standing posture. When shooting, based on this concept and approach is the preparation before the ball shooting action.

On the take-off, the action of the coherence, coordination, and effort can be measured by the size of the horizontal impulse to take off. The horizontal impulse is the impulse of the human body to move forward and backward when the human body takes off, and the vertical jump is offset by the two. The horizontal force and impulse in a certain sense is a waste, because they do not directly affect the height of the jump.

E. Shooting Posture Training and Experiment

The control group and experimental group of 20 players, in which the experimental group according to the standard pose for training, respectively, in the 2 week, 4 weeks and 6 weeks, and the control group to carry out the test, the average number is as follows:

<table>
<thead>
<tr>
<th>Number of People</th>
<th>Times</th>
<th>Before training</th>
<th>2 weeks</th>
<th>4 weeks</th>
<th>6 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Experimental group</td>
<td>Control group</td>
<td>Experimental group</td>
<td>Control group</td>
</tr>
<tr>
<td>20</td>
<td>10*3</td>
<td>16.4%</td>
<td>17.6%</td>
<td>18.1%</td>
<td>18.2</td>
</tr>
</tbody>
</table>

From the above table, it can be obtained from the experimental group, the experimental group of the standard shooting posture is obviously higher, which shows that the standard of shooting position has a key role in the hit rate.

V. CONCLUSION

In this paper, we analyzed the mechanics characteristics of the shooting technique and the various aspects of the
process, and discussed the factors that affect the shooting rate of the different situations.

The fierce competition of the modern basketball match, the requirements of the athletes must be in the complex and changeable skills and tactics to master and use the technology of shooting. The shooting technique contains a variety of laws of human motion, in which the content of motion mechanics plays a decisive role. Coaches and athletes should pay great attention to this, in basketball teaching and training, it’s important to make full use of the mechanics of the technology, and work together to actively explore and use to improve the scientific law of the shooting. The pre-and post-spin of the ball in the basket depends on the action of the shot. The rotation is mainly used for moving shovel shot, which is mainly used for long-distance basketball rotation of the ball faster after the spin cast speed for better stability. After the flight of the ball spin increase radian, improving the hit rate, increasing the speed of spin and aiming at the more scientific than other points for the ring break shot. The act of shooting is constituted by a number of technical links between the overall foundations. Therefore, to master the technology of shooting, one should pay attention to the function of the technology, the coordination of the operation and the comprehensive effect of the technology.

REFERENCES