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Research of the Changing Trends of Biomechanical Parameters for Volleyball Passing and Digging Based on Image Analysis

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Abstract: Sports biomechanics research methods and measuring methods are associated with the development of computer technology and other auxiliary discipline gradually mature. Volleyball action technology mainly has the basis of setting up and smash technology, these two technologies of reasonable use can increase the number of teams win. To research and analyze the above two base motion technologies, the technical features of the first to cushion the ball movement and force of the ball was analyzed and then to smash the technical features of the action are summarized and the whipping effect are analyzed in theory, the sports biomechanics research methods to collect the balls during the whole process of pad body movement parameters and spiking motion of major joints of the whole process of the Angle of the lower limb joints parameters and analyzes the characteristics of the data. According to the analysis method and the results it is concluded that the volleyball mat base ball technology and spiking base motion characteristics of the movement, so as to volleyball training effect inspiration and advice.

Key words: Sports biomechanics, phase, joint angles

INTRODUCTION

With high-speed cameras, force platforms and Electromyography techniques are widely used in sports science, the volleyball player technology training level have significantly improved. At present, domestic scholars generally use empirical research with the theory of sports biomechanics for volleyball movement analysis and also do many comparison studies for the characteristics of technology at home and abroad.

Many people have made the effort for biomechanical research methods, measurement techniques and volleyball movement technology research, these people's efforts make volleyball technology reform and some scholars put forward their views. It concludes that the proportion of lunge-smash takeoff time for each stage occupying the total is the key factor that influences the jump effect (Lin, 2004). The speed-loss of the body center of gravity at the second stage and the vertical displacement at the third stage are important factors that affect the height of the center of gravity. The third stage features the movement of small joints driven by that of the big joints and the extension of the hips, the knees and the ankle joints accelerated in proper order (Cui, 2013).

Based on previous studies, sports biomechanics theory and kinematic parameters of the data on the volleyball technical features of digging and spiking ball technical characteristics are analyzed make contribution to china's volleyball career to provide a theoretical basis for volleyball training.

ANALYSIS OF CHARACTERISTICS OF VOLLEYBALL BASIC MOTION TECHNOLOGY

Volleyball technology refers that use the principles of human anatomy and movement biomechanics, adopt all reasonable action shots and finish with a general term for hitting other actions under the movement of the rules conditions allowed, the of, using (Liu, 2013). Volleyball techniques through different technical characteristics and application method will be divided into six kinds of technologies: Ready posture and mobile technology, passing skills, digging technology, serving techniques, spiking and blocking technology. In the above six technologies, digging and spiking technologies are the basis technology and are the rest outside the technical composition of the essential technologies in addition to ready and mobile technology, so this section analyze technology characteristics of digging and spiking (Hua, 2010).

Analysis of characteristics of digging technology:

Digging technology used very frequently in the volleyball match, its role is to receive serving ball, spiking ball, blocking ball and defense and handle a variety of ball. When pass low ball, you can dig the second pass to organize the attack, therefore digging technique is an important part to organize an attack, counterattack and protect against (Zhang, 2013).

Digging technology divide into two-handed dig and single-handed dig and two-hand dig called don't fall on



Fig. 1: Schematic of digging hand type

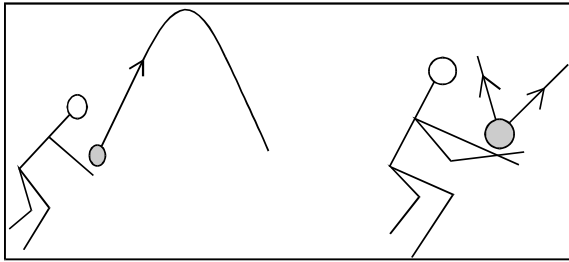


Fig. 2: Schematic diagram of dig motion ball

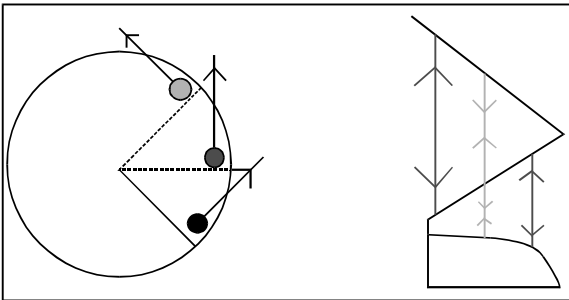


Fig. 3: Schematic diagram of the force distribution during digging

the ground dig, there is a positive dig, side dig, step dig, half kneeling dig, back dig and block ball. Single-handed dig is also known as the fell to the ground dig ball, there is rolling dig, the side down dig, front rolling dig and fish diving dig. Digging ball hand shape have Baoquan style, stacked and mutual finger-style by style, its external manifestations from left to right in Fig. 1.

From the perspective of the mechanical analysis, the pad volleyball wishing to improve the quality of the ball, you need to act volleyball as the study object. Study the state of the ball is not in contact players hand, anticipated motion state of volleyball left hand and the ball collision force, the final analysis is to control all aspects of the body so that the spot position, direction and intensity reaches a preset volleyball trajectory values. Figure 2 shows the schematic diagram of dig motion ball.

As shown in the left of the Fig. 2, people's hands need to give the volleyball an oblique upward force, so

the units of the force are arms. When the volleyball flies toward athlete and has a collision with players' forearm, the volleyball is subjected to reactive force at the same time and it generates static friction force between the arm and the volleyball. Just due to the relatively static friction force, the volleyball can be digging out high-quality. The athlete's elbow action will affect the stability of digging the ball in order to coordinate each joint of athlete's body. As shown in the right Fig. 2, when the left arm elbow digs, it will generate an additional force. Due to the arm elbow, the friction force generated by forearm will be decomposed, followed by a frictional force in the opposite direction which can result in a rotated volleyball artificially and affect the accuracy and the quality of the volleyball. The elbow can also cause a gap between the arms which results in decreasing the contact area between the volleyball and arms and reducing the stability of volleyball.

Digging a volleyball need a relatively static friction force generated by the volleyball and arms and also need the force generated by lower limbs and waist. The static friction force which can dig the volleyball, the foot pedal force and the elastic force generated by bending knees are shown in Fig. 3.

As shown in the left Fig. 3, draw all of the hitting points together, it can give the volleyball an oblique upward force from the below yellow point, a vertical upward force from the middle pink point and the volleyball can be padded a parabola away from the above green point in the opposite direction with a predetermined route. So, athlete's arm is doing circular motion by clamping arm straight to below the point to draw round until contact with the ball and arm can give an oblique upward force to the volleyball by the approximate trajectory of circular motion. As shown in the right Fig. 3, when the flexion movement of bending knees and pressing foot is released, it can produce elastic potential energies approximately as to the principle of spring. With the release of energy can effectively increase the height and techniques of digging the volleyball and maintain the coordinated state of the body and then the athlete's arm will be cushioned and it can reach the purpose to reduce the arm's burden from frequent use.

Technical characteristics of spiking action: Spiking technique is mainly used in the process of attacking each other, the technology is the primary means of scoring the game, its purpose is to cause difficulties ball to each other, making it impossible to organize a strong attack and create conditions for own team's offense again.

When spiking, arm elbow's ideal position should be higher than shoulder and the lowest level is at the same

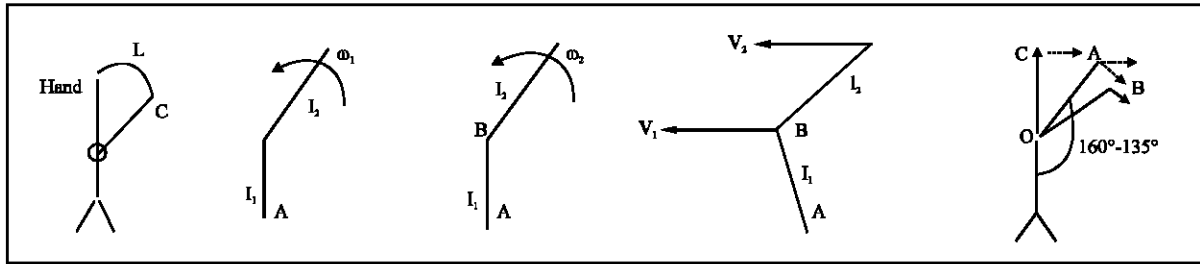


Fig. 4: Schematic of arm's condition and whipping process when body is not bow

level with the shoulder, in order to directly hit the volleyball by waving arms behind. The structure of shoulder joints determine straight arm's cutting volleyball which can shorten the working distance of the arm. As shown in Fig. 4, in the absence of the body bow arm is substantially perpendicular to the ground. If the ball hitting point is at the point C, the arm's working distance is only L arc length which is not conducive to the speed of waving arms. If the take-off point at the bottom of the ball, the athlete cannot spike, when the athlete cuts volleyball with straight arms, the rotational inertia of the arm I will increase, causing the angular velocity of rotation ω reduced and the length of the arm r is invariant. According to the Eq. 1, if ω reduces, the linear velocity of arm must be reduced, then it has a great impact on hitting force:

$$V = \omega \cdot r \quad (1)$$

The principle of whipping action is shown in Fig. 4, during spiking arm accelerates to maximum speed, it brakes at the elbow joint B, the angular velocity of forearm is increased to ω_2 , the momentum between the distal part and B is M, the angular acceleration β is the changing rate of the angular velocity, so the relationship is shown on Eq. 2:

$$\left. \begin{aligned} M &= I_2 \cdot \beta \\ \beta &= \Delta\omega / \Delta t \end{aligned} \right\} \Rightarrow \omega_2 = \omega_1 + \frac{M\Delta t}{I_2} \quad (2)$$

So, the speed of the distal part is shown on Eq. 3:

$$V = L_1\omega_1 + L_2\omega_2 + \frac{L_2 \cdot M\Delta t}{I_2} \quad (3)$$

BIOMECHANICAL ANALYSIS OF VOLLEYBALL'S BASED ACTION

Biomechanical Analysis of digging technology: Research objects: the process of digging 3m by four stair female volleyball athletes. Research methods: two types of

Nissan Sony DXC-637 to point shot the athletes to take the whole process of digging and get the biomechanical parameters of digging by parsing the video.

As shown in Fig. 5, during digging the volleyball pre-knee angle, knee angle, hip angle and vertical displacement of the center of gravity are gradually increasing which proves in this process stomp and extensor action are continuing. From the changing trend of horizontal displacement of the center of gravity can see that in the process of producing force before kicking the volleyball pedaling ground is carried to the front top of the body. The angle between the ground and the body has the trend to gradually decrease from the arms touch the volleyball to the volleyball leaves which proves that waist action is in parallel with the stomp extensor action. By the shoulder angle's changing trend can see that it increases by a big margin before touch the volleyball, but from the volleyball touch to leave athlete's arm, shoulder angle increasing magnitude is smaller. By the shoulder angle's changing rate trend see that when it began to force, the volleyball can get a great increasing rate and before the arm touches the ball the rate begins to decrease and it decreases rapidly after touching the ball and the angular velocity is very small when the volleyball leaves the arm. From these two aspects of the trend see that the rate maintains a translational stage from the ball begins to touch the arm to leave the arm.

Spiking technique biomechanics analysis: The study objects: Takeoff spiking lower limb movement of four female first class volleyball players.

Research methods: Two Nissan Sony DXC-637 on the fixed-point shooting for athletes, shooting the entire process of smashing, through analysis the film to acquire the lower limbs movement joint angles of smashing process.

Figure 6 shows volleyball players in the off buffer stages: The maximum buffer hip angle is $90.25^\circ \pm 4.15$, changes in amplitude $12.69^\circ \pm 4.15$, it is small range indicating that hip angle at the beginning of digging

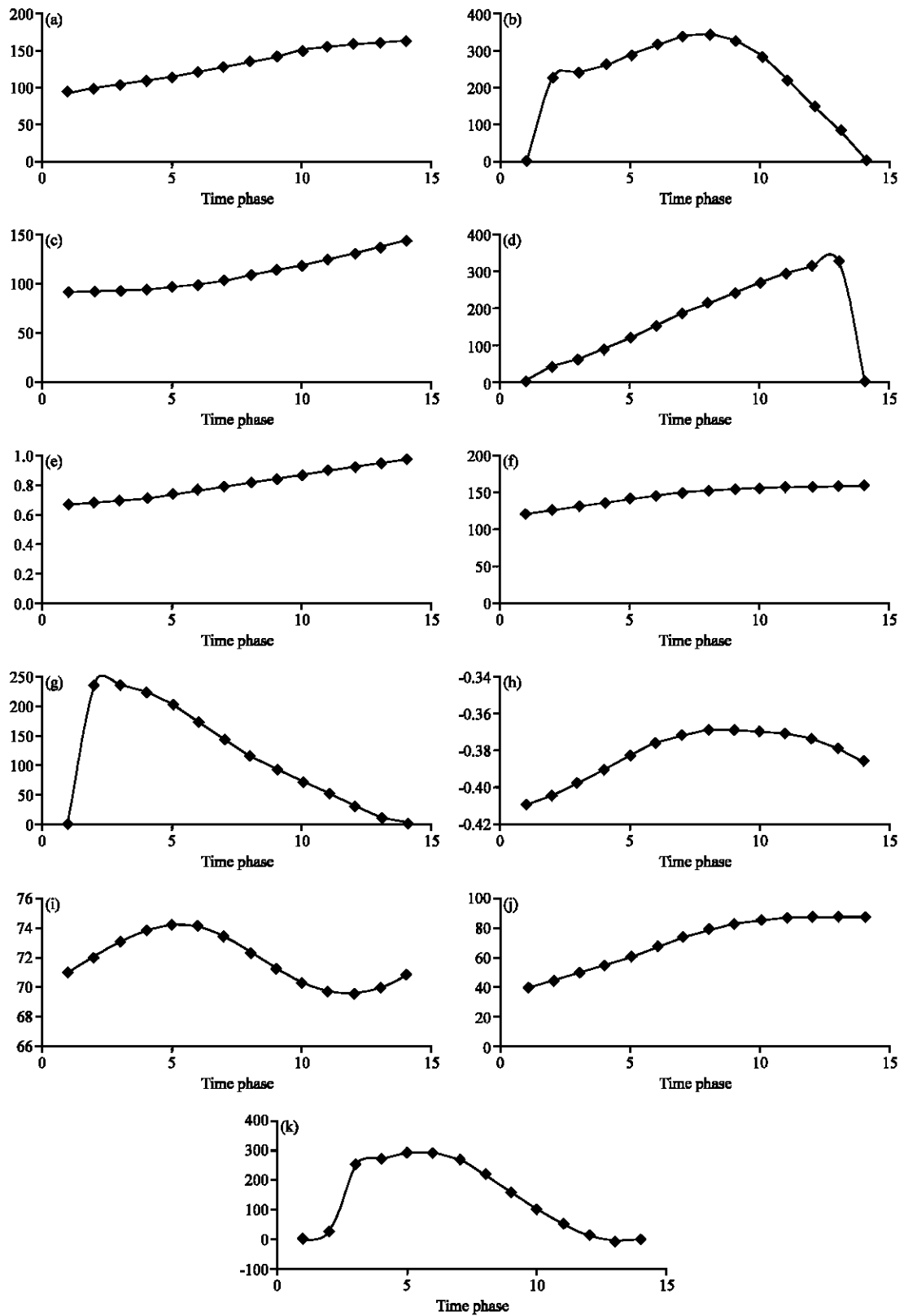


Fig. 5: Motion parameters' changing trend during each step of digging

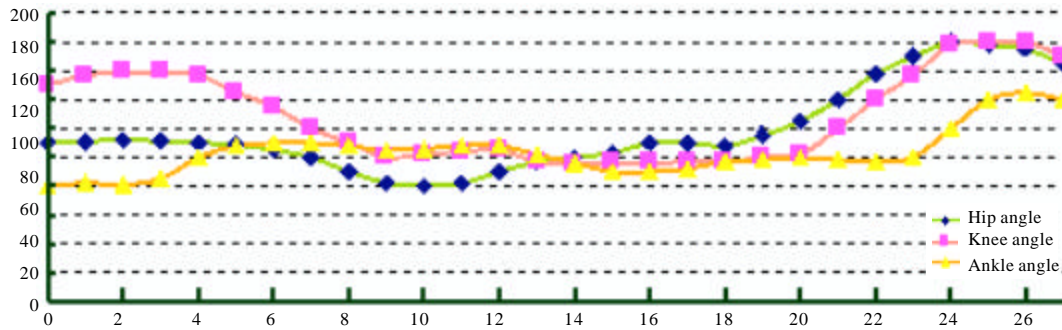


Fig. 6: Changing trend of lower limb joints' angular variation during digging

action has already in a smaller position; The maximum buffer angle of knee joints is 96.41 ± 7.45 , the maximum amplitude of the buffer is 46.54 ± 6.51 illustrating that the knees of athlete are conscious and initiative to complete the sinking action in the buffer stage and cause a large buffer margin which will produce some impact on completing the action; The angle of ankle joint's changing extent is small. Taking off stage: Hip joints accelerate kicking first and knee and ankle joints' angle continues to reduce, then the knee joints' angle is reduced to the minimum, then began to kick while the ankle joints' angle is continuing to reduce, ankle joints' angle begins to increase at last. When the athlete takes off, the angular velocity of hip, knee, ankle joints have an increasing trend and the angular velocity of knee joints is largest, followed by the ankle and hip joints which shows that the athletes pay more emphasis on large joints and muscles to force first and the end part to accelerate kicking and large joints drive small joints, making the hip, knee and the ankle joints accelerate kicking in order to achieve the desired effect. So the lower limb joints' reasonable order to accelerate force and each joint's stretching ability have a certain impact on taking off.

CONCLUSION

Analyzes the technical characteristics of volleyball digging and spiking, studies these two basic actions of sequence, spatial rendering and force features. Analyzes the whipping effect principles of the arm spiking, states the principle of hand speed formation of instantaneous spike. By means of biomechanics research, collected the

ball moves the whole body motion parameters of each link in the process of the characteristics of the phase change at any time, it is concluded that the movement parameter transformation trend diagram and analyses the characteristics of the movement of each link. Using biomechanical research, collected the characteristics of the body each stage motion parameters changes by phase during the digging process and derived transformation trends and analyzed movement characteristics of the various aspects. Using biomechanical research methods, collected lower extremity three joint angle phase change data during the course of the lunge-smash takeoff and receive the contrasting trends chart of the three links angle change and analyzed the motion characteristics of the three links.

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