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Mathematical statistic analysis-based teenager tennis net volley technical features research

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ABSTRACT

The paper starts from tennis net volley technical motions analysis to build foundation for subsequent mathematical statistics indicator selection and indicators screening. From the perspective of kinematics, it carries on video parsing studies on forehand net volley and backhand net volley technical motions, focuses on analyzing speed features and wrist joint angular speed features when tennis racket volleys straight line, it provides partial suggestions for improving net volley quality. Apply single factor variance analysis and independent sample T test method to make comparative analysis of different grades levels men's teenager tennis players' net volley ability evaluation indicators, with an aim to provide theoretical basis for different levels athlete net volley ability main evaluation indicators extraction. © 2014 Trade Science Inc. - INDIA

KEYWORDS

Kinematics;
Volley ability;
Single factor variance analysis;
T test;
Chi-square test.

INTRODUCTION

Tennis net volley technique is also called backstop, presently domestic many excellent tennis players adopted service and volley or receiving and volley techniques, so, net volley technique was mentioned as attack playing indispensable most important positions. The paper starts from forehand net volley technique and backhand net volley technique motion features, studies on Chinese teenagers net volley techniques from the perspective of video parsing data kinematics and net volley ability comparative analysis, in the hope of making contributions to Chinese tennis reserve force expanding.

For tennis net volley technical training, volley ability and volley efficiency promoted researches, many scholars have made efforts, these scholars applied research method and proposed views as well as

suggestions are of certain help to athletes' net volley ability improvement and competitive ability promotion, from which Xu Jin-Fu and others(2014)applied three-dimensional video, Aijie parsing system to make camera shooting and analysis of students' net volley techniques that were from tennis specialized class, sports science institute in Fujian normal college, which provided certain help for teaching and self exercising^[1]; Ke Yong(2013)analyzed the sixth city games top five teenager men tennis players net initiative tackling abilities techniques each item indicator, which provided theoretical reference basis for tennis training and technical evaluation^[2]; Lan Long-Xuan and others(2013)made brief statement on how to apply "three points positioning method" in tennis double volley teaching^[3].

The paper on the basis of previous research,

FULL PAPER

analyzes tennis net volley technique, in the hope of exploring net volley technique effects in contest, and provides feasible suggestions for teenager athletic ability promoting.

TENNIS NET VOLLEY TECHNICAL MOTIONS ANALYSIS

Tennis is one of global popular events, in the sports contest, net volley technique is one of weapons for members winning. Volley refers to play incoming back in the air before it landing, volley often can divide into forehand volley, backhand volley, high volley, low volley, back court volley, midfield volley and net volley, the paper carries out analysis of net volley. Chen Xiao (2013) pointed out net volley technique was that tennis was beaten back before landing, intercepting ball out of threaten area, its returning strength was big, speed was fast, which brought difficulties in counter back and helpless troubles to opponents, skillful sports net volley technique, no matter is single or doubles net playing, it would play great roles^[4]. Therefore, net volley technique was athlete general adopted net combating technique in competition process.

In teenager tennis player net volley technical training process, it needs athlete to have a better A1-racket control ability and A2-body balance control ability, from which player to racket control mainly starts from A11-racket gripping method and A12- racket face control such two aspects, player self body balance control mainly starts from A21-positioning0A22- preliminary postures0A23- hitting postures0A24- swinging racket0A25- hitting way and A26-pace these six aspects. Therefore, teenager tennis players' net volley technical training notes structure is as Figure 1 shows.

In Figure 1, A represents net volley technical fulfillment quality. In the following, it makes respective statements with forehand volley and backhand volley two kinds of net volley techniques, in the hope of building basis for net volley technical mathematical statistic analysis. Among them, forehand net volley motions are as Figure 2 shows.

Net forehand volley motion elements

Athlete backswing motions should be simple, rapid and in small range, after back swinging, it needs to

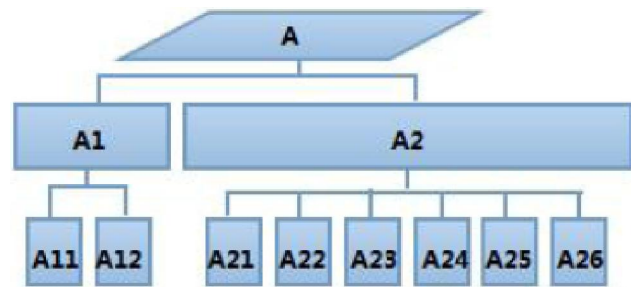


Figure 1 : Tennis net volley technical training notes

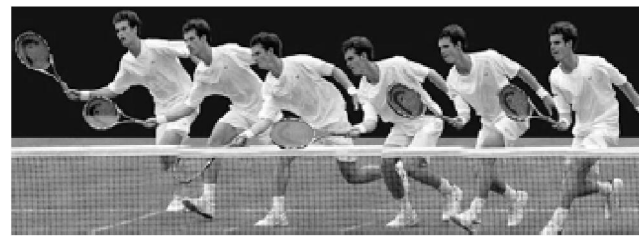


Figure 2 : Tennis net forehand volley motion

control racket to be parallel to shoulder and slightly higher than shoulder racket face and higher than wrist in the height, and meanwhile athlete should focus on incoming ball. Tennis racket head part is straight and forward, batter's wrist should lie in the front of body, it can provide some support by relaxing batters' relaxation on racket, knees should slightly bend, and prepared to move and carry out forehand volley at times Huang Yong-Tian (2012) pointed out when swing forward, it should step left foot and hurdle forward with forehand when forward swinging, and meanwhile move center forward, drive fixed right shoulders to swing racket forward at one's convenience, just in the moment ball is out of opponent racket, rapidly twist shoulder so that can let own party athlete racket face and ball to lie in the same straight line, hitting point position should try to move forward so that can initiative approach and meet and attack ball, fully utilize body strength, if incoming ball lies in the side of forehand, it needs athlete to slight twist non-holding racket hand side shoulder to ball net, should not excessive backswing, when forehand hits the ball, it should use wrist to lead body to hit ball that wrist lies in the first when hitting, let racket and arms to show the shape of "<<[5].

Net backhand volley motion elements

Backhand volley and forehand volley have two differences, Jiang Ming-Fei (2004) pointed out when forward swings the racket in backhand volley process, it should step out right foot and hurdle forward with

backhand, batter’s elbow lies in the front of body, and meanwhile center moves forward, drive tight fixed right shoulder to swing racket forward at one’s convenience, batter’s motions and racket face should be coordinate, let elbow to lead body to hit ball that elbow lies in the front of body when hitting, due to hand most part lies between rackets, it causes difficulties in controlling and volleying, so it needs to let racket and arms to show shape of “>”[6].

TENNIS NET VOLLEY TECHNIQUES KINEMATICS ANALYSIS

Net volley techniques can divide into forehand volley and backhand volley techniques, to essentially research on tennis net volley technique, make clear technical motion process motion structures, motion rhythms and exertion orders, it needs to analyze athlete upper limbs joint and should joint kinematics parameters changes in time, in the hope of providing theoretical basis for net volley technical scientific training.

Research objects and research methods

Research objects: For one university tennis specialized class six students, it makes research, in the paper research process, it will not appear students’ names, only appear in the form of codes that student 1~student 6.

Research method: Adopt three-dimensional DLT measurement, video image shooting and analytic method, mathematical statistics method and literature review method, from which video shooting adopts two units videos, its erection heights are all 1.35m, and fix them in research object opposite tennis field single, doubles lines and research objects distance is 10m effects, video shooting and analytic tool is American APAS analytic system, camera shooting frequency is 50HZ, before shooting the writer applies Aijie coordinate frame to calibrate. According to six research objects net forehand volley motion and backhand volley motion movement process, it make comparison with shot videos, select every athlete best motion effect as research samples, and record analytic data into EXCEL table, carry out data comparison and image manufacturing, in the hope of carrying out scientific analysis of motion process each joint shape.

Kinematics parameters statistical analysis when tennis net volleys straight line

By video analyzing, it can when backhand volleys straight line, it gets six athletes racket speed values in every millisecond, and record them into EXCEL table, it can get Figure 3 showed racket speed status in 0ms-41ms time range.

By Figure 3 showed backhand volley straight line moment racket speed change status with time, it is clear that racket speed in hitting ball instant is almost as 0, if use backhand volleys straight line instant racket speed time table and hitting arm upper limbs’ shoulder, elbow and wrist joint speed to make combinative analysis, it is clear in racket contacting ball instant, three joints are in the states of acceleration, by human body upper limbs

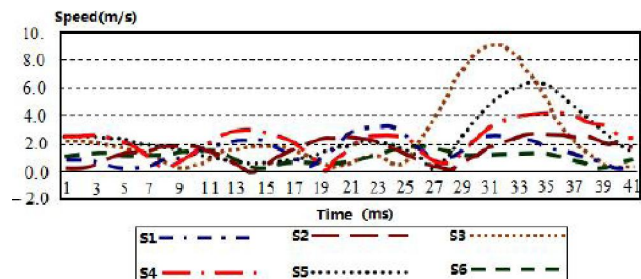


Figure 3 : Racket speed change trend with time when backhand volleys straight line

joint and racket force transiting status, it is clear that now if racket doesn’t collide with ball, it also surely will be in the state of acceleration, but in colliding process, racket appears stopping status. On the condition internal force is far bigger than external force, racket and tennis collision meet momentum conservation law, if set racket quality as M , tennis quality is m , incoming speed size is v , speed that racket just contacts with tennis but not appearing interactive effect instant racket is V , then it has formula(1) shows momentum conservation law:

$$MV - mv = mv' - M \cdot V' \tag{1}$$

In formula(1), v' represents speed size after ball hit by racket, V' represents racket obtained speed size in hitting straight line after racket hitting ball, V and directions may be on the contrary, in direction changing process, it appears moment that racket hitting speed is 0.

When tennis player net volley is over, racket exerted reaction force on human body direct force part is wrist joint, in order to more clearly understand wrist joint

FULL PAPER

force status when volley straight line, it can obtain forehand volley and backhand volley straight line instant wrist joint angular speed numerical values presentation state to analyze by experiments, record two kinds of net volley process wrist joint angles data into EXCEL table, it gets as Figure 4 and Figure 5 showed net forehand volleys straight line instant wrist joint angular speed change trend chart with time and net backhand volley straight line instant wrist joint angular speed change trend chart with time.

In Figure 4 and Figure 5, in the moment of 30ms, bracket and tennis contact, by angular speed changing trend with time, it is clear that wrist angular speed change basic concentrates on the 30ms moment, it appears lengthwise relative movement in change process, by graphics and wrist joint angular speed status, it is clear that No. 4 and No.6 students' angular speed changes are relative stable, and stable angular speed change features are helpful for wrist joint locked-in effect, which has significant effects on tennis route scientific controlling.

To sum up, complete tennis net volley motion rhythm is backswing, swing hitting and follow-through motions, players should focus on wrist joint hitting process change

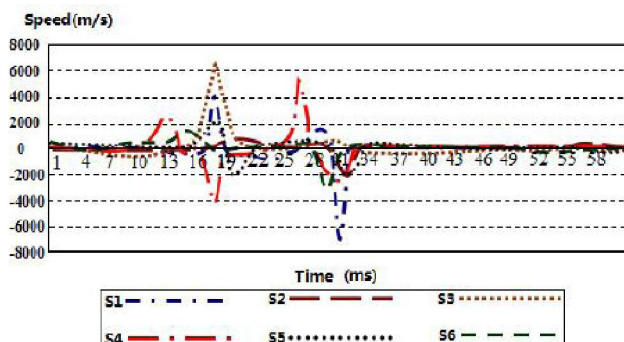


Figure 4 : Net forehand volleys straight line instant wrist joint angular speed change trend with time

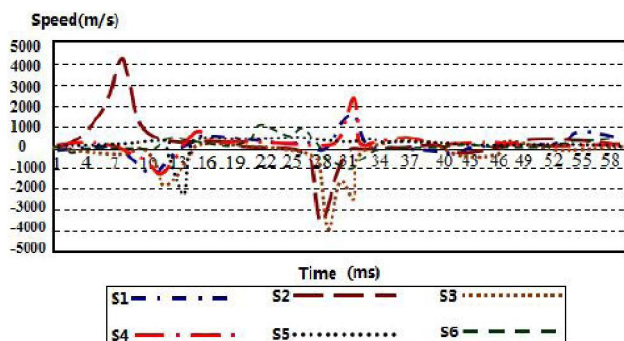


Figure 5 : Net backhand volleys straight line instant wrist joint angular speed change trend with time

steady controlling, strengthen locked-in wrist awareness, and improve control force on volley.

TEENAGER TENNIS NET VOLLEY ABILITY EVALUATION AND ANALYSIS

Net volley technique plays crucial roles in contest result. Wen Yi and others(2009) points out net volley technique is classic hitting technique in tennis development history, grasps net volley technique will be of great help to single instant service and volley, random ball net playing and doubles net playing, presently domestic excellent tennis players prevail adopt service and volley as well as receiving and volley tactics^[7]. Therefore, tennis player net initiative volley ability is a key indicator to mark player overall technical levels.

Research objects and research methods

Research object: For Hubei province, Henan province, Tianjin municipality, An Hui province as well as Beijing municipality three levels athletes and coaches to carry out net volley ability researching, as TABLE 1 shows research objects basic information.

Research methods: The paper adopts documents literature, questionnaire survey, experts interview, spot test method and mathematical statistic method, from which documents literature method provides theoretical basis for tennis volley ability evaluation indicators selection, questionnaire survey and experts interview provide data basis for indicators screening, spot test method provides basis for indicators data obtaining, in mathematical statistics, it adopts single factor variance analysis and independent sample T test, which provides theoretical basis for data comparative analysis.

Teenager tennis net volley ability analysis method

Method adopts single factor variance and independent sample T test to carry on; single factor variance analysis and independent sample T test analysis principle and its SPSS implementation steps as following show.

Single factor variance research is a classified independent variable impacts on a numeric type dependent variable impact. In practical problems single factor variance analysis, firstly it needs to put forward

TABLE 1: Net volley ability research objects status table

Research objects province sources	Coaches		Athletes					
	Number of people	Age	First grade athlete		Second grade athlete		Third grade athlete	
			Number of people	Age	Number of people	Age	Number of people	Age
Beijing	3	40.23 ± 3.25	6	16.06 ± 2.42	6	15.45 ± 1.73	12	14.95 ± 3.48
Anhui	4	43.14 ± 3.12	4	16.27 ± 1.59	6	15.41 ± 2.58	7	15.03 ± 2.53
Tianjin	3	41.22 ± 2.21	5	16.06 ± 2.22	8	15.37 ± 1.43	10	15.01 ± 1.41
Henan	5	37.35 ± 3.20	4	16.34 ± 1.37	7	15.22 ± 2.01	9	14.76 ± 1.37
Hubei	5	39.01 ± 2.11	6	16.06 ± 1.01	9	15.34 ± 2.32	11	14.68 ± 2.45
Total	20	42.46 ± 2.13	25	16.06 ± 1.22	36	15.06 ± 1.38	49	14.88 ± 2.23

hypothesis, if investigation result after processing data is from s pieces of different total sample value, it needs to successive record each totality average value as $\mu_1, \mu_2, \dots, \mu_s$, according to problems analysis purpose, it can make as formula(2) showed test hypothesis:

$$\begin{aligned}
 H_0 : & \mu_1 = \mu_2 = \dots = \mu_s \\
 H_1 : & \forall \mu_i \neq \bar{\mu}, (i = 1, 2, \dots, s); \bar{\mu} = \frac{1}{s} \sum_{i=1}^s \mu_i
 \end{aligned}
 \tag{2}$$

And then calculate each sample average value (\bar{x}_i), whole observed value total average value ($\bar{\bar{x}}$) and each error squares sum (total squares sum SST , intergroup squares sum SSA as well as intra-group squares sum SSE), its computational method is as formula (3) show:

$$\begin{cases}
 \bar{x}_i = \frac{1}{n_i} \sum_{j=1}^{n_i} x_{ij}; \bar{\bar{x}} = \frac{1}{n} \sum_{i=1}^k n_i \bar{x}_i \\
 SST = \sum_{i=1}^k \sum_{j=1}^{n_i} (x_{ij} - \bar{\bar{x}})^2; SSA = \sum_{i=1}^k n_i (\bar{x}_i - \bar{\bar{x}})^2; SSE = \sum_{i=1}^k \sum_{j=1}^{n_i} (x_{ij} - \bar{x}_i)^2
 \end{cases}
 \tag{3}$$

In formula (3), n represents number of observed value, k represents factor level number, n_i represents the i sample observed value number, three squares sum freedom degree are respectively $(n - 1), (k - 1), (n - k)$, variance analysis compared is difference between intra-group average square and intergroup average square, therefore total squares sum SST , intergroup squares sum SSA and intra-group squares sum SSE average squares respectively record as MST, MSA, MSE , their value computing method is squares sum and freedom degree ratio, when test hypothesis H_0 , MSA and MSE ratio conforms to numerator freedom degree as $k - 1$, and denominator freedom degree as $n - k$ Chi-squared

distribution, expression is as formula (4) show:

$$F = \frac{MSA}{MSE} \sim F(k-1, n-k)
 \tag{4}$$

Finally, according to given significance level α in Chi-squared distribution table, find out numerator freedom degree $df_1 = k - 1$ and denominator freedom degree $df_2 = n - k$ corresponding critical value $F_\alpha(k - 1, n - k)$, if obtained $F > F_\alpha$ then refuse original hypothesis H_0 , which shows tested factor has significant impacts on observed value, if $F < F_\alpha$ and then don't refuse original hypothesis, which shows tested factor has no significant impacts on observed value.

For fully random designed single factor variance analysis, path in SPSS single factor analysis is **【Analyze】—>【Compare means】—>【One-Way ANOVA】—>【Post Hoc Multiple Comparisons】—>【Equal Variances Assumed 0—>【LSD/S-N-K】**, for random unit group designed single factor variance analysis, path in SPSS single factor analysis is **【Analyze】—>【General Linear Models】—>【Univariate】—>【Post Hoc Multiple Comparisons for Observed Means】—>【Equal Variances Assumed】—>【LSD】**.

Different levels teenager tennis athletes' net volley ability indicator data analysis

Huang Gang-Qiang (2006) pointed out tennis initiative volley technique reflects athlete attack ability, it needed athlete to possess attack-based and winning by quickness tactics awareness, when select teenage men tennis player tennis initiative volley ability indicators,

FULL PAPER

it mainly takes athlete competition process volley effects indicators as evaluation evidence. The paper targeted teenager tennis net volley ability analysis indicator contents as following show:

Indicator 1: Symbol is using *n* to represent; indicator content is average every round competition player applying initiative net volley technique times.

Indicator 2: Symbol is using *g* to represent, indicator content is average every round competition player applying initiative net volley technique ace.

Indicator 3: Symbol is using *s* to represent, indicator content is average every round competition player applying initiative net volley technique used success proportion.

Indicator 4: Symbol is using *m* to represent, indicator content is average every round competition player applying initiative net volley technique losing scores.

Indicator 5: Symbol is using *f* to represent, indicator content is average every round competition player applying initiative net volley technique used losing proportion.

Indicator 6: Symbol is using *normal* to represent, indicator content is average every round competition non-efficiency times after player applying initiative net

volley technique

Indicator 7: Symbol is using *normal%* to represent, indicator content is average every round competition non-efficiency times proportion after player applying initiative net volley technique

As TABLE 2 showed 120 different levels teenager tennis players' seven indicators that are from five provinces, indicator variance analysis, and set single factor variance analysis independent sample T test $P < 0.05$ is significant difference.

By TABLE 2, it is clear that in the paper extracted seven indicators, only "Indicator 3: Symbol is using *s* to represent, indicator content is average every round competition player applying initiative net volley technique used success proportion." has significant differences in different levels, from numerical values, it is clear that grade gets higher, the indicators will be more excellent, in order to make each grade each indicator data differences obvious, in the paper, it gets as TABLE 3 shows three grades teenager tennis athletes initiative volley technique ability indicator independent sample T test result, in the hope of verifying teenager initiative volley efficiency influential key factors.

By TABLE 3 result, it is clear that net volley ability

TABLE 2 : Three levels' teenager tennis players' net initiative volley ability indicator comparative analysis result

Statistics indicator	<i>n</i>	<i>g</i>	<i>s</i>	<i>m</i>	<i>f</i>	normal	normal%
First grade	3.80	2.85	69.40%	0.80	13.90%	0.80	16.70%
Second grade	6.60	3.60	52.90%	1.70	22.10%	1.70	15.00%
Three grade	7.30	4.20	47.80%	2.10	24.50%	2.30	14.80%
Variance analysis <i>P</i>	0.738	0.056	0.046	0.152	0.152	0.177	0.177

TABLE 3 : Research objects initiative volley technical ability indicator data independent sample T test result in three levels

T test result indicator	<i>n</i>	<i>g</i>	<i>s</i>	<i>m</i>	<i>f</i>	normal	normal%
First grade and second grade	0.578	0.059	0.039*	0.328	0.328	0.176	0.176
Second grade and third grade	0.642	0.069	0.026*	0.117	0.117	0.196	0.196
First grade and third grade	0.786	0.034*	0.034*	0.083	0.083	0.069	0.069

differences in each grade is "Indicator 3: Symbol is using *s* to represent, indicator content is average every round competition player applying initiative net volley technique used success proportion." arrives at T test result $P < 0.05$ is first grade and third grade "Indicator 2: Symbol is using *g* to represent, indicator content is average every round competition player applying initiative net volley technique ace."

To sum up: the paper selected indicator 3 can be used as different levels' teenager tennis player net volley technical ability evaluation indicator.

CONCLUSION

The paper firstly analyzes tennis net volley technical motions, starts from forehand net volley and backhand

net volley two items contents, it gets net volley technical motion key points and notes, which builds basis for subsequent mathematical statistical indicators selection and indicator screening. Carry out video analytic research on one university tennis specialized class six students' forehand net volley and backhand net volley technical motions from dynamics perspective, focus on analysis of speed features and wrist joint angular speed features when tennis racket volleys straight lines, it provides partial suggestions for improving net volley quality. Apply single factor variance analysis and independent sample T test methods to make comparative analysis of five provinces originated 120 different grades and levels men teenagers tennis players net volley ability evaluation indicators, with an aim to provide theoretical basis for different grades athletes net volley ability main evaluation indicators extraction, finally it gets different grades tennis players' net volley ability important indicators evaluation is "Indicator 3:Symbol is using s to represent, indicator content is average every round competition player applying initiative net volley technique used success proportion."

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