Research on the Model of Scoring Ability of Rafael Nadal on Clay Court

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Abstract: By using the methods of literature, expert interviews, mathematical statistics and video observation, etc. to comprehend Nadal's match on clay court, and find the feature of single match on clay court, this paper studies Nadal's single match which is played on clay court   including 173 matches. Make a regression analyses to the relevant factors of influencing Nadal's ability to win point, find out the main factors that influence the Nadal's ability to win point on clay court, and then establish a mathematical model on Nadal's ability to win point.

1. Introduction

The development of a tennis player is a long-term and complex process, which takes place in the fields of tactics, playing technique, psychology and physical fitness [1]. Moreover, tennis coach aren't allowed to give any coaching during the play except the team events. Therefore, it's very important for tennis players to have good technique, tactics and self-adjustment. Skilled technique, which is closely connected with scoring ability, is the foundation of tactics [2]. As we all know, Nadal is a great tennis player who gives us profound impression on clay court matches. The aim of this study is to find the feature of technique and tactics and factors influencing scoring ability of Nadal on clay court. Making a regression analyses to the relevant factors of influencing Nadal's scoring ability to find out the main factors that influence the Nadal's scoring ability on clay court, and then establish a mathematical model on Nadal's scoring ability. We choose seventeen factors as independent variable, including ACE, double fault, success of first serve, first serve points won, second serve points won, break points saved, first serve return points won, second serve return points won, success of break points, chance of break points, times of break points, times of break points saved, service points won, volley points won, success of volley, winning shot, unforced faults. The total points of each match are dependent variable. We have downloaded the statistics data of 173 videos of single matches on clay court from ATP official website. To make regression analyses, the number of sample must be 5-10 times of independent variables. We have 17 independent variables, so the statistics data of 173 videos fit the bill.

2. Research methods

2.1 Experimental approach to the problem

Tennis is a demanding game based on complex playing technique, tactics and psychology[3]. Compared with other type of tennis court, clay court is difficult for player to play. The ball bounds higher on clay court than the grass court and hard court, and topspin is much stronger. This multidirectional nature of tennis match on clay court and the extended period of games (2-3 hours) necessitate scoring ability even more [4]. The present study evaluates 17 factors that influence the scoring ability of Rafael Nadal on clay court to find the main factors and the reason why Nadal who often defeats opponents on clay court, especially between 2005 year and 2008 year, won 81 matches successively.

2.2 Subjects

The study was conducted on the data of 173 matches played on clay court of Nadal and his opponents. A total of 17 indexes, including ACE(X1), double fault(X2), success of first serve(X3), first serve points won(X4), second serve points won(X5), break points saved(X6), first serve return points won(X7), second serve return points won(X8), success of break points(X9),　chance of break points(X10), times of break points(X11), times of break points saved(X12), service points won(X13), volley points won(X14), success of volley(X15), winning shot(X16), unforced faults(X17), were counted. Tennis matches is complex situation, scoring ability may be influenced by some other factors which is uncontrolled by player. So we consulted some experts, coaches and professors how to determine the independent variable, eventually, we chose 17 factors.

2.3 Procedures

After determining the index, database, as is shown in Table 1, was built by watching video over and over again and by checking on the ATP official website[5].

Table 1 Database of factor of Nadal (n=173)

Matches	Total points	x1	x2	x3	x4	x5	x6	x7	x8
1	60.00	2.00	1.00	0.46	0.78	0.68	1.00	0.40	0.76
2	70.0	3.00	1.00	0.60	0.78	0.66	1.00	0.32	0.70
3	53.00	6.00	1.00	0.60	0.74	0.70	1.00	0.55	0.52
4	75.00	2.00	1.00	0.62	0.80	0.52	0.00	0.48	0.55
5	61.00	3.00	2.00	0.69	0.69	0.46	0.60	0.41	0.57
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169	71.00	2.00	0.00	0.69	0.79	0.76	1.00	0.42	0.55
170	82.00	0.00	1.00	0.78	0.74	0.53	1.00	0.37	0.75
171	62.00	2.00	2.00	0.75	0.72	0.50	1.00	0.28	0.50
172	59.00	0.00	1.00	0.76	0.69	0.54	0.85	0.27	0.72
173	65.00	3.00	0.00	0.80	0.77	0.63	1.00	0.37	0.60

Matches	Total points	x9	x10	x11	x12	x13	x14	x15	x16	x17
1	60.00	0.50	5.00	9.00	1.00	5.00	0.00	0.00	7.00	31.00
2	70.00	0.50	4.00	8.00	3.00	10.00	3.00	60.00	18.00	43.00
3	53.00	0.55	5.00	9.00	2.00	9.00	2.00	100.00	23.00	17.00
4	75.00	0.50	5.00	10.00	0.00	13.00	5.00	50.00	33.00	35.00
5	61.00	0.28	6.00	21.00	3.00	4.00	4.00	40.00	15.00	29.00
6	60.00	0.55	5.00	9.00	1.00	5.00	0.00	0.00	7.00	31.00
7	70.00	0.50	4.00	8.00	3.00	10.00	3.00	60.00	18.00	43.00
8	53.00	0.55	5.00	9.00	2.00	9.00	2.00	100.00	23.00	17.00
9	75.00	0.50	5.00	10.00	0.00	13.00	5.00	50.00	33.00	35.00
10	61.00	0.28	6.00	21.00	3.00	4.00	4.00	40.00	15.00	29.00
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170	82.00	0.42	3.00	7.00	5.00	18.00	5.00	38.00	41.00	51.00
171	62.00	0.50	3.00	6.00	2.00	16.00	0.00	100.00	31.00	26.00
172	59.00	0.16	2.00	12.00	6.00	15.00	7.00	0.00	20.00	35.00
173	65.00	0.23	3.00	13.00	1.00	12.00	3.00	50.00	37.00	14.00

In order to find the main factors influencing scoring ability of Nadal, stepwise regression analysis is a better approach. Stepwise regression analysis is a method which is provided by multiple statistics to select the factors that are significant from all of factors [6]. It introduces the factors into the regression model one by one, the condition is that sum of square of partial regression is significant [7]. After a new factor is introduced, the selected factor will be tested one by one, the sum of square of partial regression that is not significant will be removed, finally the remains are significant [8].

2.4 Statistical analyses

Regression coefficient and standard regression coefficient were calculated by stepwise regression analysis method. The variance analysis method was used to test regression equation ($P<0.01$), therefore this equation is significant. The relationship between independent variable describing the characteristic of Nadal and the scoring ability (total points) obtained at the end of each match was determined using stepwise regression analysis. Ninety-five percent confidence limits were also calculated. The level of significance was set at $P<0.01$.

3. Results analysis

The regression coefficient and standard regression coefficient are shown in Table 2. The constant is 19.703, 13 factors were removed, 4 factors remain, they are unforced faults, winning shot, service points won, first serve points won. These four are main factors influencing the scoring ability of Nadal on clay court. Moreover, all of them are significance (P<0.01.).

Based on the above conditions, mathematical model of scoring ability of Nadal could be concluded as below:

$$Y = 19.703 + 0.633X1 + 0.574X2 + 0.371X3 + 11.512X4 \tag{1}$$

Table 2 Regression coefficient and standard regression coefficient

	constant	X1	X2	X3	X4
Regression coefficient	19.703	0.633	0.574	0.371	11.512
Standard Regression coefficient		0.564	0.433	0.113	0.058
P		0.000	0.000	0.003	0.015

XI=unforced faults; X2=winning shot; X3=service points won; X4=first serve points won

The equation that was tested using variance analysis is significant (P<0.01), they are presented in Table 3.

Table 3 Anvoa

Model		Sum of Squares	df	Mean Squares	F	**Sig**
1	Regression	40884.116	4	10221.029	406.004	0.000
	Residual	4229.352	168	25.175		
	Total	45113.468	172			

4. Conclusions

It doesn't represent that the 13 factors which was removed have no effect on tennis match, the subject of this study is Nadal, and the result of this paper is just suit for Nadal. As for Nadal, these 13

indexes aren't the main factors that influence his scoring ability. What the standard regression coefficient represent is that the larger the coefficient, the greater the effect. So the order of main factors which influence scoring ability is unforced faults, winning shot, service points won, first serve points won.

Table 2 has shown that 4 standard regression coefficients are positive, which means the relationship between the four factors and scoring ability is positive correlation. Looking from the meaning of regression coefficient, when the other variables in the model don't change, if the variable changes, dependent variables will also change. Take unforced faults for example, its standard regression coefficient is 0.564, which present in the premise of the other 3 variables don't change, if unforced faults increase by one time, the scoring ability of Nadal on clay court will move up by 0.564.

Unforced fault is mistake made by player who try to attack the opponent and to score without external pressure [9]. From this point, the more unforced faults, the more chances to score, and scoring ability must be up. Winning shot emphasize initiative, the more winning shots, the stronger the scoring ability. Starting the tennis match with serve, player makes the receiver into the trouble through changing the service location [10]. So the player who is good at serving, such as changing location, changing rotation, owns higher service scoring ability. With the increasing competitive competition, improving the service ability is undoubted the key to win.

In conclusion, there are many factors affecting the scoring ability of Nadal, the main factors are unforced faults, winning shot, service points win, first serve points win. The mathematical model of scoring ability is effective, according to actual situation, coach can make the training for Nadal to improve the scoring ability on clay court. In order to test the effectiveness of mathematical model, we random chose some matches that Nadal played on clay court, the effectiveness rate reached 83.23%. So the mathematical model reflects Nadal's scoring ability well on clay court.

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