

UPPER LIMB MOVEMENT CHARACTERISTICS IN VOLLEYBALL ATHLETES



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CARACTERÍSTICAS DO MOVIMENTO DOS MEMBROS SUPERIORES EM ATLETAS DE VOLEIBOL

CARACTERÍSTICAS DEL MOVIMIENTO DE LAS EXTREMIDADES SUPERIORES EN ATLETAS DE VOLEIBOL

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ABSTRACT

Introduction: Passing and serving are the most direct and efficient tactics for scoring points in volleyball. The recoil of the upper limbs in dominating the ball requires strength and muscular explosion, where the effect of the body's angular momentum accompanies a joint and rhythmic action. **Objective:** This study aims to analyze muscle strength in upper limb movements in volleyball athletes. **Methods:** Several volleyball players volunteered for the research. The movement when the athlete hits the ball was analyzed using kinematic analysis. The relationship between muscle strength and ball movement was also analyzed. **Results:** Body muscle tissue can be effectively trained during volleyball practice. The compound movements also help in the elasticity of the abdominal muscles. The stimulation of other muscle groups was observed in the participation of the movements. **Conclusion:** In modern volleyball training, athletes should strengthen their training with rapid trunk muscle swing exercises to improve the coordination ability of the sets of muscle groups. The protocols presented can assist in improving players' skills and performance. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Volleyball; Kinematics; Athletes; Muscle Strength.

RESUMO

Introdução: Passar e servir são as táticas mais diretas e eficientes de marcar pontos no voleibol. O recuo dos membros superiores no domínio da bola requer força e explosão muscular onde o efeito do momento angular do corpo acompanha uma ação conjunta e rítmica. **Objetivo:** O objetivo deste estudo é analisar a força muscular no movimento dos membros superiores em atletas de voleibol. **Métodos:** Vários jogadores de voleibol voluntariaram-se para a pesquisa. Foi analisado o movimento quando o atleta acerta a bola utilizando o recurso de análise cinemática. Também foi analisada a relação entre a força muscular e o movimento da bola. **Resultados:** O tecido muscular corporal pode ser efetivamente treinado durante a prática do voleibol. Os movimentos compostos também auxiliam na elasticidade da musculatura abdominal. O estímulo de outros grupos musculares foi observado na participação dos movimentos. **Conclusão:** No treinamento moderno de voleibol, os atletas devem fortalecer o treinamento com exercício rápido de balanço dos músculos do tronco para melhorar a capacidade de coordenação dos conjuntos de grupos musculares. Os protocolos apresentados podem auxiliar na melhoria das habilidades e no desempenho dos jogadores. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Voleibol; Cinemática; Atletas; Força Muscular.

RESUMEN

Introducción: El pase y el saque son las tácticas más directas y eficaces para conseguir puntos en el voleibol. El retroceso de los miembros superiores en el dominio del balón requiere fuerza y explosión muscular donde el efecto del momento angular del cuerpo acompaña una acción conjunta y rítmica. **Objetivo:** El objetivo de este estudio es analizar la fuerza muscular en el movimiento de las extremidades superiores en atletas de voleibol. **Métodos:** Varios jugadores de voleibol se ofrecieron como voluntarios para la investigación. El movimiento cuando el atleta golpea la pelota se analizó mediante la función de análisis cinemático. También se analizó la relación entre la fuerza muscular y el movimiento del balón. **Resultados:** El tejido muscular del cuerpo puede entrenarse eficazmente durante la práctica del voleibol. Los movimientos compuestos también ayudan a la elasticidad de los músculos abdominales. Se observó la estimulación de otros grupos musculares en la participación de los movimientos. **Conclusión:** En el entrenamiento moderno de voleibol, los atletas deben reforzar su entrenamiento con ejercicios de balanceo rápido de los músculos del tronco para mejorar la capacidad de coordinación de los conjuntos de grupos musculares. Los protocolos presentados pueden ayudar a mejorar las habilidades y el rendimiento de los jugadores. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptor: Voleibol; Cinemática; Atletas; Fuerza Muscular.



INTRODUCTION

Volleyball training pays attention to the coordination of the athlete's body and muscles to achieve the volleyball transfer process. In hitting the volleyball, the upper limbs of the human body pull the muscles to move. These muscle movements work together to enable the athlete to exert a high skill level. This is also the effect of volleyball players deliberately training their muscles. Human muscles affect the accuracy of hitting and timing of serving through coordination. Studies have pointed out that pure upper body strength exercises can easily overlook the training of certain smaller or weak muscle groups. As a result, the training response of the muscles is not very effective. And this training method also hinders the improvement of their unique skills and the improvement of individual sports performance.¹ Through three-dimensional photography, this article will analyze the dynamics of jumping and passing aerial hits of Chinese outstanding women's volleyball players. This paper reveals the kinematic characteristics of outstanding Chinese women's volleyball players' jumping and passing aerial hits. Therefore, we explore the far-reaching effects of timing, vehicle speed, distance, and angle parameters on the jump serve technology. The research results of this paper provide a theoretical basis for future practice and teaching activities. At the same time, the research results of this paper provide a theoretical reference for improving the jump serve technique of professional women's volleyball players.

METHOD

Research objects

This paper selects four outstanding female volleyball players as research objects.² This article understands the external characteristics of the jump serve by observing players' game videos many times.

Simulation of volleyball frontal spike hitting point

k'_{high} indicates the height area of the hitting point. Z'_{sort} indicates the background of the bounding rectangle. ω'_{high} expresses a given property. Assuming that $M(i)$ is represented as the target histogram under the feature ω'_{high} , the formula (1) can be used in this paper to obtain the ratio function of the distribution direction of the target image feature on the hitting point and the background.

$$S'_{zcv} = \frac{M(i) \times \omega'_{high}}{Z'_{sort} \pm m'_{sort}} * k'_{high} \quad (1)$$

This paper examines the specific differences between the hitting height area and the place to hit the ball. Then this paper uses the formula (2) to calculate the difference between the area where the player hits the ball and other areas

$$M'_{dfj} = \frac{m'_{sort} \pm m'_{high}}{m'_{qrt}} + \phi'_{kop} \quad (2)$$

ϕ'_{kop} represents the height similarity between the hitting spot height range and the waiting spot range. S'_{fj} represents the discrimination threshold between the hit point height area and its background area. We can use formula (3) to extract the degree of discrimination between the hit point height features

$$T'_{MF} = \frac{s'_{fj} \pm d'_{fg}}{s'_{fj}} \quad (3)$$

Mathematical Statistics

In this paper, the data obtained from analysis and technical statistics are processed on the computer, and SPSS10.0 software is used for statistical processing.

There is no need for a code of ethics for this type of study.

RESULTS

The high-altitude hitting action is the hitting action in which the upper limbs are guided by the opposite movement of the upper and lower limbs to whip the ball when the body is in the air. This is the essential part of the jump serve technique.

Analysis of shoulder rotation angle

The shoulder rotation angle refers to the angle formed by the line connecting the two shoulders concerning the horizontal plane.³ It also represents the direction of upper body rotation (Table 1 is a table of shoulder rotation and angle changes in mid-air shots).

In Table 1, the shoulder rotation angle of NO.1 and NO.4 is the largest at the maximum time of the lead arm. When hitting the ball, NO.2 has the smallest shoulder rotation angle.⁴ Regarding the angle change of the shoulder rotation angle, NO.2 has the most significant angle change. This shows the athlete's number. NO.2 has an extensive rotation range and a reasonable rotation force.

Hip angle analysis

The hip angle refers to the angle formed by connecting the three main joint points of the shoulder, hip, and knee. Hip angle shift refers to the instantaneous change in the hip angle of a shot that brings the wrist to the extreme point of the jump. It represents how difficult it is to close the abdomen in the trunk space and the degree of exertion on the abdominal muscles.⁵ In Table 2, the hip angle of B is the largest at the moment when the pull arm is at its maximum. Its body forms a sizeable dorsal arch in the air. A has the smallest hip angle and a relatively small dorsal arch. A larger hip angle can lengthen the abdominal muscles to increase the elastic potential energy of the abdominal muscles and stimulate more motor units to participate in work. This can facilitate an increase in the swing rate. B's left and right hip angular displacement are large, the waist-abdominal contraction is significant, and the abdominal contraction force is reasonable. This shows that the player's body flexibility and strength are better than other players.

Table 1. Shoulder Rotation and Angle Variation in Aerial Shots.

Numbering	When the arm is at its maximum	Hit the ball	Angle change
NO.1	57.61	24.46	33.14
NO.2	54.07	12.45	41.56
NO.3	52.86	20.34	32.52
NO.4	60.53	29.93	30.60
NO.5	54.62	21.80	32.80
NO.6	5.72	7.37	1.79

Table 2. Aerial movement hip angle change table (°).

Numbering	The maximum hip angle of the leading arm		The hip angle at the moment of hitting		Hip angle change in degrees	
	Right	Left	Right	Left	Right	Left
NO.1	194.18	191.14	175.17	161.25	19.01	30.89
NO.2	224.16	212.81	184.25	167.18	40.91	45.63
NO.3	211.53	197.65	181.31	170.51	30.22	27.14
NO.4	186.91	179.32	173.16	163.21	13.57	16.11
NO.5	204.2	195.23	178.47	165.54	25.97	29.94
NO.6	16.85	13.96	5.18	4.13	12.1	12.2

Knee Angle Analysis

Knee angle refers to the angle difference between the hip, knee, and ankle of an athlete during exercise.⁶ It is used to indicate the flexion of the knee. The position of the knee angle at the moment of hitting the ball when the pull arm is at its maximum is called the knee angle displacement. It indicates how stretched the knee is.

From Table 3, it is found that the left and right hip angles of the NO.1 athlete are smaller when the arms are at their maximum. The hip joint flexion is greater, and the left and right knee angles are the largest at the moment of impact. This shows that the left and right knee joints of the NO.1 player have a large extent of extension. It is manifested in the technical characteristics of a large flexion angle of the leg when the pull arm is at its maximum and the rapid forward swing of the calf when hitting the ball. This is good for hitting the ball. Increases the tension of the thigh tendon when the knee is flexed, increasing the elastic potential energy between the muscle and the tendon.⁷ The athlete converts the stored power of the body into angular momentum when the knee is extended to the maximum. This allows the motion of the knee joint to be transmitted forward with a large amount of angular momentum.⁸

DISCUSSION

Athletes' serving skills focus on the success rate of serving. At the same time, athletes must also improve their accuracy and attack power. Athletes must first master the skills of serving.⁹ The eccentric muscle contraction exercise can effectively increase the pressure of the chest and abdomen on the shoulders when the athlete performs the pull-up movement. This increases the elastic potential energy of the muscle. At the same time, it can effectively increase the exercise load of muscle concentric contraction. This can make the muscles more conducive to improving the swing ball's space, speed, and power in the athlete's body in serving. Athletes have a very significant effect on sports performance by improving the range of motion of their limbs. It can improve the efficiency by about 30%. These ranges and spaces can increase the space for muscle storage capacity to improve the efficiency of the player hitting the volleyball.

Table 3. Comparison table of knee angle when hitting the ball in the air (°).

Numbering	Knee angle at max.		Knee angle at the moment of hitting		knee angle change	
	Right	Left	Right	Left	Right	Left
NO.1	213.598	210.254	192.687	177.375	20.911	33.979
NO.2	246.576	234.091	202.675	183.898	45.001	50.193
NO.3	232.683	217.415	199.441	187.561	33.242	29.854
NO.4	205.601	197.252	190.476	179.531	14.927	17.721
NO.5	224.62	214.753	196.317	182.094	28.567	32.934
NO.6	18.535	15.356	5.698	4.543	13.31	13.42

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With different arm swings, the action characteristics of the services are also different. From the perspective of hydrodynamics, the rotational speed, motion track, impact position, force level, hitting angle, hitting time, contact area, etc., of the hitting link determine the moving direction, rotation speed, and acceleration of the ball after it is released. Since the upper body tendons have acquired the exercise load and stored elastic capacity during the arm-pulling stage, the movement range and movement rate will also increase when the arm is swinging.¹⁰ Because the athlete must master the reaction speed, the arms swinging action also requires more sports cooperation. This requires that the person serving the ball has a solid upper body, sports coordination in all aspects, and reasonable arm ball control. The shoulder angle is formed by the line connecting the hip, arm, and elbow joint points. The shoulder girdle muscles become the external rotators. It performs eccentric contractions to maintain any upper arm position and perform any sports to convey optimal power.

Athletes will form an angle between their limbs and elbows when hitting the ball. This angled tool can have a considerable movement speed. This allows the athlete to continuously increase the body's speed after hitting the ball in the process of hitting the ball. This process, in turn, increases the strength of the body's musculature. During this exercise, the athlete can continuously stabilize the balance performance of the body. This improves coordination between the arms and elbows. After continuous testing, the researchers found that even if the elbow joint angle reached 180°, it still had good stability. It can quickly respond to various complicated movements made by athletes on the court. These actions can prompt the athlete to score and win the corresponding game.

CONCLUSION

The athlete's movement to accelerate the forward swing of the calf when hitting the ball in the air helps to change the position of the center of gravity and improve the airborne force. Flexing the opposite arm and accelerating the hem when the athlete hits the ball also helps increase the hitting arm's speed. Athletes can enhance their body functions more effectively after long-term scientific exercise. At the same time, the athlete also improves human function. It also has a very positive effect on muscle tissue exercise. In volleyball practice, the athletes gradually strengthened the training of the rapid arm swing ability of the upper body muscles. At the same time, the athlete also improves the coordination ability of the whole body in training. This also has a very positive sign for improving players' serving skills.

The author declare no potential conflict of interest related to this article