A prior research on the technical move of tennis service based on the test of physiological parameters

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ABSTRACT

With the development of physical culture and sports, tennis is stepping into ordinary people's life. As a result, a good serving technique has become of importance in both normal exercise and tournaments. On this basis, the serving action is systematically analyzed and studied, applying correlative kinematics theories in this paper. The research shows that the higher the technical level of the players is, the stronger the regularity above is and therefore, to improve the serving accuracy and to make every movement easier and smoother, tennis players should enhance their coordination and self-control abilities in their routine training.

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KEYWORDS

Kinematics analysis;
Serving techniques;
Electromyogram;
Bioelectricity.

INTRODUCTION

As the standard of living is increasingly improved, more and more attention has been paid to exercise, which, at the same time, has driven the rapid development of tennis. And tennis has gained more and more popularity among people.

There have been many researches on tennis. For instance, in his mechanical analysis of serving action, Wang Guoxiang put forward that players should have powerful serving speed if they want to get high scores in tournaments. He has also made some propositions for having higher level of serving technique. Starting from mechanics, he made careful analysis and research from the aspects of placement, rotation, force, speed, and arc. Ma Yanhui, in his mechanical analysis of the touching action in the process of hitting, got the conclusion that players can carry out the correct way of forehand hit and improve their technical level through the actions of touching, backswing, and preparatory pose, on the ground of the analysis of all parts of coordination in mechanics.

On the basis of forefathers, the research in this paper has analyzed the kinematic pertinence in the process of service with the case of six tennis players. By comparing their statures and the height they serve a ball, it shows that the best serving height is in the same horizontal plane of their eyebrows and the better serving technique the players have, the smaller the margin is, with a higher speed of their right shoulder joint. With all these, the players have better service and the serving speed is higher, too. In consequence, this research will guide the development of tennis service techniques.

THE ESTABLISHMENT OF THE TENNIS

SERVING MODE

While serving, every player will experience the process that the ball goes out of the hand, reaches its ver-

TABLE 1: The conditions of the six athletes

Athlete	Gender	Age	Height (m)	Weight (kg)	Training Years
NO.1	male	25	1.78	65	16
NO.2	male	23	1.86	85	12
NO.3	male	27	1.85	75	10
NO.4	male	25	1.73	65	5
NO.5	male	25	1.73	55	6
NO.6	male	23	1.75	68	6

tex, and then goes back to the racket. According to kinematics and the process above, the analysis focuses on the process in which the ball reaches its vertex, and then goes back to the racket. The researching process is as following:

First, six national level-1 athletes from a sports school have been chosen, and the terms are as TABLE 1 shows:

By the test of athletes' muscle, in terms of the process of serving, Figure 1 shows the results:

According to the experiment scheme, the six athletes are divided into two groups, and to make them reach a better level, first they were required to make five good service. Then, in the second-round test, the
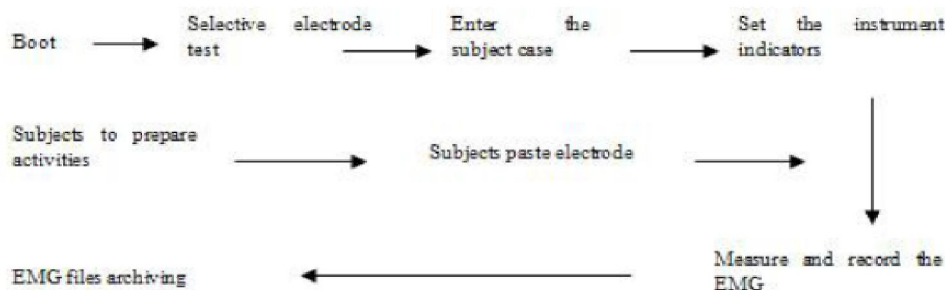

Figure 1:EMG measurement flowchart

researching terms include turnover, rotation, speed, force, and so on. TABLE 2 informs the results:

From the two tests we can find that athlete NO.1 is the better among them and his hit rate has proved that

he has service of high speed, high quality, and good angle of controlling the ball. For these reasons, we regard him as our researching target.

Shooting with a camera and other tools and pro-

TABLE 2: A chart of the hit rate of kick serve

| Athlete	Round 1						Round 2						Hit Rate
	Service 1	Service 2	Service 3	Service 4	Service 5	Service 6	Service 1	Service 2	Service 3	Service 4	Service 5	Service 6	
NO.1	√	√	√	√	√	√	√	√	√	√	√	net	91.67
NO.2	√	√	√	√	√	√	√	wrong court	√	√	off the sideline	off the sideline	75
NO.3	√	√	√	√	√	√	√	off the sideline	√	√	wrong court	√	83.8
NO.4	√	√	√	√	√	off the baseline	√	√	√	off the baseline	off the sideline	off the baseline	66.7
NO.5	net	√	√	√	√	√	√	net	√	off the baseline	net	off the sideline	58.3
NO.6	√	√	off the baseline	√	√	off the sideline	√	net	off the center line	net	net	off the sideline	41.67

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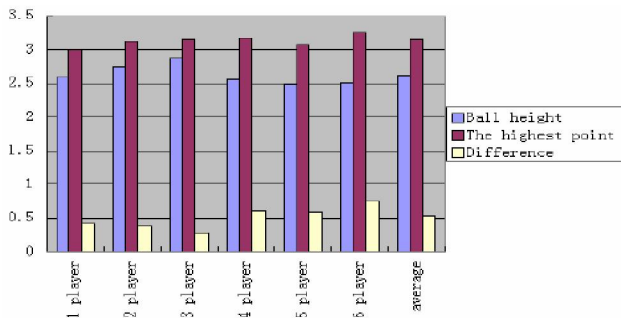
Figure 2: Appearances with the corresponding

cessing the datum with the computer, we the following figures of kick serve after the comprehensive analysis by the software of SPSS:

From the table above we can notice that except athlete NO.1, all the others serve at a height that is higher their body heights. The athletes' body heights are different from each other, for which their heights of serving are different, too. In consequence, we get the average—1.78m—of their body heights. If the serving height is too high, it will be for the ball to go off the limited lines. On the contrary, if serving too low, the ball will be over-rotated and it will be difficult for the athlete to hit the ball. Besides, we can also find out that the average of the serving heights is 1.701m while the average of body heights is 1.78m. In conclusion, it will be the best if the serving height is just slightly lower than the body height.

The following bar chart Figure 2 is based on the heights of touching, the highest heights of the ball, and the D-values of the two in TABLE 3:

According to Figure 2 and TABLE 3, we can find that among the six players that in the investigation, the difference of No.3 is the smallest and the second small-

TABLE 3 : The correlative heights in the process of kick serve (unit: m)

Target	Height of athlete	Height of serving	Height of touching	The highest height of the ball
No.1	1.78	1.728	2.584	3.000
No.2	1.86	1.725	2.748	3.125
NO.3	1.85	1.804	2.864	3.146
NO.4	1.73	1.811	2.57	3.178
NO.5	1.73	1.698	2.483	3.068
NO.6	1.75	1.684	2.507	3.256
Average	1.78	1.701	2.612	3.154
Standard Deviation	0.059	0.18	0.17	0.113

est is No.1. The biggest difference comes from No.6. The average of Ball height and the highest point is respectively 2.62m and 3.154m.

THE ANALYSIS OF STANCES IN TENNIS SERVES

In accordance with this article, the stances in tennis serve can be divided into two types. One is the pinpoint stance; the other is the platform stance. In the pinpoint stance, the feet start apart. But as the serve is made, the back foot moves forward until it is adjacent to the front foot. The center of gravity move quickly in order to gather the strength to hit the ball. The weakness of the pinpoint stance is that it will influence the accuracy. In the platform stance, the feet also start apart and throughout the serve, the feet keep separated. The platform stance makes players lift the accuracy but sacrifice some power. This article divides the six players into two groups. No.1, No.3 and No.5 are in the platform stance. No.2, No.4 and No.6 are in the pinpoint stance.

The analysis of external abdominal muscles on the right side based on the two different stances

When the racket is in a proper height, players' elbow serves as a shaft to joint the racket head, hand and forearm to drive their back to turn around, providing the player a posture like a bow. In the process of hitting balls, if a player wants to make topspin serve, the right abdominal oblique will present the state of arucs dorsails. In this way, players must use more strength. Based on the comparison of two different stances, TABLE 4 is formed.

To present the relativity among the six players vividly, Figure3 was made:
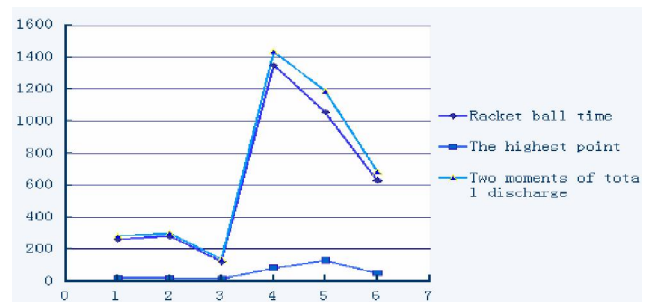
According to Figure3 and TABLE 4, it is easy for

Figure 3: Appearances with the corresponding

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TABLE 4 : The comparison of the quantity of electricity discharged by right abdominal oblique between two different stances

Stances	Players	Racket ball time	The highest point	Two moments of total discharge
The	No.1	264	19	284
Pinpoint	No.2	283	20	302
stance	No.3	122	16	138
The	No.4	1350	85	1435
Platform	No.5	1058	132	1190
stance	No.6	632	52	684

us to find that throughout the process of making a top-spin serve, the electricity discharge in the racket ball time and the highest point is very conspicuous. So in the two moments the influence on making a serve is relatively big. Anyway, it is rather reasonable to choose the two moments to analysis in this text.

Based on the charts above, we can draw the conclusion that the two different stances have different effects on serving a ball. The electricity discharge made by player No.4 is nearly ten times more than player No.3. From Figure3 we see that player No.1 and No.3 make an electricity discharge ranging only from 100 to 300. To conclude, the pinpoint stance is much less effective than the platform stance is.

Hitting-ball speed analysis

Throughout the whole process of playing tennis, the moment the racket hits the ball is a key point for which the process of throwing makes preparation and the swift-
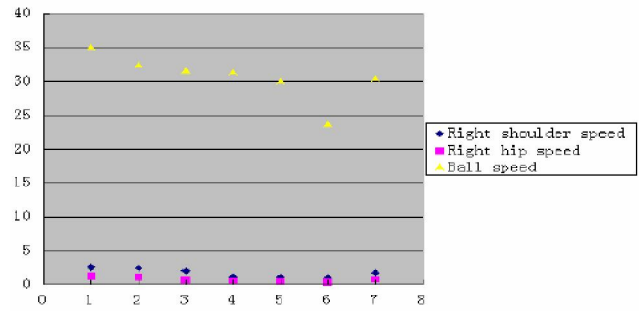

Figure 4 : Appearances with the corresponding graph

est one among other movements. In this text, parameters from six players were gathered as TABLE5 shows:

The comparison of three different kinds of speeds from the six players is shown in Figure 4:

We can clearly figure out from Figure 4 TABLE 5 that athlete No.1 is always the fastest in three kinds of speed, and with the No.6 right after him.

Analysis based on the condition of the tennis ball reached the highest level

To analyze the conditions when the tennis ball reached the peak, we chose the Integrated Electromyogram to calculate the average value, with the result showed the amount of exercise and the discharge capacity. We chose the actions of whip, wheel, pedal and back scratching at the same time in the upward movement of the ball. The parameters of the six athletes is shown in TABLE 6.

From TABLE 6, we can see that the average value of the Right Biceps Femoris Muscle is the minimum value, and the Integrated Electromyogram of the Right
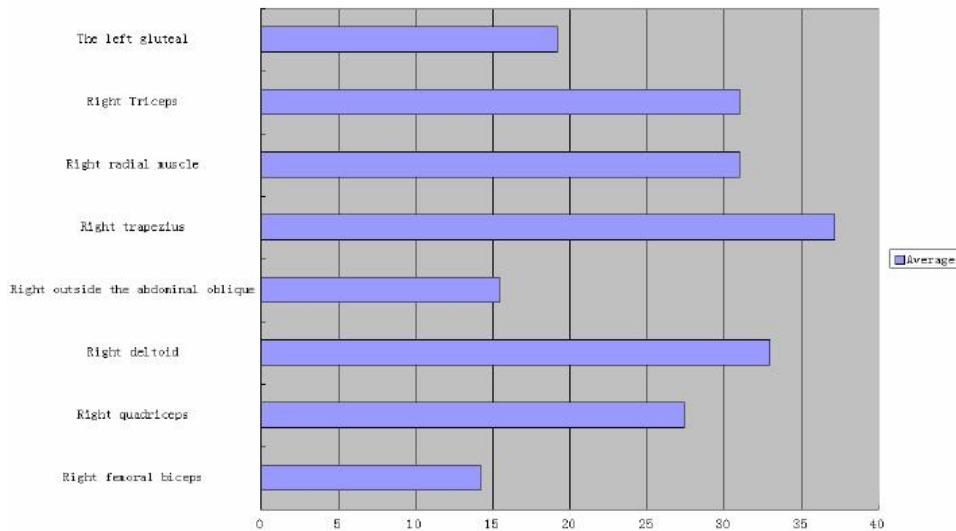

Figure 5 : Appearances with the corresponding

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TABLE 5 : Some parameters of hitting-ball speed made by different body parts (Unit:m/s)

Players	Speed of the right shoulder	Speed of the right hip	Ball speed
No.1	2.541	1.214	35.014
No.2	2.418	1.105	32.549
No.3	2.016	0.758	31.543
No.4	1.152	0.654	31.321
No.5	1.125	0.509	30.117
No.6	1.041	0.379	23.646
Average	1.735	0.778	30.418

Quadratus is the maximum value.

So, by analyze the average value of the Integrated Electromyogram that for different athletes, the peak of the ball's arrival will be lead to a different result influenced by their stature and their weight. Therefore, we used the average calculation to analyze the result. And we used bar chart in Figure 5 to show it more clearly.

We can summarize from Figure 5 that in the time of the ball's peak arrival, the bigger value the Right Quadratus reach, the more electric quantity it release. So, this is an important part we should pay attention when we

TABLE 6 : The Integrated Electromyogram from the peak to impact with the ball in ten frames

Search Project	Right Biceps Femoris Muscle	Right Quadriceps Femoris	Right Deltoid	Right External Abdominal Muscle	Right Quadratus	Right Brachioadialis	Right Triceps Brachii Muscle	Left Gluteus Maximus
No. 1	12	76	48	14	47	26	42	33
No. 2	14	20	27	30	21	43	20	18
No. 3	17	20	36	14	25	21	30	30
No. 4	15	23	30	18	48	34	38	13
No. 5	14	14	30	10	26	32	28	14
No. 6	8	10	30	6	51	22	29	8
Average value	14.2	27.4	33	15.4	37.2	31	31	19.2
standard deviation	4.21	23.9	7.2	8.45	13.6	8.59	8.21	9.88

TABLE 7 : The electric quantity release of the Muscles in three key times of athlete No.3

Muscles	At the peak	Impact with the ball	After impact with the ball in ten frames
Right Brahioadialis	30	392	45
Right Triceps Brachii Muscle	24	1460	18
Right Deltoid	60	2698	124
Right Quadratus	176	345	69
Right External Abdominal Muscle	18	384	123

are doing exercises. In addition, the Right Femoris Muscles, the Right Brachioadialis and the Right Deltoid are also should be pay attention to during your daily exercises.

Analysis based on the electric quantity release of the Muscles

From TABLE 6, we can come to a conclusion that the muscles' performances of athlete No.3 changes enormously. Therefore, we use the athlete No.3 as the

project, to study the electric quantity release of the Muscles in key time when the ball is moving upward. The parameter is in TABLE 7.

We analyzed that the muscles of athlete No.3 could loose and tighten his muscles in a short time. His explosive power is very strong, and has a balance tempo.

CONCLUSIONS

(1) This essay made a correlation study of kinematics

in the example of six tennis player's serve. We made compare of stature and serving height, and came to the conclusion that the best height is where the ball is beside the eyebrow. And the higher the serve level is, the smaller the difference will be.

(2) About the point of the players are trying to make the ball reach the peak when they serve, they need to make height between the impacts with the ball to the peak as smaller as they can. So that they can rise their proportions of net passing and hit rate. Therefore, the higher level the athlete is, the smaller difference between impacts with the ball to the ball reach its peak will be.

(3) For the stepping forward player, they need to strength their training to the Right External Abdominal Muscle in daily training if they want to keep a stable balance. So that they can keep a stable balance when they serving.

(4) The player's right hip joint speeded when tennis ball reach the peak, then the player will twist his waist stronger. And at the same time, his right shoulder joint will also speeded. Therefore, the higher level the serve is, the faster serve speed will be.

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