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Impact of Racquet Evolution: How New Technologies Affected Tennis Players' Statistics?

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Abstract

Like in many sport branches, technological developments have had a significant impact on how tennis is played. The evolution of materials used for the production of equipments created further evolution for the game. In this study, my purpose is to observe the impact of four racquets of different production date (An average 10-year difference between each production date). Five volunteers of average age of 24±3.54 years, average height of 179±8.19 centimetres, average weight of 80.2 ±2.17 kilograms and average sport year of 5.8±3.83 have participated in this study. Also, Wilson RF Autobiograph (100inch² head size, 340gr. Unstrung weight) production date 2017, Babolat Pure Drive (100 inch² head size, 300gr. Unstrung weight production date 2006), Expo (247gr. Strung weight, 90 inch², production date 1980). Donnay (253gr.strung weight, 90inch², production date,1970) were used. The data are analysed by SPSS Statistics Program. According to statistical analysis correlations between production dates of racquets and their effect on the tennis plays were found. T-test was found for the statistical analysis. The outcomes of the research point out to a positive impact of new racquet technologies on the game, especially in second serve percentages for all game and double faults numbers per a service game (As well as the other parameters, such as first serve percentage, winner and unforced errors per game). This study also makes certain predictions about possible future changes of the game of tennis.

Keywords: Tennis, tennis racquets, technology

INTRODUCTION

Like all other sport branches, tennis game is also always affected by technological innovations. Equipment used in tennis such as racquets, balls, shoes etc. are enhanced due to new production possibilities. Nowadays, all equipments are much more comfortable, durable and reachable than previous tennis eras.

Firstly, the materials used in racket production and the changes in these production processes were investigated (Gandu, 2018). Then, how tennis racquets' weight, head size, raw-material changed over the years were searched. Wooden and composite racquets were compared in the study as shown in Table 1 (Miller, 2006). Also, many other scientific studies prove that today's tennis game is being played much faster and with less unforced errors. In addition, some studies clearly show that there is an increase in serve speeds and the number of aces and double faults in grand slams between 1991-2012 changes remarkably (Cross et al., 2009).

Table 1. Comparison of average characteristics between wood and composite racquets (Miller, 2006).

Characteristic	Wood	Composite
Length (cm)	69	70
Mass (g)	380	295
Head Size (cm^2)	439	680
Stiffness (Hz)	100	150
Swing weight (kg/cm^2)	450	310

According to Miller study, racquet characteristics had changed over years and this indicates that this can cause major changes in the play of tennis.

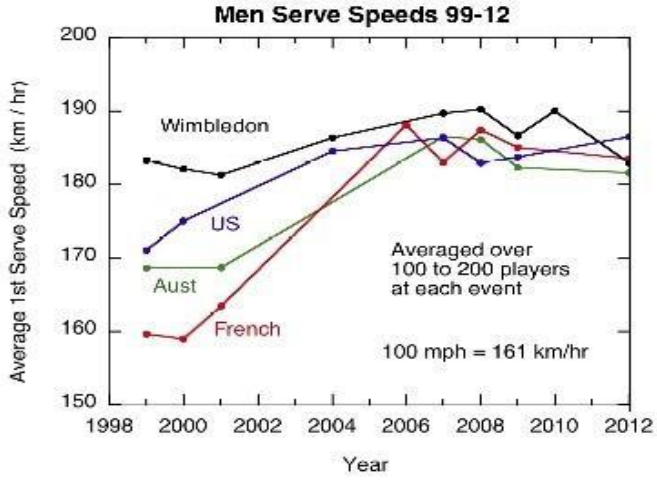

Figure 1. Men serve speeds in grand slams between 1999-2012 years (Cross et al., 2009).

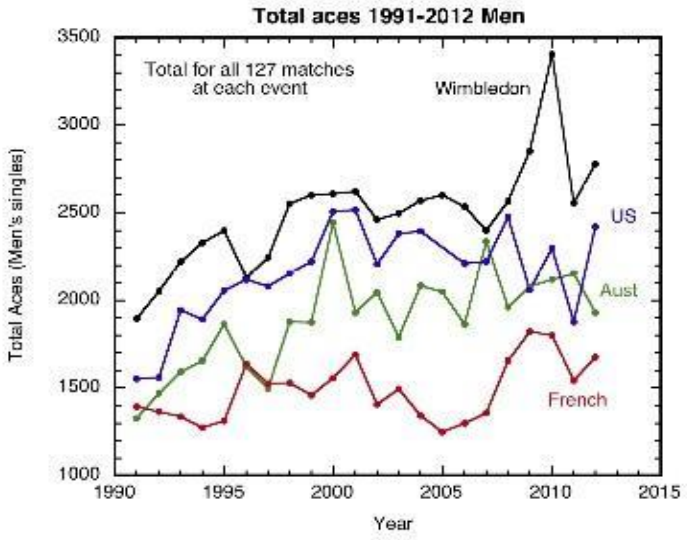

Figure 2. Total aces in grand slams between 1991-2012 years (Cross et al., 2009).

This total aces graph shows that all grand slams tournaments of tennis world improves their game quality and the number of aces of them. Thanks to new racquet technologies players can make faster serves and it increases the number of aces. In the current study, we tried to analyse the impact of differences in racquet production which result from the usage of different materials and technologies within certain parameters of tennis game. These crucial parameters are first serve percentage, second serve percentage, unforced errors, winners and double faults, all of which are investigated individually, and the collected data are analysed both quantitatively and qualitatively.

METHOD

Research Group

Research group contains players from tennis team of Bogazici University.

Table 2. Players characteristics

PLAYERS	AGE	HEIGHT (cm)	WEIGHT kg)	SPORT AGE	GAME STYLE	STROKE POWER
A	22	170	79	16	Baseliner	Heavy Hittter
E	20	175	83	11	All Around	Heavy Hitter
O	29	178	78	5	Volleyer	Controlled
Sh	26	180	82	4	All Around	Balanced
M	23	192	79	1	Baseliner	Balanced

Apparatus

4 different racquets are used in the study which are produced in:

Racquet Name	Production Date	ab.
Roger Federer	2017	RF
Prue Drive	2008	PD
Ancient	1980	AE
Wooden	1971	WD

Data Collection

The study contains first serve and second serve percentage, because they give clues about the comfort of racquets. Compact racquets can allow high first and second serve percentage. Comfort of a racquet is also related to the number of average unforced errors. High average winner number requires powerful strokes without errors. Finally, players should have smooth serve mechanics for a low double fault rate. All these data are very crucial for tennis game and they are included in this research due to this importance. Collected data in the Table 3 below are then transferred to computers. Firstly, five players contribute to five different inputs with their own racquets. Then each player gave inputs with other racquets (5 parameters for a single racquet per player). Thus, there are 25 inputs for each player and the study contains 125 different inputs.

Table 3. Data collection sheet

Winners		1.Serve								1.Serve	Winners	
		2. Serve								2. Serve		
		1.Serve								1.Serve		
		2. Serve								2. Serve		
		1.Serve								1.Serve		
		2. Serve								2. Serve		
		1.Serve								1.Serve		
Unforced Errors		2. Serve								2. Serve	Unforced Errors	
		1.Serve								1.Serve		
		2. Serve								2. Serve		
		1.Serve								1.Serve		
		2. Serve								2. Serve		
		1.Serve								1.Serve		
		2. Serve								2. Serve		
		Ace								Ace		
		Player:								Player:		
		Racquet:								Racquet:		

Tennis Quality Index

'Tennis Quality Index, shortly TQI, is a way to measure quality of a tennis game played by a certain player. It was evaluated for this study. In a tennis competition such as a match or a set, even a whole tennis tournament, the data of a player were collected. Then these data are evaluated in Tennis Quality Index Formula.

The Formula is;

$$TQI = QUOTE \frac{\frac{1.SERVE\ \% + 2.SERVE\% + \left(\frac{WINNER - UNFORCED\ ERROR}{3} * 100\right)}{3}}{\frac{1.SERVE\ \% + 2.SERVE\% + \left(\frac{WINNER - UNFORCED\ ERROR}{3} * 100\right)}{3}}$$

High level of TQI indicate the quality of the game is better. Certain parameters can affect the number of TQI such as weather conditions, court type, balls or racquets.

Data Analysis

The data were analysed by SPSS 21 Statistics Program. T-test was used for the analysis. The groups show a non-parametric distribution.

RESULTS

The study indicates that changes in racquet technologies affect the game statistics positively. So, data suggested that new racquets are much powerful and do have a better control feeling. Also, it is clear that all these changes determine the content of tennis game and many other parts of it.

Table 4. Players statistics

PLAYER	1.Serve Percentange					2.Serve Percentange					Unforced Errors Per a Game					Winners per a Game					Double Fault Per a Game				
	KD	RF	PD	AE	WD	KD	RF	PD	AE	WD	KD	RF	PD	AE	WD	KD	RF	PD	AE	WD	KD	RF	PD	AE	WD
A	53	77	58	22	70	100	100	100	57	33	1,8	0,3	1,3	2,8	1,5	0,5	0,5	0,5	0,5	0,3	0	0	0	1,5	1
E	50	27	55	54	46	81	62	77	50	57	1,8	1,6	1	1	1,8	0,9	1	0,7	0,5	0,4	0,5	1,5	0,6	1	1,5
O	53	69	67	25	55	100	80	73	66	66	1,4	1,2	1,3	0,8	1,7	0,8	1,8	1,1	0,4	0,8	0	0,3	0,6	0,7	1
Sh	53	35	47	83	91	62	73	88	50	50	4,6	1,8	1,4	2,8	2	0,4	0,7	0,8	0,5	0,8	1	1	0,3	0,5	0,3
M	48	55	67	66	48	86	100	83	75	75	1,3	1	1,5	2	1	0,6	0,5	0,5	0	0,3	0,4	0	0,3	0,5	0,8
Mean	51	53	59	50	62	86	83	84	60	56	2,2	1,2	1,3	1,9	1,6	0,6	0,9	0,7	0,4	0,5	0,4	0,6	0,4	0,8	0,9

Table 4 shows the players and their 5 different statistics with 5 different racquets.

KD column is the player's own racquets' inputs.

When the data are studied there are some differences for each player. Average data show that with more recent production dates, players have much more positive TQI. Especially, data of AE and WD are always lower than the others.

Table 5. Player TQI statistics

Players	TQI				
	KD	RF	PD	AE	WD
A	36.2	61.8	44.3	-15.3	9.3
E	28.9	6.3	34.0	18.0	2.1
O	44.3	52.7	38.4	18.6	20.0
Sh	-19.4	11.9	34.7	13.8	30.3
M	32.4	46.1	35.2	19.2	24.3
Mean	**24.4±25,2**	**35.8±25,1**	**37.3±14,7**	**10.9±26,3**	**17.3±11,4**

According to statistical analysis TQI numbers shows high positive correlations with first and second percentages and winner numbers per a game. In addition, they have negative correlations with double fault numbers per a service game and unforced error numbers per a game.

For example, TQI numbers are highly correlated (double star) wih the First serve percentage (0,984) and unforced errors (-0,975). Also double faults are higly correlated with second serve percentages.

Some data also have single star correlations such as unforced errors and TQI (-0,881). In addition, with all racquets first serve and second serve percentages, second serve and winner numbers, first serve and double faults numbers have correlations with single star.

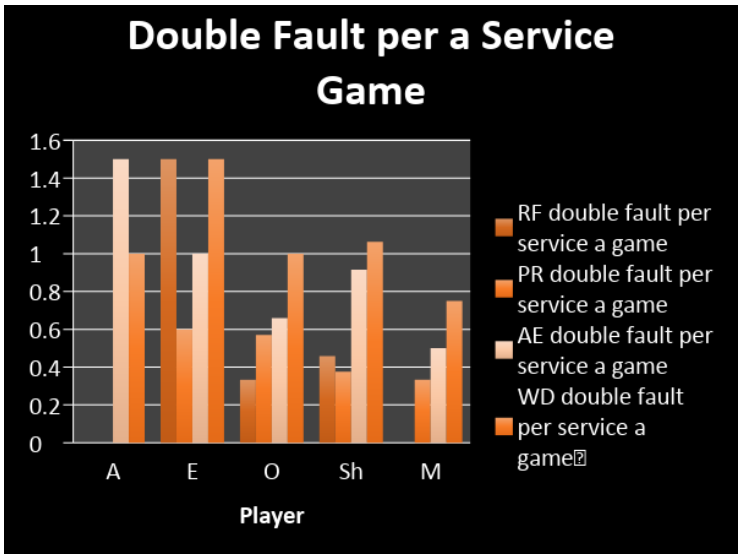

Figure 3. Double faults numbers per a service game grand slams between

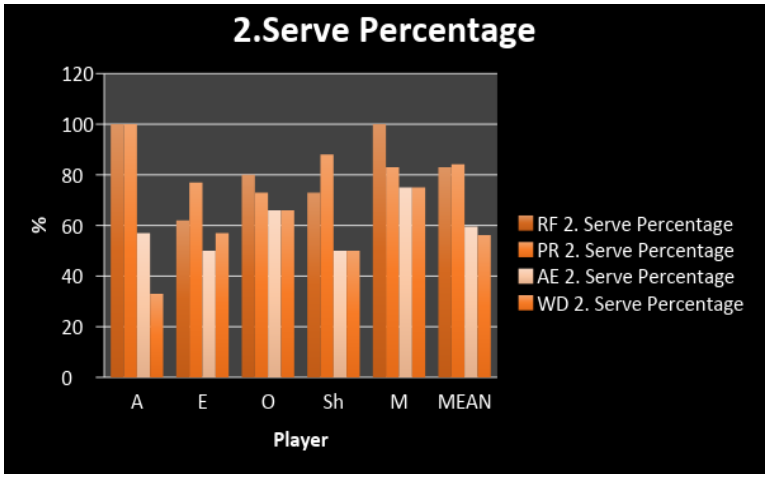

Figure 4. Second serve percentage

In conclusion, new racquet technologies increases the quality of tennis game. Players make less errors and have high percentages with new racquets.

DISCUSSION

Interestingly, Player Sh gave better data with all racquets than its own racquets. The reason for that may be claimed to be the play style of the player. The fear of double fault with a different racquet increases the first and second serve percentages. Of course, due to the same reason unforced errors per a game and double fault per a service game decreases. These results show the playing style may affect some parameters. However, the average data are always similar, and they suggest higher success for the new racquets. On the other hand, first serve percentages with other racquets are generally higher than the players' first serve rate with their own racquets. During the data collection players have lower performance for first serve and the speed of serves is very much lower. It can be seen clearly but the study didn't contain stroke speed radar to measure the serve speeds. In future works, there should be more focus on the speeds in addition to percentages.

Without player Sh and first serve percentage of all players, only 15 inputs (25%) of total 64 input are against the hypothesis of in the current study. 9 are tied with other data most probably due to the limitedness the study cause. 42 inputs (63%) shows a clear peak and if we add the half of the tied inputs (14%) the data reaches 70%.

Technologial innovations create big changes in tennis like other sort branches. The racquets are main material which are affected these innovations. According to Aussie researchers, tennis changes and develops regularly (Cross, 2009). New racquets can much power without losing the control feeling. In the study increasing winner numbers with new racquets prove that and also some other studies show that the weight of racquets drops the angles of rebound of tennis balls and increases the control feeling during a stroke (Allen, 2010). Also damping effect is a important parameter to create power and the damping level after a stroke of string is lower for the old racquets (Cass, 2003). The quality level of a tennis game is higher in oversized racquets than the standard racquets (Gruetter, 2013) and the new racquets have much bigger head sizes. Some studies show that the racquets have swing-weight numbers between 0.030 - 0.0350 kg/m2 allow more accuracy and speed (Allen, 2015) and in our study new technology racquets have this kind of swing-weight numbers. In another article, tennis players have not only power but also control thanks to new generation racquets (Oidemizu, 2018). In our study the length,

weight and stiffness of racquets were not measured but these parameters are very important for tennis game (Miller, 2006). Racquet producers increase the head-size of racquets and sweet spot area and then, reduce the probability of miss (Cross, 2009). The data which are taken from the study also shows the same results. Some researchers consider tennis players as labourers and thanks to new racquets the average age of retirement increases and is contributed the economic wellness levels of tennis players (Fillmore, 2017). Much power with a good control feeling is better for human muscles and prevents major tennis injuries like tennis elbows and it extends the career of tennis players. According to some studies tennis needs only one serve rule instead of first and second serves (Sheridan, 2006). However, we believe that the second serve adds variety and increases the enjoyment and audience.

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