Kinematics Analysis of Forehand Stroke of Albert Ramos in ATP Chengdu Open 2016

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Abstract: The forehand motion of Ramos Albert in ATP Chengdu Tournament 2016 was divided into four moments and three phases through a camera. Then, three-dimensional photograph analysis was made on his motion for important kinematic data of each phase, so that the data found can offer reference of necessary technical constructing mode for athletes and coaches.

Keywords: Ramos, Tennis, Forehand Technique

1. INTRODUCTION
Forehand is the foundation of tennis techniques as well as one of the most important techniques. There are often rallies between the players with their forehand on the baseline, and high-level players can control the opponent’s rhythm and position with their forehand, so they can lead the match at the very beginning. In this passage, we have a three-dimensional photograph analysis on Albert Ramos’ forehand motion, who won the second place in ATP 250 Chengdu Tournament 2016, for the purpose of revealing the kinematic feature and law in forehand technique of excellent tennis players and offering some important data for athletes and coaches to refer to.

2. OBJECTS AND METHODS OF RESEARCH
2.1 Objects
Defeated by Russian player Karen Khachanov, Albert Ramos won the second place in ATP 250 Chengdu Tournament 2016, with scores of 7-6, 6-7, 3-6. Ramos was born on Jan 17, 1988 in Spain. He is left-handed and once got the highest rank of No.27 for men’s single.
2.2 Methods
2.2.1 Literature
We rearranged and categorize features and kinematic data of tennis forehand technique on the basis of related literature on CNKI and careful reading, so that theoretical foundation of this thesis can be laid.

2.2.2 Three-Dimensional Photograph Analysis
Two JVC GC-PX10AC cameras made in Japan were used in ATP 250 Chengdu Tournament 2016 for simultaneous three-dimensional shot. The cameras were placed about 5 meters away from the doubles lines. The No.1 camera was in front of Ramos on the right and the No.2 on the left. The angle of principal optic axis is about 60 degrees and the shot frequency is 50 Hertz. After watching the match, we took the Ramos’ second forehand shot in the second game of the first set when the score was 0-15 to conduct analysis on his motion. We took 3D-SignalTec Three-dimensional Video Analysis System developed by Beijing Senmiaoxin Company to analyze Ramos’ forehand motion, and we chose Dempster human model to conduct our research, which contains 16 links and 21 joints. We make the video more smooth through digital filtering and set cut frequency at 8 Hertz. According to the features of tennis forehand techniques, we chose kinematic data of shoulder and elbow for the upper arms and knees and hip for the lower arms.

3. RESULTS AND ANALYSIS
3.1 Division of Motion Phases
We can learn from the video that Ramos used open stance for forehand shot. In this passage, Ramos' forehand motion was divided into four moments and three phases to meet the requirements of research.

Four moments:
(1) Completion of preparation: when the player approaches the incoming ball, he has small motion on his feet and his left foot touches the ground.
(2) Completion of backswing: the racket reaches the farthest away from his body when doing the backswing.
(3) Contact: the racket moves forward until it hits the incoming tennis ball.
(4) Follow-through: the racket was swung to the player’s right shoulder, while the arm begins to return and the angle of shoulder begins to decrease.

Three phases:
(1) Backswing phase: this is from preparing position to backswing finished.
(2) The phase of swing forward: this is from backswing finished to the moment of contact.
(3) Follow-through phase: this is from contact to the end of follow through.

3.2 Analysis on the Results
3.2.1 Backswing Phase
Backswing is from preparing position to backswing finished. On the foundation that tennis player can move to the right position of stroke, the assisting arm drives the backswing of arm holding the racket, the shoulder rotation and hip rotation for act-shaped backswing. Backswing must be rapid
or can be done in the process of move, with the racket point pointing to the fence backward. The racket head must be slightly higher than wrist and the assisting arm points to the incoming ball after unit-turn is completed. Regarding sports biomechanics, the purpose of backswing is to accumulate static energy and momentum for strokes. Since a nice preparing position can lead to a fabulous stroke, excellent backswing can be of great influence on the stroke following backswing and unit-turn.

Ramos had small motions of jump on his feet when the ball came. Ramos took open stance and held the racket with his left hand. The angle of his left and right hip joint was respectively 107.7 degrees and 108.9 degrees, and that of his knees 130.3 degrees and 112.4 degrees when the backswing was finished. The figure above indicates that his joints have been bended and his gravity has been lowered. At the same moment, the angle of Nadal's left and right hip joint was respectively 130.8 degrees and 160.6 degrees, and that of his knees 132.3 degrees and 141.8 degrees. This indicates that the angle of Ramos hip joint was obviously smaller with hip joint stretched inadequately, comparing to that Nadal. The angle of his left and right shoulder was respectively 42.5 degrees and 62.2 degrees when the backswing was finished, while the angle of elbow was respectively 109.8 degrees and 45 degrees. From the data of his shoulder and elbow, we can learn that Ramos had an adequate backswing when this motion was finished, with his arms stretched out adequately compared to his body for conversion of energy to release more kinetic energy to hit the ball.

3.2.2 The Phase of Swing Forward

The player must swing forward when he began to swing for the position of backswing finished. The force forward mainly derives from pedal on the ground that generates an equal force in opposite direction. In terms of sports bio mechanics, the player uses the theory of acting force and anti-acting force.

The angle his hip when the racket reached the contact was 133.6 degrees, so that there was adequate angle and space for rotating forward. The time elapsed in his swing forward was 0.1 seconds. When his racket reached the contact, the speed of left shoulder joint was 2.41 meters per second, left elbow joint 4.35 meters per second, left wrist joint 5.65 meters per second, left hand 6.49 meters per second, and the racket head 18.84 meters per second. It can learned that the speed of racket head is the maximum one, left hand the second and left shoulder joint the minimum, which conforms the sequence of joint speed of forehand technique, known as the whipping motion. The speed of Nadal's left shoulder joint was 2.21 meters per second, left wrist 6.27 meters per second, left hand 7.50 meters per second. Compared to Nadal, Ramos had a faster racket speed so that his could make a faster stroke.

3.2.3 Follow-Through Phase

The motion forward after contact must be based on stable angle between racket and ground. The direction of stroke is forward and upward and the racket reaches the shoulder on the other side after adequate stretch. The follow-through can strengthen the power of stroke and lower the risk of injury.
It can also help the player maintain his coordination and stability of stroke when he enters the ending phase of stroke.[2]

At the moment when follow-through is completed, the angle of Ramos' left shoulder is 108.6 degrees and left elbow 69.5 degrees. At the moment of contact, the angle of Ramos' left shoulder joint was 65.3 degrees and left elbow 90.4 degrees. From contact to follow-through completed, the angle of left shoulder joint increased by 43.3 degrees and left elbow decreased by 20.9 degrees. This indicates that his elbow joint went away from his body so that he can adequately swing his shoulder and racket. Meanwhile, Ramos' hand holding the racket had obvious motion upward when the follow-through was completed, which resembles that of Nadal's forehand stroke. At the same moment, the angle of Nadal's left shoulder joint was 113.4 degrees and left elbow 87.9 degrees. This indicates that Nadal, who made his racket move around his head, had a more adequate follow-through, compared with Ramos.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

4.1.1 Backswing Phase

When the preparation was completed, the angle of Ramos' left and right hip joints was respectively 107.7 degrees and 108.9 degrees. The angle of his left and right knee joints was respectively 130.3 degrees and 112.4 degrees. That indicates that Ramos's hip and knee was bended and his gravity was lowered obviously so that he could have an adequate unit turn through pedal on the ground. At the moment when the racket was the farthest from his body, the angle of his left and right shoulders was respectively 42.5 degrees and 62.2 degrees and left and right elbow 109.8 degrees and 45 degrees. This indicates that the radius of swinging racket was increased by Ramos's motion and so his stroke was provided more kinetic energy.

4.1.2 The Phase of Swing Forward

When his racket reached the contact, the speed of left shoulder joint was 2.41 meters per second, left elbow joint 4.35 meters per second, left wrist joint 5.65 meters per second, left hand 6.49 meters per second, and the racket head 18.84 meters per second. It can learned that the speed of racket head is the maximum one, left hand the second and left shoulder joint the minimum. This indicates that only when these motions are completed subsequently and coordinately can these motions generate a "step" effect. The resultant velocity of each acceleration and deceleration forms the racket speed of contact.

4.1.3 Follow-Through Phase

The angle of Ramos' left shoulder joint increased by 43.3 degrees while that of left elbow joint decreased by 20.9 degrees from the contact to follow-through completed. This indicates that his elbow joints went away from his body so that he can adequately swing his shoulder and racket. As a result, he had a larger range of swinging and increased the time of racket biting the ball and lengthened the range of swinging, making a faster and stronger shot.
4.2 Suggestion
(1) For faster speed of the ball, Ramos must increase the range of hip rotation when he does the backswing, which makes his leg generate more power upward and makes stronger shot through hip rotation.
(2) The elite men tennis player have follow-through on the shoulder of another side of their body. But Ramos has a follow-through upward after the motion is completed, different from other players. Therefore, it is not advised to imitate Ramos' forehand motion.

5. REFERENCES