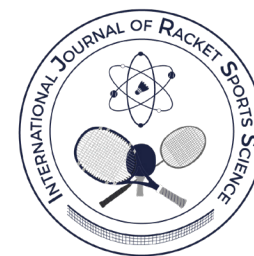


Stroke placement in women's professional tennis: What's after the serve?

La colocación de los golpes en el tenis profesional femenino: ¿qué sigue luego del servicio?



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Abstract

The aim of the present study was to investigate the placement of the return, and the 3rd and 4th strokes in professional women's tennis, the possible differences related to the level of play and to derive practical recommendations from the results. In total this study contains an examination of 2562 returns, 2065 3rd strokes and 1606 4th strokes from 28 players in 19 professional women's tennis matches (WTA & ITF 2018-2020 season). All strokes were classified using a specific court division method taking outcome (i.e., in, out, net) and placements into account for statistical analyses. Results show that returns are mainly placed into the court's middle zones whereas 3rd strokes are placed more into offensive zone groups with 4th strokes similarly placed but more scattered. No correlation was found between the placement of the return and the 3rd stroke. Correlations were found between the placement of 4th stroke and the return, between the 4th and the 3rd stroke as well as between WTA and ITF players regarding all three strokes (return, 3rd stroke, 4th stroke). Present findings may be of interest to female tennis players and their coaches aiming to improve practice patterns in training and competitive performance in matches.

Keywords: *game opening – coaching – court division – return – target zones.*

Resumen

El objetivo del presente estudio fue investigar la colocación de la devolución, el tercer golpe y el cuarto golpe en el tenis profesional femenino, así como las posibles diferencias relacionadas con el nivel de juego y, finalmente, derivar recomendaciones prácticas a partir de los resultados. En total, este estudio contiene el examen de 2562 devoluciones, 2065 terceros golpes y 1606 cuartos golpes de 19 partidos de tenis profesional femenino de 14 jugadoras (tanto de la WTA como de la ITF) entre los años 2018 y 2020. Todos los golpes se clasificaron usando un método específico de división de la cancha que tiene en cuenta el resultado (es decir, *in, out, net*) y las colocaciones para los análisis estadísticos. Los resultados muestran que las devoluciones se colocan principalmente en las zonas centrales de la cancha (66,7 %), mientras que los terceros golpes se colocan más en grupos de zonas ofensivas (es decir, zonas exteriores 58,1 %, zona exterior prohibida 72,6 % zonas C 28,7 %) y los cuartos golpes colocados de manera similar, aunque más dispersos. No se encontró ninguna correlación entre la colocación de la devolución y el tercer golpe ($r = 0,517$, $p = 0,085$). Se encontraron correlaciones entre la colocación del cuarto golpe y la devolución ($r = 0,653$, $p < 0,05$), entre el cuarto y el tercer golpes ($r = 0,961$, $p < 0,001$), así como entre jugadoras de la WTA y la ITF con respecto a los tres golpes (devolución $r = 0,818$, $p < 0,01$; tercer golpe $r = 0,942$, $p < 0,001$; cuarto golpe $r = 0,821$, $p < 0,01$). Los presentes resultados pueden ser de gran interés para las jugadoras de tenis y sus entrenadores con el fin de mejorar los métodos de práctica en el entrenamiento y el rendimiento competitivo en los partidos.

Palabras clave: *apertura del juego, zonas objetivo, devolución, división de la cancha, entrenamiento.*

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Introduction

The game opening is a crucial feature of tennis (Born, 1996). Not only does every point start with a serve and in most cases with a return, these two strokes also have a strong impact on the outcome of a match (Gillet et al., 2009; Ma et al., 2013). Previous research has shown that the mean rally length in tennis is between three to six strokes, depending on the surface (Born, 2017; Carboch et al., 2018; Fernandez-Fernandez et al., 2008; Weber et al., 2010; Weber & Born, 2012), the 3rd and 4th stroke of a rally can be added to the so-called extended game opening that consists of the first four strokes of a rally (Born, 2017; Weber & Born, 2012). Also, 50-70% of all points played in professional tennis, no matter if it is men's or women's tennis and which surface is played, are finished after an extended game opening (Born, 2017; Carboch et al., 2018; Weber et al., 2010; Weber & Born, 2012). While the serve is probably the most examined stroke or match situation in tennis, respectively (Elliot et al., 2013; Gillet et al., 2009; Grambow et al., 2020; Grambow et al., 2021; Klaasen & Magnus, 2014; Mecheri et al., 2016; Meffert et al., 2018; O'Donoghue & Brown, 2008; Vaverka et al., 2018; Weber & Born, 2012), there is far less research on the return and almost none on the 3rd and 4th stroke although experts claim that the importance of these strokes for a successful tennis player is undeniable (Born, 1996; Born, 2017; Brabenec, 2000; Crespo & Miley, 1998; Giffenig, 2013; Gillet et al., 2009; Klaus et al., 2017; Meffert et al., 2018; Schönborn, 2006 & 2012; Weber et al., 2010; Weber & Born, 2012).

According to the tactical principals of tennis, one of the factors for a successful stroke execution is the placement of the stroke (Crespo & Miley, 1998; Ferrauti et al., 2014) which can be used to (1) move the opponent sideways out of the court, (2) push the opponent back away from the baseline or (3) put the opponent under time pressure (Ferrauti et al., 2014; Tiley, 2002; Schönborn, 2012). The placement into certain zones of the court is useful to execute these goals, whereas a misplaced stroke (e.g., central and short) can lead to an offensive situation for the opponent and put the player itself under pressure. For a systematic analysis of the stroke placement several court divisions have been established until today (Born, 2017; Giffenig, 2013; Gillet et al., 2009; Molina, 1995; Nowak & Panfil, 2012; Schönborn, 2008 & 2012; Tiley, 2002).

While most research on the return focuses primarily on performance indicators other than placement like winning percentages or winning outcome (Cui et al., 2018; Hizan et al., 2011; Ma et al., 2013; Merghes et al., 2014), contact point or ball trajectories (Reid et al., 2016) or efficiency (Filipic et al., 2015), only a few references can be found for the placement of the return; additionally, all of them refer to men's tennis: Gillet et al. (2009) state that 75.5% of all returns in men's tennis are aimed to the central zone of the court and that aiming there leads to a higher winning

percentage than aiming to outer zones. According to de Witt (2019) 67% to 92% of the returns on the ATP Tour are played through the middle of the court depending on the serve direction. Nowak and Panfil (2012) present similar findings while Hedelund and Rasmussen (1997) provide coaching tips by advising to aim the return to the middle and/or crosscourt.

Previous research from men's professional tennis for the 3rd and 4th stroke shows that approximately 80% are placed longer than the service line and 30% into the zones close to the baseline. The so-called forbidden zone (FZ) which is located in the center of the court and is related to strokes that are easy to return for the opponent is played into 30% of the time, making it 70% of all 3rd and 4th strokes placed outside the FZ. 60-70% of all 3rd and 4th strokes are placed into the zones close to the sidelines. Most of these strokes – approximately 30% of all strokes – are placed into the zones close to the sidelines directly behind the service line, referred to as C-Zones by Born (2017; Schönborn, 2008 & 2012). The difference between the two strokes can be described as the 3rd stroke being more precise than the 4th, meaning being placed more frequent into the latter described zones, the zones on the sideline, the zones close to the baseline as well as outside the FZ. Other research on the 3rd stroke focused on the position of the player and the error- and winner-rate (Klaus et al., 2017). Brabenec (2000) states that players should try to dominate the point with a fast and well-placed 3rd stroke but does not state any specific placement or target zones. Nowak and Panfil (2012) state that strokes to win points are directed to the outer zones of the court.

In contrast, there is a clear research gap regarding the mentioned strokes in women's tennis. Thus, to the best of the authors' knowledge, the present study is the first which examines the placement of the three strokes after the serve in women's professional tennis. In particular, this study tries to answer the following questions:

- (1) Into which zones and zone groups of the court do professional women's tennis players place their (a) return (b) 3rd stroke and (c) 4th stroke?
- (2) Can differences be observed between the placement of the three strokes?
- (3) Can possible differences in the stroke placement be related to the level of play?

The main goal of the present study is to generate a first overview of the stroke placement in women's professional tennis. This could offer useful numbers for coaches and players to derive practical recommendations as well as being a starting point for following research.

Materials and Methodology

Participants: The research material consists of data from 19 professional women's tennis matches in

total: 7 at the WTA Premier Mandatory¹ Tournament Mutua Madrid Open 2019, 5 at the WTA Premier 5² Tournament Internazionali BNL d'Italia 2019 as well as 7 matches from \$15,000 and \$25,000 ITF³ Tournaments from 2018, 2019 and 2020. The 14 players examined at the WTA tournaments had a mean ranking at the end of the year 2019 of position 15.2 ± 14.4 with a mean age of 25.8 ± 3.1 years. The 14 players examined at the ITF tournaments had a mean ranking at the time of the tournaments of position 586.6 ± 291.3 with a mean age of 21.3 ± 5.1 years. These matches were chosen to get an overview of professional women's tennis and to show possible similarities and differences between different playing levels. Inferring from these numbers hereinafter the WTA players are referred to as the better players within the sample. In total this study contains examination of 2562 returns (1647 of the WTA players, 915 of the ITF players), 2065 3rd strokes (1317 WTA, 748 ITF) and 1606 4th strokes (1021 WTA, 585 ITF).

Design & Procedures: Matches examined in this study were recorded digitally and watched on a laptop using the VLC Media Player. Matches were allocated among three well trained observers on pre-defined criteria (specific zones, see figure 1) according to standard procedures as follows: Every return, 3rd and 4th strokes were observed regarding the outcome (i.e., in, out or net) and the placement (e.g., into zone 1c). Microsoft Excel was used to collect the observed data.

For the observation of the placement a modified court division method using 12 different zones based on Born (2017) was used (figure 1). This court division has the purpose of dividing the court as close-meshed as possible to guarantee a differentiated analysis of the stroke placement and, at the same time, keep the court division simple enough to make it applicable for coaches and players (Born, 2017). For the purpose of this study the original division into 14 zones was modified by setting aside the zones 5a and 5b, located directly at the net, because data shows that less than 2% of all strokes are placed into these zones (Born, 2017). Instead, the zones 3a, 3b, 4a and 4b, originally located between service line and the zones 5a and 5b, were enlarged up to the net. All in all, the area between the service line and the net is divided lengthways into 4 equally sized zones (3a, 3b, 4a, 4b) while the area between the service line and the baseline is divided lengthways the same way and additionally across in two parts which results in 8 equally sized zones (1a-d, 2a-d). Also based on Born

(2017) certain zones are combined into zone groups to get a better overview: Zones 1c and 2c form the zone group *C-Zones*; zones 1a, 1b, 2a, 2b form *Baseline*; zones 1a-d, 2a-d form *Longer than serviceline*; zones 1d, 2d, 3b, 4b form *Forbidden Zone (FZ)*; zones 1a-c, 2a-c, 3a, 4a form *Outside FZ*; zones 1b, 1d, 2b, 2d, 3b, 4b form *Middle Zones* and zones 1a, 1c, 2a, 2c, 3a, 4a form *Outer Zones*. The collected data was edited in Microsoft Excel for Mac. Since only video footage of professional players, resulting in publicly open-access data, was used, no approval of the ethics committee was necessary.

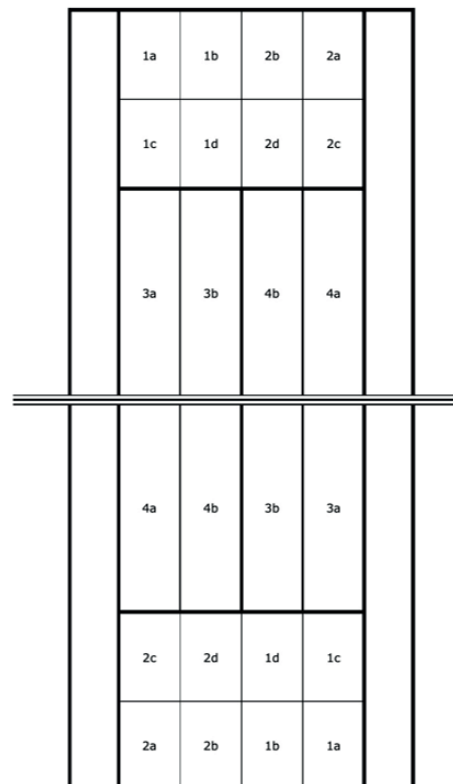


Figure 1. Modified court division used for this study based on Born (2017).

Analysis: The collected data were first sorted in Microsoft Excel for Mac to get an overview. The statistical analyses were carried out using IBM SPSS Statistics 27 (SPSS Inc., Chicago, Illinois, USA). First the Chi square test was computed to test for equal distribution. Second the Chi square test of independence was used to test for a relationship between stroke (i.e., return, 3rd, 4th) and placement frequency (i.e., different zones).

Correlations between the three strokes as well as between the level of play (i.e., WTA, ITF) were computed using Spearman's rank correlation. The level of significance was set to $p < .05$ and if applicable to $p < .01$ and $p < .001$.

Results

Main findings show that female pro tennis players hit their returns most frequently into the zones 2d

1 WTA: Women's Tennis Association. This tournament category is the 2nd highest after the Grand Slam tournaments in women's professional tennis.

2 This tournament category is the 3rd highest after the Grand Slam and the Premier Mandatory tournaments in women's professional tennis

3 ITF: International Tennis Federation. The examined tournaments are the lowest categories of professional tournaments in women's tennis.

(18.9%), 1d (14.0%), 2b (11.6%) and 1b (10.3%), 66.7% into the middle zones, 82.4% longer than the service line and 33.6% into the zones at the baseline. Further, their 3rd strokes were hit into the zones 2c (16.7%), 2d (12.2%), 1c and 2a (both 12.0%) most frequently, 28.7% into the C-Zones, 84.8% longer than the service line and 35.8% into the zones at the baseline and 72.6% outside the FZ. Their 4th strokes were targeted most frequently into 2c (15.0%), 2d (12.6%), 2a (11.4%), 1d (9.9%) and 1c (9.7%), 24.7% go into the C-Zones, 83.4% longer than the service line, 36.3% into the zones at the baseline as well as 68.5% outside the FZ.

Details on descriptive findings for the return are presented in table 1, for the 3rd stroke in table 2 and for the 4th stroke in table 3.

Chi square test revealed an unequal distribution between the number of strokes to the different zones ($p < .001$) which means that the ball placement was different in every zone of the court (see table 1-3). Chi square test of independence showed significant relationships between the respective stroke (return, 3rd, 4th) and the placement frequency into the different zones ($\chi^2 (df) = 22, p < .001, Cramer-V .162$).

Table 1.
Return WTA & ITF Players.

CATEGORY	SUBCATEGORY	RETURN TOTAL	RETURN ITF	RETURN WTA
n =		2562	915	1647
Result	in (%)	83.4%	84.4%	82.8%
n =		2136	772	1364
Zones	1a	5.3%	6.3%	4.7%
	1b	10.3%	6.6%	12.5%
	1c	6.9%	9.1%	5.7%
	1d	14.0%	12.7%	14.8%
	2a	6.4%	6.0%	6.7%
	2b	11.6%	11.5%	11.6%
	2c	8.9%	12.4%	7.0%
	2d	18.9%	18.4%	19.2%
	3a	2.3%	3.2%	1.8%
	3b	5.4%	4.4%	6.0%
	4a	3.4%	3.6%	3.2%
	4b	6.4%	5.7%	6.8%
Zone	C-Zones	15.9%	21.5%	12.7%
Groups	Baseline	33.6%	30.4%	35.4%
	Longer than service line	82.4%	83.0%	82.1%
	FZ	44.8%	41.2%	46.8%
	Outside FZ	55.2%	58.8%	53.2%
	Middle Zones	66.7%	59.3%	70.8%
	Outer Zones	33.3%	40.7%	29.1%

Table 2.
3rd Stroke WTA & ITF Players.

CATEGORY	SUBCATEGORY	3rd STROKE TOTAL	3rd STROKE ITF	3rd STROKE WTA
n =		2065	748	1317
Result	in (%)	85.5%	85.3%	85.6%
n =		1765	638	1127
Zones	1a	9.3%	9.6%	9.1%
	1b	6.3%	6.3%	6.3%
	1c	12.0%	13.5%	11.2%
	1d	8.0%	7.5%	8.3%
	2a	12.0%	14.7%	10.5%
	2b	8.2%	7.4%	8.7%
	2c	16.7%	17.6%	16.2%
	2d	12.2%	11.3%	12.8%
	3a	3.7%	3.1%	4.0%
	3b	3.4%	1.6%	4.4%
	4a	4.4%	4.1%	4.5%
	4b	3.8%	3.4%	4.0%
Zone	C-Zones	28.7%	31.0%	27.4%
Groups	Baseline	35.8%	37.9%	34.6%
	Longer than service line	84.8%	87.8%	83.1%
	FZ	27.4%	23.8%	29.5%
	Outside FZ	72.6%	76.2%	70.5%
	Middle Zones	41.9%	37.5%	44.5%
	Outer Zones	58.1%	62.5%	55.5%

Table 3.
4th Stroke WTA & ITF Players.

CATEGORY	SUBCATEGORY	4th STROKE TOTAL	4th STROKE ITF	4th STROKE WTA
n =		1606	585	1021
Result	in	84.6%	85.3%	84.2%
n =		1359	499	860
Zones	1a	8.8%	11.0%	7.6%
	1b	7.5%	6.2%	8.3%
	1c	9.7%	11.6%	8.6%
	1d	9.9%	6.2%	12.0%
	2a	11.4%	12.0%	11.0%
	2b	8.5%	9.4%	8.0%
	2c	15.0%	17.0%	13.8%
	2d	12.6%	11.8%	13.0%
	3a	3.5%	3.0%	3.7%
	3b	4.3%	2.8%	5.2%
	4a	4.0%	4.4%	3.8%
	4b	4.7%	4.4%	4.9%
Zone	C-Zones	24.7%	28.7%	22.4%
Groups	Baseline	36.3%	38.7%	34.9%
	Longer than service line	83.4%	85.4%	82.3%
	FZ	31.5%	25.3%	35.1%
	Outside FZ	68.5%	74.7%	64.9%
	Middle Zones	47.5%	40.9%	51.4%
	Outer Zones	52.5%	59.1%	48.6%

The results of the Spearman's rank correlations are displayed in figure 2. They showed significant correlations between the placement of the 3rd and 4th stroke ($p < .001$) as well as between the return and the 4th stroke ($p < .05$). There was no significant correlation between the return and the 3rd stroke. Also, significant correlations were shown between the WTA and ITF players regarding all three strokes (return $p < .01$; 3rd stroke $p < .001$; 4th stroke $p < .01$).

Discussion

This study aimed to examine the placement of the return, 3rd and 4th stroke in professional women's tennis in general and also possible differences related to the level of play.

The difference between strokes (i.e., return, 3rd, 4th) revealed different placement frequencies into the respective 12 zones of the court. However, significant correlations between the return and 4th stroke as well as between the 3rd and 4th stroke indicate a similar distribution of these strokes into the respective 12 zone. However, the return and the 3rd stroke data were not inspected since there was no significant correlation between these two strokes. Also, the significant correlation between WTA and ITF players regarding all three strokes indicate that

the two groups place the respective strokes with the same distribution into the 12 zones.

Return: The four most frequently targeted zones of the return (2d, 1d, 2b, 1b) are all located behind the service line in the middle part of the court and accumulate 54.9% of all returns and even 66.7% when adding the shorter middle zones 3b and 4b. Also, the returns tend to go more to the backhand side – of a right-handed opponent – with zone 2d being the most frequented zone and all zones on this side of the court being more frequented than their counterparts on the forehand side of a right-handed player. This is in line with previous research findings regarding the return, which suggest players to aim more often to the backhand side to avoid the presumably better forehand of the opponent (de Witt, 2019; Gillet et al., 2009; Hedelund & Rasmussen, 1997; Nowak & Panfil, 2012).

Alongside a correlation between WTA and ITF players regarding their return placement, some differences seem noteworthy: WTA players place their returns longer and more frequent to the middle zones compared to ITF players; however, this striking feature failed statistical significance. Still, the middle zones and especially those closer to the baseline are recommendable targets for the return derived from this data.

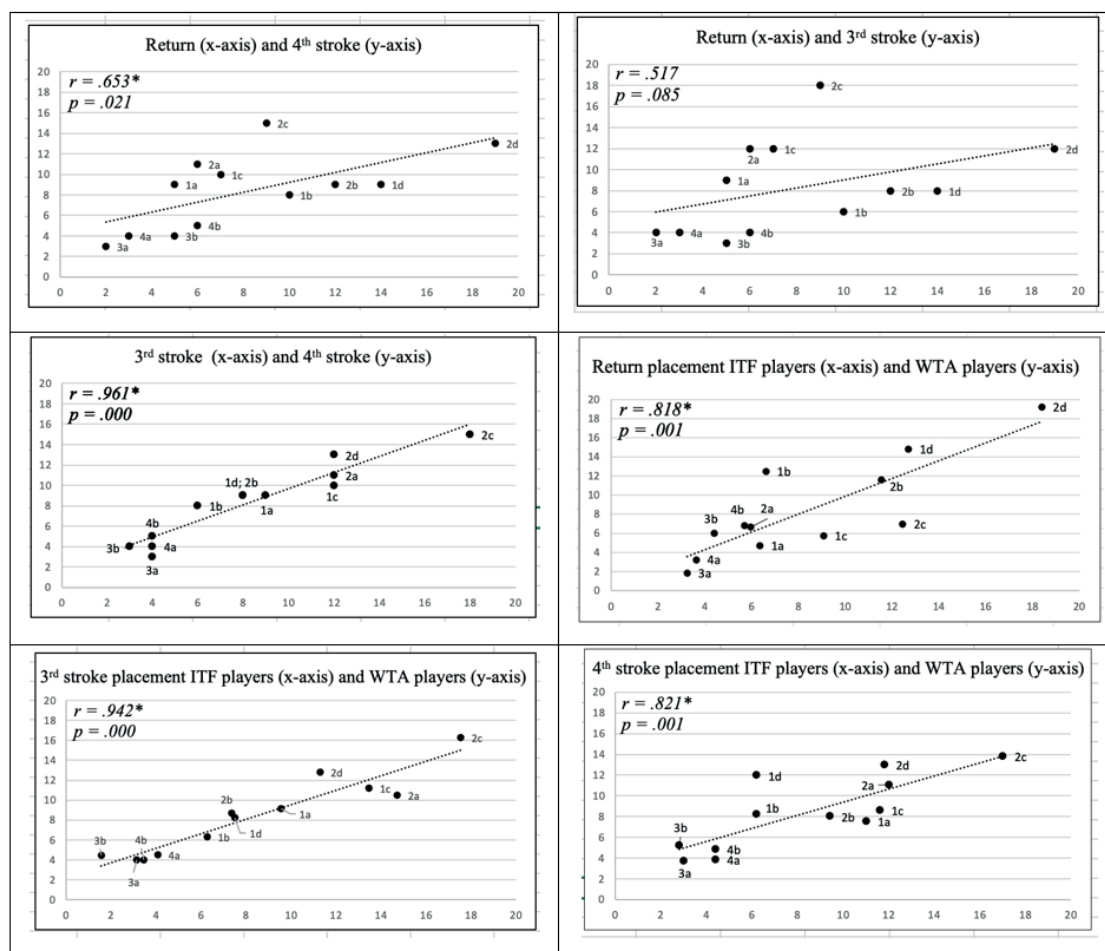


Figure 2. Spearman's rank correlations for stroke placement regarding respective zones.

3rd Stroke: The placement of the 3rd stroke is mostly in line with the data from men's professional tennis (Born, 2017; Nowak & Panfil, 2012; Schönborn, 2008) but also shows some differences. ATP players surpass the women regarding the C-Zones, the Outside FZ and Outer Zones while women are playing close to the baseline more often. Based on this, ATP players seem to play more angles and move the opponent more to the sides of the court while women tend to play the 3rd stroke deeper but less often to the sidelines. A possible explanation could be the overall more aggressive and offensive return of female players in comparison to male players which makes it more challenging to play an offensive 3rd stroke.

However, following the numbers for the C-Zones, Outer-Zones and Outside FZ (see table 2) the data from this study meets the intention of the serving player to move the opponent and indicates an overall offensive character of most of the 3rd strokes (Born, 2017; Brabenec, 2000; Crespo & Miley, 1998; Nowak & Panfil, 2012). This is also the main difference to the return placement which is by far more frequent to the middle zones, possibly explaining missing correlations between these two strokes.

Although there is a significant correlation between WTA and ITF players regarding the 3rd stroke, every zone group related to an offensive tactic (C-Zones, Baseline, Longer than service line, Outside FZ, Outer Zones) is targeted more often by ITF players while both player groups hit the same percentage of 3rd strokes in. With this, it seems reasonable that a lower return quality on the ITF level (less long and less into the middle zones) may lead to an offensive situation for the 3rd stroke more often. Thus, the recommendation derived from this data is to try and place the 3rd stroke at least longer than the service line or even either into the baseline zones or into the C-Zones.

4th Stroke: All in all, the placement of the 4th stroke is comparable to the placement of the 3rd stroke as the returning player seems to have the same placement intentions when hitting the 4th stroke as the serving player when hitting the 3rd stroke.

Although correlating, the WTA and ITF players' 4th stroke placement differs marginally. Quite surprisingly at first sight, ITF players hit, similar to the findings regarding the 3rd stroke, more often into the offensive zone groups than WTA players (see table 3). A second look triggers an attempt to explain this by a still overall lower quality of the 3rd stroke of ITF players in comparison to the WTA players in spite of the placement. This suggests – and underlines the obvious – that stroke placement is just one factor that defines the quality of a stroke and its effect on an opponent. Other factors being stroke velocity, stroke timing and spin.

All in all, the recommendation derived from this data for the placement of the 4th stroke is the same as for the placement of the 3rd stroke whilst always depending on the situation the player is in.

Although previous research reported differences between men's and women's tennis regarding the game opening with respect to i.e., winning percentages (Carboch, 2017; Hizan et al., 2011), the present findings on stroke placement support previous research on men's tennis.

Conclusion

The present study aimed to investigate the placement of the return, 3rd and 4th stroke in professional women's tennis, find possible differences related to the level of play and derive practical recommendations from the findings.

In line with previous research (de Witt, 2019; Gillet et al., 2009; Hedelund & Rasmussen, 1997; Nowak & Panfil, 2012), findings show that the return is mainly placed to the middle zones of the court (66.7%) with a tendency of being directed more to the backhand side of a right-handed opponent, most frequented in zone 2d (18.9%). With the return and 3rd stroke not correlating, the 3rd stroke is placed less central than the return but more to offensive zone groups such as Outside FZ 72.6%, most frequented in 2c (16.7%) which specifies previous reports (Born, 2017; Nowak & Panfil, 2012; Schönborn, 2008). The return and 4th stroke as well as the 3rd and 4th stroke, however, correlated with the 4th stroke being more scattered, again most frequently into zone 2c (15.0%). Further, WTA and ITF players correlate regarding their placement of all strokes (i.e., return, 3rd and 4th stroke), indicating no difference regarding the level of play (rankings: WTA 15.2 ± 14.4, ITF 586.6 ± 291.3).

The present findings may serve women and men tennis players and their coaches to better understand the placement of the different strokes in the extended game opening.

Building on that they can use this knowledge to improve their on-court practice by practicing with certain target zones for each stroke. Also, players can improve their competitive performance by having clear target areas for their own strokes and the knowledge where the opponents' strokes most probably will land.

However, future research may further address presumable correlations between placement and (direct) success as well as stroke placement in different tactical situations. Since the present data didn't allow differentiation between points after 1st or 2nd serve and the placement of all three examined strokes probably is dependent of the quality of the

preceding serve, the difference between points starting with a 1st or 2nd serve is of highest interest for future research.

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