ANALYSIS OF TIME AND GAME CHARACTERISTICS IN TOP PROFILE TENNIS

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SUMMARY

Tennis is classified among acyclic polystructural sports and sports games involving a racquet and a ball. The success of a player in a tennis match is established indirectly and directly. The analysis of men's tennis matches at the 2001 Grand Slam tournaments is presented further in the document. The focus is mainly on the variables of direct competitive successfulness of tennis players, especially as regards the differences between the duel winners and losers.

Key words: tennis, competitive successfulness, analysis of the game

INTRODUCTION

Tennis is classified among acyclic polystructural sports and sports games involving a racquet and a ball. It is characterised by fast flight of the ball, speedy ball exchange between players and coverage of the court. In a tennis match a player carefully monitors the ball's flight and decides among various tactical possibilities. A player uses a wide range of strokes, which classifies tennis among the so-called "open" sports games, since specific tactical and technical actions are never repeated. It is difficult to divide tennis game into the defence and offence phase, but some parts of it may be categorised as offensive and others as defensive, while both players during the match constantly alternate in defence and offence positions. The success of a player in a tennis match is established indirectly and directly. Indirect (prognostic) success can be determined by testing as many factors as possible, namely those factors which influence competitive successfulness and reflect the development level of those factors that have the strongest impact on successfulness (e.g. motor abilities - speed, co-ordination, strength, etc.; morphological characteristics - body height and weight, the percentage of subcutaneous fat, body somatotype; functional abilities - maximum oxygen consumption, etc.; psychological abilities - concentration, emotional control, motivation, etc.). Direct (competitive) success is reflected in competitive successfulness of an individual, which is checked by statistical data (the percentage of serves won, the number of winning strokes, faults, etc.) and also by the classification of tennis players on ranking lists, either national, European or international.

Several interesting items of research have been carried out in the field of time and game characteristics of tennis game, however, they covered only a small number of tennis matches played by players of various age and quality categories. A group of German experts (Lames, Perl, Schroder, Uthmann; 1990) presented the project of establishing the expert tennis system, called TESSY (tennis simulation system). The TESSY system functions within the scope of three major phases, namely: description and observation of the game and tactics, processing and interpretation of results and the transposition of obtained results into practice. The above-mentioned experts processed the final match of the 1989 Wimbledon tournament, played by Becker and Edberg. The serve analysis showed that Becker was successful in long serves directed into both corners of the service court. On the backhand side of the court mostly all serves were straight. Contrary to Becker, Edberg had difficulties with the length and direction (accuracy) of the serve. Most often he used the body serve (right: 17.8% and left: 12.7%) and the spin serve typical of him. The analysis confirmed the finding about the great importance of return in matches played on fast courts. The importance of faults in defence and offence is clearly distinguished depending on which player has the serve. Baseline game is of no particular importance on such fast court. Due to the spectacularity, the importance of aces is overestimated, since according to the total number of points played, the aces represent relatively rare events. The final conclusion of the researchers was that the expert system provides the opportunity for presenting expert knowledge in a certain sports field, that such procedure can be included in the interpretation of a complex

sports achievement and that the existing intuitive rules are checked by means of the system as well as new ones formulated.

Several studies that analysed tennis game and time characteristics were presented among Slovenian researchers. Planinšek (1993) analysed the elements of tennis game and time characteristics of the finals at the 1993 US Open and 1993 French Open. She processed the gathered data using the Tennis Expert System. The goal of her research was to determine how the court surface influenced the type of the game and what type of the game an individual player used. The analysis of the game showed that the tennis court surface is an important factor of tennis game, determining the game type. The results revealed that tennis game on asphalt surface was much faster than that on clay court, the breaks between points were shorter and net playing time represented only the fifth of total playing time on asphalt surface.

Frčej (1994) carried out a research with the aim of establishing and comparing the structure of tennis game in matches played by tennis players of different age categories. This research presented the analysis of the tennis game elements by means of the Tennis Expert System statistical programme. The research covered the matches between various age categories, i.e. senior, under 16 and under 14. The elements of the analysis were the serve, the last stroke within a point and the result. In the case of the majority of observed elements of tennis game the results did not show significant differences between matches played by players of different age categories. The differences, however, were recorded in the serve location, as the serve dispersion was lower in older players. Differences were apparent as the winners and losers were compared. All winners won a greater percentage of points on the first serve, had a higher percentage of point-winning strokes in the game, a lower percentage of forced errors and more points in series, they also recorded a higher number of series, more breaks of serve and a higher number of total points than the losers.

Cvetko (1995) established and compared the structure of tennis game in male and female matches. He analysed matches played by fourteen-year old boys and girls. The elements of the analysis included: serve, the last stroke within a point and the result. He established that there were no major differences between matches played by boys and those played by girls. But a difference was recorded in the percentage of won and lost points using the flat and rotated serve. Boys used flat as well as spin serve, while girls seldom resorted to flat serve. All winners, among boys and girls, reached a higher percentage of points by rotated serve, more points in series, recorded a greater number of series, more breaks of serve and won a higher number of total points.

Ferjan (2001) compared the game characteristics of final matches at open championships (hereinafter referred to as OC) of the USA and Australia in 2000 and 2001. He presented the structure of tennis elements and time characteristics in men's final matches at the 2000 US OC (Sampras - Safin) and the 2001 Australia OC (Agassi - Clement). The elements of the analysis included: serve-return, density and position of hits of all successful strokes and the last stroke within a point. He found that the winner achieves a higher total number of points than the loser and also more points in series. The analysis of the number of faults and winning strokes revealed that between the winners and losers there were differences in the ratio between the number of faults and winning strokes, namely, the winners always recorded a better ratio. Major differences between the winner and the loser were noted in the number of hits in the "negative" zones (5, 4), which the losers hit considerably more often than the winners, the latter being more successful in targeting the "positive" zones (D3, L3, D2 and L2). The analysis of time characteristics revealed that these depend on the playing method of both competitors. Baseline players (Agassi and Clement) played every point on average two seconds longer than the other two finalists, of which one played serve volley (Sampras).

Pintarič (2002) analysed the elements of tennis game and time characteristics of the final matches at the 2001 French and Wimbledon OC. He established that the game is becoming faster also on

clay courts - individual points are becoming shorter. The game structure analysis revealed the differences between players who played at the French and Wimbledon OC, which perhaps points to the fact that players are specialising in different court surfaces. Zlatoper (2002) compared the game characteristics of the final matches at the 2002 French and US OC. He analysed the game from the point of view of serve - return, density, the position of hits and the last stroke within a point. He discovered that the percentage of serves hit does not have a decisive impact on the result. It turned out that more important was the serve return (the quality of return) and the percentage of points won after the first and second serve. As the direction of the serve, the density and the position of hits within the court during the match were observed, it was established that the players direct most balls to the opponent's backhand. With winners it was noticeable that they targeted more balls to D2, L2, D3 and L3 (positive zones), while the losers directed more balls to the negative zones 4 and 5. The winner of the match recorded a higher total number of points and more points in series.

Based on the findings of the previous research the purpose of the present investigation was to analyse and compare **time characteristics** of men's final matches at all four Grand Slam tournaments, to identify and compare **game characteristics** of individual matches and to establish and compare the **differences in the position** of selected hits in individual matches.

METHODS

The variables were divided into three sets: **basic data about the match:** tournament, year, match status, players - opponents, result, court type; **time characteristics:** no. of sets, no. of games, no. of points, average no. of point per set, total playing time, average point duration, average rest time between points, average rest time – changing sides, average rest time – no changing sides, ratio - rest : game (playing time), ratio - rest : game (total time), % of points last $\leq$ 10 s, % of points last 10 - 25 s, % of points last $\geq$ 25 s; **game characteristics**: total no. of. points, total points won; *serve - return*: 1st serve %, 2nd serve %, won on serve, won on 1st serve, successful returns after 1st serve, successful returns after 2nd serve; *last stroke within a point*: no. of faults (all strokes): serve (double fault), return, forehand & backhand, volley & smash; winners (all strokes): serve (ace), return, forehand & backhand, volley & smash; *no. of points won in series*: 3 points series, 4 points series, 5 points series, 6 points or more series; *break points:* break points won, break points had; *ratio - points*: ratio between total no. of points and faults, ratio between winners and total no. of points, ratio between winners and faults; *position of hits in the court:* total no. of serve (1st, 2nd), no. of serve from deuce court (right) in zone 6, no. of serve from deuce court (right) in zone 7, no. of serve from deuce court (right) in zone 8, no. of serve from ad court (left) in zone 6, no. of serve from ad court (left) in zone 7, no. of serve from ad court (left) in zone 8, no. of hits in zone 1 – 4, no. of hits in zone 4, no. of hits in zone 3 right, no. of hits in zone 3 left, no. of hits in zone 2 right, no. of hits in zone 3 left, no. of hits in zone 1 (right & left), no. of hits in zone 5.

The collected data were arranged and divided by individual match. We calculated the ratio between the total number of points, the number of faults and the number of winning strokes as well as the ratio between the number of winning strokes and faults. Data were analysed using expert analysis. We focused mainly on the comparison of winners and losers in individual matches and on the comparison of individual matches, if such comparison was possible. As we analysed the hit positions we used the zones presented in Figures 1 and 2. The zones 1, 2, 3 and 4 were characterised as positive, while zone 5 was considered negative, i.e. the zone where players should not direct balls very often.

The sample of observed tennis matches included the following matches:

Table 1: Basic data about individual final matches

Based on the observation of videos of final matches we have collected all the data necessary for research. Time characteristics were gathered by measurements of individual parts of the match. Data about the density and position of hits were collected using the Schönborn system of tennis court division as shown in Figures 1 and 2. We have slightly adjusted the specification of serve zones with the aim of greater differentiation of serve direction.

Figure 1: Court zones for return and other strokes (forehand, backhand, volley, smash...)

Figure 2: Court zones for serve

RESULTS AND DISCUSSION

Data about **time characteristics** of individual matches are interesting, but on the other hand also expected. While data about the number of sets, games and points have merely descriptive meaning, the information about the average number of points within a set is interesting, as it points to rather small differences between matches. In a point of average duration a high correlation can be established between the speed of the court surface and the duration of a point. On average, points last the longest at FO (French Open), somewhat less at AO (Australian Open) and are significantly shorter at UO (US Open) and WIM (Wimbledon). The average break between points - with the exception of FO, where also the active part of the game is the longest - is within the applicable rules, i.e. less than 20 seconds. The ratios between the game and break are interesting. A certain relation can be established with the speed of the court surface and the average duration of a point. The ratios referred to above are quite similar for AO and FO, while a considerable deviation was recorded in UO and particularly WIM. The reason for this lies in the fact that the differences in the duration of the passive part of the game are very small, whereas the duration of the active part varies from one match to another. Thus in WIM the active part of the game accounts only for the fourteenth part of the total match. The data about the duration of points show that most points are over in less than 10 seconds. At WIM none of the points exceeded 10 seconds, at AO and FO one fifth and one fourth of the points respectively lasted from 10 to 25 seconds. At UO a little more than 0.5% of points lasted more than 25 seconds, whereas such points at AO and FO represented between 3 and 4%. In sum, it can be established that there is a connection between the speed of the court surface and the duration of the active part of the game, that the players use as much time for a break as permitted by tennis rules (or some more). Most of the points are finished within 10 seconds, which denotes extremely anaerobic nature of tennis. Tennis is (has become) a game where high speed of projectiles and consequently the movement of players result in high intensity of all activities carried out in the active part of the match.

Table 2: Time characteristics of individual matches

As we analysed the data referring to **game characteristics** of individual final matches we were above all interested in the differences between the winners and the losers.

Serve – return. Three winners (Agassi, Kuerten, and Hewitt) have a higher percentage of first serve, whereas at the WIM finals Rafter, who lost the match, was in this respect better than the winner. As established later in the document, some game characteristics recorded at the WIM finals deviate from the other three matches, as a result of which the interpretation of results is difficult. This was in our opinion caused by extremely equal match (winner won 4 points more then runner-up); the characteristics of the game played by both players (serve - net) as well as very risky game by the winner, which in the end brought him victory. The comparison of the percentage of points won after the serve and the 1st serve shows that the winners of matches had in most cases a much higher percentage than the losers. The fact is that in modern tennis a successful serve gives a great advantage. This means that a player, who without difficulties wins points on his serve, saves much energy and, in addition, can play a more risky and relaxed game to the opponent's serve. The analysis of the results of successfully returned 1st and 2nd serves reveals that the three winners

(Agassi, Kuerten and Ivanišević) recorded better results in this aspect, whereas Sampras, who lost the UO finals, recorded a higher percentage than Hewitt. In spite of that it can be established that a successful return is a precondition for the continuation of the game and that this stroke is equally important as the serve. We can also discover a certain connection between the percentage of successful returns and the speed of the court surface (the faster the surface the lower the percentage), since the lowest percentages were recorded by the players of the WIM finals.

Last stroke within a point. Based on the comparison of the number of faults it can be established for the total number of strokes that the winners Agassi, Kuerten and Hewitt made significantly less faults, whereas at the WIM finals the loser was more successful in this respect. If data are examined more closely, we can find that the highest number of faults at the AO, FO and UO result from forehand and backhand, which are also the most common strokes on such court surfaces. The WIM finals show a different picture, since the players made most return faults, with equal number of faults with return. According to the number of return faults, Sampras was better than Hewitt, but he made more volley and smash faults. The comparison of the number of winning strokes gives a somewhat different picture, since Clement and Corretja had more winning strokes than the winners, but at WIM and UO finals the winners were slightly successful. All winners, with the exception of Hewitt, hit more aces. Clement and Corretja were significantly better as regards the number of winning forehand and backhand strokes, which points to extremely offensive and often risky game reflecting certain powerlessness. The analysis of the net play showed that Rafter and Sampras were more successful, as they recorded more volley and smash winning strokes than the winners.

Number of points won in series. Extremely interesting are the data about the number of points won. In the total number of points won Agassi, Kuerten and Hewitt were considerably more successful than the losers. At the WIM finals the players recorded the same number of points and the game came to a tie. Equally interesting are the data about the number of points won in series, which refers to the number of successively won points. A series consists of at least three points won. Also in this case the winners of the AO, FO and UO finals won considerably more points in series, while at the WIM finals Rafter was in this respect better than the winner. In any case, the total number of points and the number of points won in series are crucial for success and point to great importance of an individual point in tennis, where the count method is specific. Matches where a loser wins more points than the winner are extremely rare, but those recorded are the result of the score count method or exceptional equality of players, part of a game (set) where one of the players played very poorly and lost heavily a set or a higher number of games.

Break points. Numbers show all break points and break point won of individual player within particular tennis match. Results revealed that winners at AO, FO and UO had more opportunities for break and also won more break points. In contradictions, finalists at WIM were equalized in this element that shows again how equal the tennis match was.

Ratio - points. Data about the number of faults and winning strokes do not provide the actual picture of the strength ratio on court, which is why we presented these data also in relation to the total number of points played and the comparison of the number of faults and winning strokes. The ratios were calculated so that a higher value denotes a better result. In this way we can establish that the winners of the AO, FO and UO recorded a better ratio between the total number of points and the number of faults. Again, the exception is the above-mentioned final match at WIM, where Rafter was slightly better than Ivanišević. Comparison number of winners and total number of points show that Clement and Corretja were better than Agassi and Kuerten. Taken together, these results provide strong evidence than on slower surfaces such AO and FO the number of winners does not give such impact on the result than on the faster surfaces (WIM, UO). However, if the ratios between the number of winning strokes and faults are compared, it can be established that all winners achieved higher values, which stands also for WIM finals, where the

difference is very small, yet it points to the fact that in this very equal match Ivanišević found the right balance between risk and reliable game.

Table 3: Game characteristics and position of hits in individual final matches

Position of hits in the court. We wanted to determine the position of hits by examining videos of matches and applying the zones to individual strokes. We are aware of the fact that the accuracy of the estimate of hit position was subjective; however, the acquired data are interesting and, although subjective, carry certain weight. The purpose of the analysis of the position of hits by a serve is not to compare winners and losers, but to find potential patterns and greater frequency in the case of serves from a particular side and in a particular direction. At the AO finals both players often served from the right to the outer side (zone 6), while Clement frequently used the body serve from both sides (zone 7). Considering the quality of Agassi's return, the player thus wanted to disable offensive return. At the FO finals Kuerten from the right often served to zone 6, Corretja used the body serve (zone 7), while from the left Kuerten served on the backhand side (zone 6) and Corretja down the T (zone 7). At the WIM finals both players used mostly the slice serve to the backhand of the opponent, but we have to consider the fact that Ivanišević is left-handed. Therefore, both players used such tactics at serving that is usual when left and right handed are opponents. It can be observed that at the UO finals Hewitt from the right served into zone 6 and from the left into zones 7 and 8, whereas Sampras directed serves from right side into zone 6 and 8, from left side into 7 and 8. It means both players served more often to the backhand of the opponent, and from the right side also to the outer side (zone 6). The analysis of the position of hits in the game (return, forehand, backhand, volley, smash, passing shot, lob, etc.) shows that the winners of the AO and FO finals hit a considerably higher number of strokes into the positive zones (1, 2, 3 and 4) than the losers. In the case of the other two matches (WIM and UO), the losers made more hits in the above-mentioned zones of the court. In our opinion this was due to the manner (serve - net) in which the three players (Ivanišević, Rafter and Sampras) played the match. If one or both players play serve - net, the opponent's optimal or positive targets change. In this event the player returning the stroke often has to direct the hit to the zones 2 or 1. Moreover, in the case of the serve - net play, a player intercepts many balls by a volley, which means that these strokes do not hit the ground. The information about the number of hits in the negative zone 5, i.e. directing rather short ball into the centre, on all types of courts proved to be poor, since all the winners recorded less hits in this zone than the losers.

CONCLUSION

The analysis of time characteristics of the final matches at four Grand Slam tournaments confirms the trend that the active part of the game is shortening, which to a high degree depends also on the speed of the court surface. As the game characteristics were analysed, it was established that there were certain differences between winners and losers. These are mainly reflected in the percentage of winning points after the 1st and 2nd serve. Also the 1st serve percentage and the percentage of successful returns in most cases distinguish the winners from losers. The winners of the three final matches made less faults than the losers, while two winners recorded a higher number of winning strokes. In all cases the winners recorded a better ratio between the number of winning strokes and faults. Most winners achieved a higher number of total points and more points in series. The analysis of the position of hits reveals that the serve and hits are more often directed into particular zones of the court, but this in no way explains the events on the court and the conclusions apply only to analysed matches.

In sum, it can be established that a tennis match analysis is very demanding, both from the technological and substance point of view. Moreover, it requires that the game is studied at least from four aspects. Firstly, a higher number of strokes (playing pattern or situation) which led a player into a situation of certain advantage have to be taken into account, since the playing pattern cannot be discerned from the position of one hit alone. Secondly, the positions of hits

resulting from individual strokes have to be examined separately, which means that the positions of hits differ according to the tactics of a player, which are not always the same, but include numerous variations of a similar game situation (e.g. after the serve a player moves toward the net or after the serve a player stays at the baseline). Thirdly, the speed and rotation of played balls can have a decisive influence on the successfulness of a player and, fourthly, the result at which a player played a certain situation has to be considered.

The approach to a solution of this problem is undoubtedly the use of modern technologies, especially the technology enabling automatic tracing of movement and actions of tennis players during a tennis match based on special footage and space determination. This will provide us numerous data about the activities of the player (information about the speed and position of movement, the hits, etc.), time characteristics and loading of players.

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Table 1: Basic data about individual final matches

Tournament	Australian Open	French Open	Wimbledon	US Open
Year	2001	2001	2001	2001
Match	Finals	Finals	Finals	Finals
Players	A. Agassi – A. Clement	G. Kuerten - A. Corretja	G. Ivanišević - P. Rafter	L. Hewitt - P. Sampras
Result	6:4,6:2,6:2	6:7,7:5,6:2,6:0	6:3,3:6,6:3,2:6,9:7	7:6,6:1,6:1
Surface	Hard court	Clay	Grass	Hard court

Figure 1: Court zones for return and other strokes (forehand, backhand, volley, smash...)

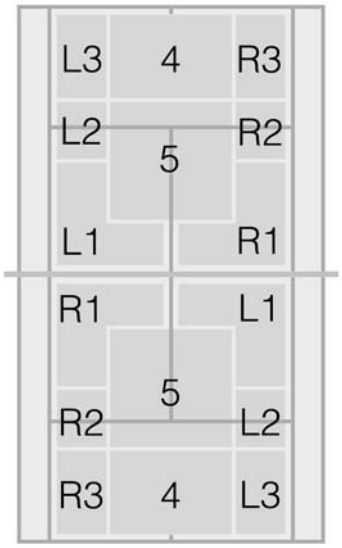

Figure 2: Court zones for serve

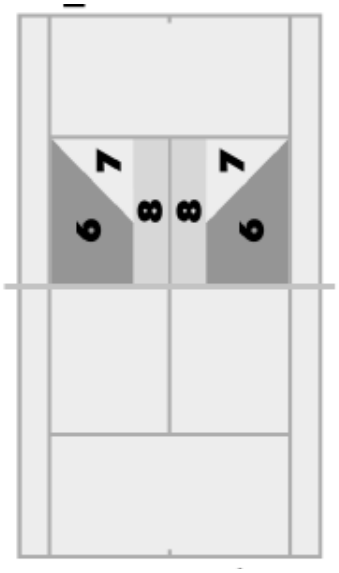

Table 2: Time characteristics of individual matches

Tournament	Australian Open	French Open	Wimbledon	US Open
Players	A. Agassi - A. Clement	G. Kuerten - A. Corretja	G. Ivanišević - P. Rafter	L. Hewitt - P. Sampras
No. of sets	3	4	5	3
No. of games	26	39	51	27
No. of points	171	244	304	176
Average no. of points per set	57	61	61	58
Total playing time (1 min.)	104	192	181	113
Average point duration (1 s)	7,3	8,2	2,7	3,8
Average rest time between points (1 s)	19,06	23,1	18,7	19,9
Average rest time - changing sides (1 s)	95,18	106,4	95,6	100,9
Average rest time - no changing sides (1 s)	31,41	35,9	38,1	30,4
Ratio - rest : game (playing time)	01:02,6	01:02,8	01:06,9	01:05,2
Ratio - rest : game (total time)	01:03,8	01:04,4	01:14,1	1:08
% of points last $\leq$ 10 s	76,40%	68,50%	100,00%	92,60%
% of points last 10 - 25 s	20,50%	27,70%	0,00%	6,80%
% of points last $\geq$ 25 s	2,90%	3,80%	0,00%	0,60%

Table 3: Game characteristics and position of hits in individual final matches

Player	A. Agassi	A. Clement	G. Kuerten	A. Corretja	G. Ivanišević	P. Rafter	L. Hewitt	P. Sampras
Total no. of points	171		244		304		176	
Total points won	94	77	136	108	154	150	100	76
Serve – return								
1st Serve %	65%	52%	59%	53%	55%	62%	64%	60%
2nd Serve %	96%	84%	98%	97%	80%	92%	82%	85%
Won on Serve	63%	52%	69%	66%	68%	69%	71%	55%
Won on 1st Serve	72%	58%	53%	35%	80%	76%	84%	63%
Successful returns after 1st Serve	68%	59%	78%	69%	50%	41%	55%	57%
Successful returns after 2nd Serve	92%	82%	98%	91%	73%	64%	76%	83%
Last stroke within a point								
No. of faults (all strokes)	44	69	60	89	77	69	39	63
Serve (double fault)	1	7	2	4	15	4	5	6
Return	12	15	7	15	38	38	17	16
Forehand & Backhand	29	47	43	69	12	14	17	20
Volley & Smash	2	0	8	1	12	13	0	21
Winners (all strokes)	21	32	47	48	76	67	34	32
Serve (ace)	7	5	10	5	27	13	7	11
Return	1	1	4	4	12	8	8	1
Forehand & Backhand	12	24	21	31	16	16	17	5
Volley & Smash	1	2	12	8	21	30	2	15
No. of points won in series	69	33	73	53	58	67	63	35
- 3 points series	10	1	10	5	9	6	6	3
- 4 points series	3	5	6	3	5	7	4	4
- 5 points series	2	2	1	4	1	3	3	2
- 6 points or more series	2	0	2	1	1	1	2	0

Break points								
Break points won	7	2	9	1	3	3	6	1
Break points had	15	6	15	7	6	6	13	2
% of break points won	47 %	33 %	60 %	14 %	50 %	50 %	46 %	50 %
Ratio – points								
Ratio between total no. of points and faults	3,89	2,48	4,07	2,74	3,95	4,41	4,51	2,79
Ratio between winners and total no. of points	0,12	0,19	0,19	0,20	0,25	0,22	0,19	0,18
Ratio between winners and faults	0,48	0,46	0,78	0,54	0,99	0,97	0,87	0,51
Position of hits in the court								
Total no. of serve (1^{st}, 2^{nd})	75	88	121	117	141	144	69	96
No. of serve from deuce court (right) in zone 6	17	14	22	11	19	34	16	18
No. of serve from deuce court (right) in zone 7	9	16	17	36	5	15	10	8
No. of serve from deuce court (right) in zone 8	14	15	25	12	52	31	10	23
No. of serve from ad court (left) in zone 6	17	8	34	19	30	23	8	11
No. of serve from ad court (left) in zone 7	6	21	21	31	13	9	12	17
No. of serve from ad court (left) in zone 8	12	14	2	8	22	32	13	19
No. of hits in zone 1 - 4	275	236	336	293	90	97	115	120
No. of hits in zone 4	54	60	64	56	7	15	11	29
No. of hits in zone 3 right (R3)	88	81	68	60	23	11	23	25
No. of hits in zone 3 left (L3)	60	35	56	38	12	23	20	25
No. of hits in zone 2 right (R2)	49	42	86	80	16	11	32	25
No. of hits in zone 3 left (L2)	20	15	46	45	22	23	17	13
No. of hits in zone 1 right & left (R1 & L1)	4	3	16	14	10	14	12	3
No. of hits in zone 5	37	66	117	124	16	18	20	39