A SYSTEMATIC STUDY ON BODY CONTROL IN GOLF PLAYERS

ESTUDO SISTEMÁTICO SOBRE O CONTROLE CORPORAL EM JOGADORES DE GOLFE

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ABSTRACT

Introduction: Golf is a high-precision sport that requires excellent manual skills and motor coordination. These requirements are essential to determine a player's swing level and, consequently, their sports performance. Objective: Investigate the impact of athletes' body control on golf performance. Methods: To study the three-dimensional motion of golf players in China, the relevant theories and techniques of sports biomechanics were used on 12 golfing volunteers. Real-time sampling correction and analysis were performed using APAS dynamic analysis technology. This paper uses the DLT method to analyze the spatial location of each point three-dimensionally. SPSS15.0 software was used for statistical processing and screening of the results of the tests. Statistics are presented as mean and standard values. Results: The correlation between the golfers' center of gravity in hitting and the rate of motion in the swing was evidenced. The velocity obtained by the racket when hitting the ball is related to the golfer's hip inversion angle. Conclusion: A lower body center of gravity is beneficial to improve golf swing efficiency. Keeping the body in balance is the key to mastering the stroke and acceleration of the racquet. When the athlete performs the reverse pull, the energy they receive also increases, highlighting the need for specific training to promote the athlete's body balance. ***Level of evidence II; Therapeutic studies – investigation of treatment outcomes.***

Keywords: Golf; Athletes; Competitive Behavior; Physical Fitness.

RESUMO

Introdução: O golfe é um esporte de alta precisão que requer excelentes habilidades manuais e coordenação motora. Estes requisitos são essenciais para determinar o nível de balanço de um jogador e, consequentemente, o seu desempenho esportivo. Objetivo: Investigar o impacto do controle corporal dos atletas no desempenho do golfe. Métodos: Para estudar o movimento tridimensional dos jogadores de golfe na China, foram utilizadas as teorias e técnicas relevantes da biomecânica do esporte sobre 12 voluntários praticantes de golfe. A correção e a análise em tempo real da amostragem foram realizadas utilizando a tecnologia de análise dinâmica da APAS. Este artigo usa o método DLT para analisar a localização espacial de cada ponto tridimensionalmente. O programa SPSS15.0 foi usado para processamento estatístico e triagem dos resultados nos testes. As estatísticas são apresentadas como valores médios e padrão. Resultados: A correlação entre o centro de gravidade dos golfistas no acerto e na taxa de movimento no balanço foi evidenciada. A velocidade obtida pela raquete no momento da tacada da bola está relacionada ao ângulo de inversão do quadril do golfista. Conclusão: Um centro de gravidade inferior do corpo é benéfico para melhorar a eficiência da tacada de golfe. Manter o corpo em equilíbrio é a chave para dominar a batida e a aceleração da raquete. Quando o atleta realiza a tração reversa, a energia que ele recebe também aumenta, evidenciando a necessidade de um treinamento específico para promover o equilíbrio corporal do esportista. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Golfe; Atletas; Comportamento Competitivo; Aptidão Física.*

RESUMEN

Introducción: El golf es un deporte de alta precisión que requiere excelentes habilidades manuales y coordinación motora. Estos requisitos son esenciales para determinar el nivel de balanceo de un jugador y, en consecuencia, su rendimiento deportivo. Objetivo: Investigar el impacto del control corporal de los atletas en el rendimiento del golf. Métodos: Para estudiar el movimiento tridimensional de los jugadores de golf en China, se utilizaron las teorías y técnicas pertinentes de la biomecánica deportiva en 12 voluntarios golfistas. La corrección y el análisis del muestreo en tiempo real se realizaron mediante la tecnología de análisis dinámico APAS. Este trabajo utiliza el método DLT para analizar la ubicación espacial de cada punto en tres dimensiones. Se utilizó el programa informático SPSS15.0 para el tratamiento estadístico y el cribado de los resultados en las pruebas. Las estadísticas se presentan como media y valores estándar. Resultados: Se evidenció la correlación entre el centro de gravedad de los golfistas en el golpeo y la velocidad de movimiento en el balanceo. La velocidad obtenida por la raqueta en el momento de golpear la pelota está relacionada con el ángulo de inversión de la cadera del golfista. Conclusión: Un centro de gravedad corporal más bajo es beneficioso para mejorar la eficiencia del balanceo de golf. Mantener el cuerpo en equilibrio es clave para dominar el golpe y la aceleración de la raqueta. Cuando el atleta realiza el tirón inverso,

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la energía que recibe también aumenta, lo que pone de manifiesto la necesidad de un entrenamiento específico para favorecer el equilibrio corporal del atleta. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptores: *Golf; Atletas; Conducta Competitiva; Aptitud Física.*

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INTRODUCTION

The golf swing technique plays a pivotal role. It is at the heart of golf technology. The overall swing is centered on the athlete's torso to form a two-bar system. The upper level is the player's shoulders and arms, and the lower is the club the player is holding. The athlete's shoulders, hips, and legs must be fully rotated during the swing. Swing the club with both arms and hands simultaneously so that the head of the club is always facing the striking surface. Sports technology includes body anatomy, mechanics, physics, and many other technologies.[1] When golf began and developed, the domestic and international research on its swing technology was mainly summarized from the usual and regular events. With the continuous development of time and technology, motion capture and analysis systems based on computer technology are also produced. This allows people to have a more detailed understanding of racket technology. The improvement of the technical level of amateur players worldwide has developed golf swing technology further. To make the Chinese people understand and develop golf, China must vigorously develop golf swing technology. On this basis, coaches need to carry out technical training for players. This article aims to analyze the complete swing techniques of some outstanding players from the perspectives of time, speed, spin angle, etc. The research results of this paper have a particular reference value for golf teaching and training.

METHOD

Objects

This article uses 12 outstanding golfers as a research sample. There were no significant differences in height, weight, and age.[2] All runners had no joint, muscle, or ligament injuries before participating in the trial.

Investigation method

Test Criteria

The test indicators include the three stages of lead-in, swing, and closing; the time for the athlete's hip, shoulder, wrist, and club head to reach the limit speed; the maximum speed of the hip, shoulder, wrist, and club head; The angle of hip dislocation.

Test Process

Golfers prepare first and then work out as much physical strength as possible. Competitors have to do three pre-checks before the official competition. In this paper, the BVP-9500 digital camera is used to record the golf player's entire hitting process in detail. Each player completes three to five full strokes. In this paper, 3~5 complete swing movements are preliminarily checked, and 2~3 optimal swing movements are selected as the final samples according to the completion of the movement. In this paper, the dynamic analysis technology of APAS is used to correct and analyze the initial sampling in real-time. In this paper, the DLT method is used to comprehensively evaluate the stereo position of each point.[3] This article takes the player's position as the benchmark and takes the direction from point A to B as the X axis, the Y axis is directly above the X axis, and the Z axis is on the vertical plane. This article combines video and data to determine the best full swing.

Golfers' energy-manipulating movement patterns

If we want to get a golf course, then what we need to know is the mechanical energy (L) of the golfer's arm, which can be expressed by formula (1). In this paper, the passive control system is used as a new energy control method, and its La partial differential equation is easier to solve. Since M and B can reflect the characteristics of the system, the development of passive control systems is also easier. Equation (3) is obtained in this paper according to the feedback control law $\tau = \beta$ satisfying the closed loop condition.[4] In the control law, there may be an oscillating orbit equal to the target energy. At this time, this paper cannot find the oscillating orbit that conforms to the edge. The main reason for this is that the motion of the impact point can have many different results than if it were at the same energy. A specific wobble trajectory cannot be established under this condition.

$$\begin{cases} \dot{\varphi} = J\dfrac{\partial^2 L}{\partial \varphi^2} + q\tau \\ U = q^T \dfrac{\partial^2 L}{\partial \varphi^2} \end{cases} \quad (1)$$

$$\dot{\varphi} = [M - B_s]\frac{\partial L}{\partial \varphi} \quad (2)$$

M is the connection architecture of the system. B_s is the dispel spell. It represents the dissipative construction of Equation (3) obtained from Equations (1) and (2).

$$[M - B_s]\frac{\partial^2 L_S}{\partial \varphi^2} = J\frac{\partial^2 L}{\partial \varphi^2} + q^{\beta} \quad (3)$$

$$\beta = \begin{bmatrix} -K_l \bar{L}\dot{\theta}_1 + K_l \bar{L}\dot{\theta}_2 \\ K_l \bar{L}\dot{\theta}_1 - K_l \bar{L}\dot{\theta}_2 \end{bmatrix} \quad (4)$$

L in the equation stands for Hamilton. L_d represents the energy of a target. K_l is the compensation factor for energy.

Mathematical Statistics

This paper, SPSS15.0 was used for statistical processing and screening of the test results. Statistics are presented as mean and standard values.

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Chengdu Sport University following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

Time Test Results

Table 1 shows the three stages' temporal characteristics of lead-in, swing, and finish. It took an excellent golfer 1.09±0.14 seconds from

Table 1. Golf full swing time test results.

Stage	The lead of the first period	Second-period swing	Closing of the third period	Total time in the whole period
Time(s)	1.09±0.14	0.28±0.06	0.54±0.12	1.92±0.17

the completion of the preparatory action to the completion of the lead, 0.28±0.06 seconds from the start to the completion of a swing, and 0.54±0.12 seconds for the last closing.[5] The average was 1.92 ± 0.17 seconds.

Swing speed test

Table 2 shows the maximum rotational angular velocity and the measured values of the maximum rotational angular velocity.[6] The maximum angular velocities of the hip, shoulder, wrist and club head were 386.37±33.06, 536.56±61.28, 861.94±91.49, 1672.67±145.92, respectively. The numerical values show a characteristic of increasing sequentially. The time points of the maximum angular velocity of the hip, shoulder, wrist, and club head were 1.26±0.18, 1.28±0.19, 1.33±0.1, 1.38±0.2, respectively. Numerical values exhibit sequential delay characteristics.

In the swing phase, the hip, shoulder, wrist, and club head start rapidly and have secondary peaks. Each action stage exceeded a peak and showed a rapid superimposed growth characteristic.

The effect of the angle test

The maximum shoulder rotation angle at the top of the lead rod was 109.63±9.35, the hip rotation angle was 34.01±4.52, and the shoulder-hip separation angle was 76.48±8.91. The maximum values of the three primary parameters at the swing are 4.18±1.01, -18.53±3.89, and 25.18±4.21. The maximum "Leading Point Max - Swing Shot" values are 105.55±8.36, 51.11±7.06, and 53.11±7.27. (Table 3)

DISCUSSION

There is a significant correlation between the force of each part of the golfer's body and the speed of the club head during the stroke. Golfers at this stage focus on exercises that improve upper body and back strength, hip and lower back flexibility, and stability. The results show a positive correlation between the movement speed and distance of the racket, the strength of the torso, and the stability of the center of gravity. The sequential transmission of these parts is critical to the golf ball's hitting system. Excellent body control aims to transmit the power of the body. This plays a crucial role in a golfer's swing.[7] Because the hitting zone is under the body, the technique is accomplished by moving the backswing, hips, shoulders, arms, and handle. These techniques are performed from various parts of the body. Some scholars have used myoelectric experiments to find that the hip and abdominal muscles are significantly correlated with the frequency of the club's movement during the athlete's swing. The movement of the hips on the downswing, the rotation of the pelvis, and the rotation of the torso, shoulders, and arms all help the athlete get the ball to the head of the bat in the fastest and most powerful way possible. This achieves high-quality strikes. This paper proposes that the effective rotation of the body and the transmission of each part positively affect the shooting efficiency. Excellent body control is the function of transmitting, engaging, and stabilizing the pelvis. Solid center stability transfers energy and helps golfers control the ball.

The movement of the human body is a rocking movement. Its center of gravity is somehow related to the position of the torso. Due to the unstable center of gravity of the body and frequent changes in technical movements, it is likely to cause errors in serving and destructive hits. Players use lower body and body force to achieve body movement, shoulder, and arm rotation, and hand control of the ball. This constitutes

Table 2. Golfers' swing speed test.

	Hip	Shoulder	Wrist	Club head
Maximum angular velocity (°)	386.37±33.06	536.56±61.28	861.94±91.49	1672.67±145.92
The time at which the maximum angular velocity occurs (s)	1.26±0.18	1.28±0.19	1.33±0.18	1.38±0.2

Table 3. Results of the Golfer's Shoulder and Hip Angle Test.

	Lead Rod Vertex Max	Batting moment	Lead Vertex Max - Hit
Shoulder rotation angle (°)	109.63±9.35	4.18±1.01	105.55±8.36
Hip rotation angle (°)	34.01±4.52	-18.53±3.89	51.11±7.06
Shoulder hip separation angle (°)	76.48±8.91	25.18±4.21	53.11±7.27

a complete golf technical chain.[8] The shape of the top of the club is close to a circle, and the center of gravity of the body is precisely in the center of the spherical surface. The torso is the center of gravity of the body rotation when swinging the racket. The body is the part that connects the upper and lower limbs. It includes multiple different skeletal muscle groups and multiple different segments. Players must pay attention to the balance and stability of each part of the body to better use the core position of each part of the body in the technical swing chain.

Athletes must focus on developing different strength training programs depending on the intensity and frequency of training. These include three types full strength training, rapid strength training, and strength training. Among them, strength training is the focus of training.[9] Coaches add stabilizing muscle groups based on athletic ability to develop the characteristics of golf. Athletes can use elastic straps to add hazardous components to the sides of the body. This increases the body's resistance. Dumbbells strengthen the stabilizing muscle groups in the shoulders. Athletes can use a balance pad to enhance ankle stability and grip. Endurance quality refers to the body's endurance for a more extended period. The golf game cycle is long. Athletes must have good endurance to maintain the intensity and quality of a particular sport throughout the competition. The content includes aerobic endurance, strength endurance, and anaerobic endurance. Golf players need to have essential cardiorespiratory fitness. Athletes in training with 20-30 minutes of aerobic exercise as the primary development method. Athletes need to cooperate with intermittent and periodic exercise can improve their willpower.

Flexibility refers to stretching soft tissues such as muscles and ligaments in the body. It can be divided into ordinary flexibility and remarkable flexibility. Exercise Stretching is a rhythmic exercise. The athlete slowly lengthens the soft tissue by repeatedly repeating the same movement. Static stretching refers to the use of dynamic stretches to stretch soft tissue. Flexibility in golf programs focuses on shoulder, hip, and core extension.

CONCLUSION

The changes in the rotation angle of the shoulder, the hip joint, and the rotation and dislocation angle of the shoulder and hip joint can intuitively reflect the changes in the torsion and torque of the upper and lower parts of the body. The magnitude of the torque will have a more significant effect on the angle of the rod. The pretension of the muscles and the flexibility of the joints during the swing are the main reasons for the rapid movement of the athletes.

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