International Journal of Performance Analysis in Sport

ISSN: 2474-8668 (Print) 1474-8185 (Online) Journal homepage: http://www.tandfonline.com/loi/rpan20

The inside out forehand as a tactical pattern in men's professional tennis

E. Martin-Lorente, J. Campos & M. Crespo

To cite this article: E. Martin-Lorente, J. Campos & M. Crespo (2017): The inside out forehand as a tactical pattern in men's professional tennis, International Journal of Performance Analysis in Sport, DOI: 10.1080/24748668.2017.1349528

To link to this article: http://dx.doi.org/10.1080/24748668.2017.1349528

INTERNATIONAL JOURNAL OF PERFORMANCE ANALYSIS IN SPORT, 2017
https://doi.org/10.1080/24748668.2017.1349528

Routledge
Taylor & Francis Group

The inside out forehand as a tactical pattern in men's professional tennis

E. Martin-Lorente[a], J. Campos[b] and M. Crespo[c,d]

[a]Department of Sport and Physical Education, University of Valencia, Valencia, Spain; [b]Department of Sport and Physical Education, Faculty of Physical Activity and Sport Sciences, University of Valencia, Valencia, Spain; [c]Department of Health Psychology, University Miguel Hernandez, Elche, Spain; [d]Spain – International Tennis Federation, Valencia, Spain

ABSTRACT

The so-called inside out forehand has an active role in the baseline strategy because it offers the players new possibilities of hitting the incoming ball with their preferred shot by covering their weaker side and, at the same time, playing the ball with more open angles and directions which create more aggressive patterns of play. The purpose of this study is to analyse the use of this shot as well as its incidence on the men's professional game both, right- and left-handed players. Eighteen matches corresponding to Grand Slam and ATP finals played between 2011 and 2014 were analysed. Eleven players (men) with ATP rankings between 1 and 14 were studied. Data show that the inside out forehand is used as a tactical weapon to counter the shots directed to the left-hand side zone of the court. The use of the inside out forehand has multiple consequences and, especially, the relationship between the use of the inside out forehand and the impact zone since it has been shown that as the player moves away laterally from the centre of the court, the percentage of transition shots is reduced, while the percentage of winners and errors increases.

ARTICLE HISTORY
Received 16 April 2017
Accepted 28 June 2017

KEYWORDS
Tennis; tactics; performance analysis

1. Introduction

Performance analysis is part of the overall training process following a strategic and systematic plan with two levels of development: (1) evaluation of the conditional and technical capacity of the athlete, and (2) evaluation of performance in competition. The information obtained from these two levels of analysis will monitor the evolution of the athlete throughout the season and help us to identify the effects of training on their specific performance (Campos, 2013).

The forehand (FH) drive has a great importance in the male professional tennis and it is considered the most important stroke after the serve (Reid, Elliot, & Crespo, 2013). In modern tennis, 75% of strokes played during a match are forehands or serves (Roetert & Groppel, 2001). Moreover, the forehand offers easier court coverage. The natural longer reach on the forehand side allows an average player coverage of 65% of the court with the

CONTACT J. Campos jose.campos@uv.es

forehand (Brabenec, 2000). Apart from the implications of this data on the physical features of the game, it is fundamental to conclude that the forehand is probable one of the two most determining shots of our sport.

However, the forehand is not any more a shot that is played just from the forehand side of the court, in fact since several decades ago players use it from all over the court. Thus, offensive players, whether men or women, are able to hit forehand winners practically from every court position and towards any direction on the opponents court with inside-in or inside-out forehands. In this way, any forehand shot variation has become a serious menace for the opponents (Bolletieri, 2000).

The so-called *inside out forehand* has an active role in the baseline strategy because it offers the players new possibilities of hitting the incoming ball with their preferred shot by covering their weaker side and, at the same time, playing the ball with more open angles and directions which create more aggressive patterns of play. This shot has been defined as "a type of forehand that is played from the backhand side of the player in which he avoids to hit a backhand and plays a forehand instead which, generally, is directed diagonally to the backhand of the opponent" (Blandón, 2008).

As per its execution, the inside out forehand can be hit towards two directions, down the line (inside in forehand) and diagonally (inside out forehand). The onset of the inside out forehand as a clearly differentiated shot in tennis play should be associated to the "modern forehand shot" according to the term used by the French Tennis Federation (Federation Français Tennis [FFT], 2001) which considers that it all started 30 years ago, era in which the wooden racquets with small heads did not forgive the errors of off-centred impacts. In this stage, the forehand shot was essentially a stroke played basically with the movement of the arm.

However, even before this period, there were initial signs of modern tennis that can be seen nowadays. Several players started to use a moderate topspin effect in their forehand, as it was the case of the Australians Rod Laver and Neale Fraser and the Spaniard Manuel Santana (FFT, 2001).

The modern forehand hit with topspin was popularised by the Swedish player Björn Borg, who used a truly revolutionary technique for the times, which decisively influenced the evolution of the forehand shot. This player was the one that imposed the use of the topspin effect in the forehand in order to clear the net with more safety. The main characteristics of the modern forehand were the following: the player would adopt an open stance and hold the racquet with a Western grip, during the backswing the racquet head was kept low and there was a short pause at the end of this movement. At impact, the player would have the shoulders facing the net and move the forearm abruptly. These were the precursor elements of the modern forehand shot that is used nowadays. In the 80s, the inside out forehand arises with the intention of being a weapon of the attacking game, but mostly built around generating a change of rhythm during the baseline rally. Ivan Lendl or Boris Becker are examples of this tactical pattern in the 90s.

Scientific studies on the inside out forehand, albeit scarce, cover several aspects related to its use. Taylor and Hughes (2002) compared patterns of play of the best British junior tennis players with players of the rest of the world; Huys, Smeeton, Hodges, Beek, and Williams (2008) studied the components that explain the anticipation of the cross court forehand and the inside out forehand in tennis; Huys et al. (2009) in a later study examined the importance of the dynamic structures identified in the previous research for the anticipation

manipulating the visual stimuli presented by creating dynamic differences in specific body areas for the cross court and inside out forehands using occlusion or neutralisation; and Smeeton, Huys, and Jacobs (2013) investigated the implications of feedback to anticipate the direction (left or right) of the inside out forehand.

However, in the light of the few studies carried out on the use of the inside out forehand as a tactical pattern from the baseline, the purpose of this study is to analyse the use of this shot as well as its incidence on the men's professional game. More specifically, the consequences of this shot depending on the zone of the court, the previous shot and his direction.

2. Methods

Eighteen matches corresponding to Grand Slam and ATP finals played between 2011 and 2014 were analysed. Eleven players (men) with ATP rankings between 1 and 14 were studied. Specifically the rankings at the time of the study were the following: 9 players ranked among the top 10 players in the world (Djokovic, Nadal, Federer, Murray, Ferrer, Raonic, Tsonga, Nishikori and Wawrinka) and 2 ranked among the top 20: Dimitrov (11) and Cilic (14). The maximum number of matches one player participated in was five. The following webs which included complete recording of the matches analysed were used: youtube.com, vimeo.com and dailymotion.com.

A spread sheet was created in Numbers for Mac, 2014, (Apple Inc., Cupertino, CA) which allowed the collection of all shots played, not only the direction of the ball hit, diagonally (inside in forehand) and down the line (inside out forehand), but also the consequence of each shot winner, rhythm change, error, rally and approach.

Shots were codified according to the following categories: (a) zone of the court in which the shot was hit; (b) previous stroke to the inside out forehand; (c) direction of the shot and its consequences in the point and (d) technical consequences.

2.1. Zone of the court in which the shot was hit

It relates to the space of the court in which the inside out forehand is played, the zone in which the incoming ball bounces. Using the official measures of the tennis court, 5 subzones were established: 4C: Central zone of the baseline; 3I + 1: From the centre of the court (baseline) up to 1.37 m; 3I + 2: The middle of the observed zone (between 1.37 and 2.74 m); 3I + 3: Side line of the singles tennis court; 3I-Ext: Doubles alley (Figure 1).

2.2. Previous stroke to the inside out forehand

This section is divided into 8 items, which relate to the stroke played by the opponent before the observed player hits the inside out forehand: S.C: Serve to the centre zone of the service box; S.T: Serve to the T zone of the service box; FH. Return: Forehand return; FH. Rally: Forehand stroke, which does not alter the action of the opponent, it could be also called as an exchange without tactical intention; D. Defensive: Forehand with a defensive intention; R. Return: Backhand shot played after the serve of the opponent; R. Rally: Backhand with no tactical intention; R. Defensive: Forehand played to defend from the opponent. As in the forehand side, it included both topspin and slice backhands.

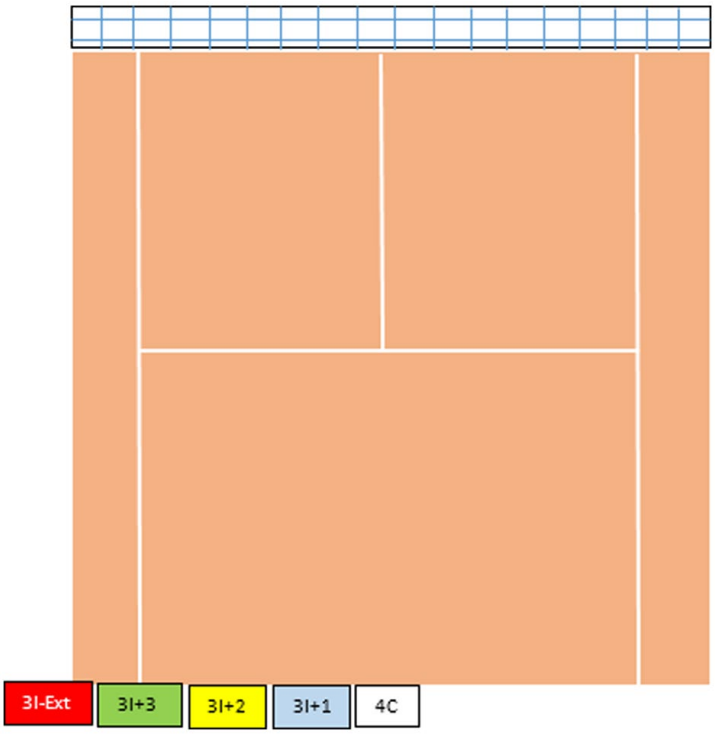

Figure 1. Zones of the tennis court for the analysis of the inside out forehand for a right-handed player.

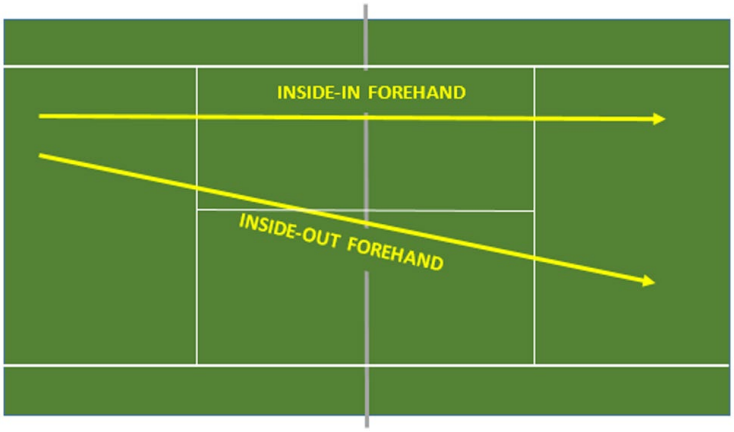

Figure 2. Directions of the Inside-in and Inside-out Forehand.

2.3. Strokes related to the direction of the inside out forehand

- *Inside-in*: ball directed down the line to the open court (Figure 2).
- *Inside-out*: ball directed cross court behind the opponent (Figure 2).

2.4. Technical actions as consequences of the inside out forehand

It consists on the recording of all the actions, which occurred after the use of the inside out forehand on the opponent. Five actions have been identified and defined as follows:

- *winner*: Inside out forehand with a result of winning the point (the ball bounced twice without being retrieved by the opponent).

Table 1. Results of Kappa Coefficients on each of the observational categories evaluated.

Categories	Kappa Coefficients (*k*)
Shot in zone 4C	0.96
Shot in zone 3I+1	0.84
Shot in zone 3I+2	0.82
Shot in zone 3I+3	0.89
Shot in zone 3I-Ext	0.96
Inside In direction	1.0
Inside Out direction	1.0
Winner shot	1.0
Rally shot	0.96
Approach shot	0.92
Rhythm change shot	0.91
Unforced error shot	1.0

- *rally*: Stroke with a "neutral" tactical intention since there is no intention of provoking any change in direction, speed, height and, thus, the opponent can play the ball back with no difficulty
- *approach*: Shot that has the intention of getting closer to the net
- *rhythm change*: Shot that has the intention of causing a tactical "unbalance" on the opponent by increasing the speed of the ball, opening angles or changing the height of the ball. It is considered a key moment during the point since after this shot the point is usually decided.
- *unforced error*: It is a mistake not caused by the action of the opponent but by the player himself, which causes the point to be lost.

Data obtained by the observation of the matches were exported to a Microsoft Excel Mac version 11.5 (2014) (Microsoft, Redmond, USA) database. The statistical analysis was done using the software SPSS version 21 for Windows (SPSS Inc., Chicago, Illinois, USA). Descriptive data were calculated (frequencies and percentages). In order to measure the degree of association among variables, contingency tables were calculated with analysis of the corrected standardised residuals (Haberman, 1973) with the use of a contrast based on the statistic Chi-square (χ^2) to identify the dependency relationships among them and with the value of statistical significance being $p \leq 0.05$.

The intra-observer reliability test was evaluated by Kappa Coefficient (Cohen, 1960) on a series of observational categories selected from the zone of the court in which the shot was hit; the direction of the shot and its consequences in the point, and the technical consequences, corresponding to one of the analysed matches. In the intra-observer test, a period of 3 months was maintained between the two registries tested in order to minimise the effect of memory and to verify if there had been changes in the categorisation of the data. The values on Kappa (*k*) coefficients oscillated between 0.82 and 1.0 as presented in Table 1, which resulted in indicative values of high concordance and reliability in the data obtained by the observer according to the interpretation of Altman (1990).

3. Results

The highest number of shots played with the inside out forehand is hit from zone 3I + 1 (36.3% of the total) and from zone 3I + 2 (33%). The rest of the zones have less number of shots since 19% are played from zone 3I + 3, 9.4% from zone 4C and lastly, 2% from 3I-Ext.

Table 2. Total inside out forehand shots played according to the court zone and its consequence on the point.

	4C		3I+1		3I+2		3I+3		3I-Ext	
Consequence on the point	*N*	%	*n*	%	*N*	%	*n*	%	*n*	%
Winners	37	1.4	116	4.1	126	4.2	105	3.7	16	0.6
Transition	121	4.3	494	17.5	325	11.4	126	4.5	5	0.1
Approach	23	0.8	46	1.7	57	2.0	27	1.0	2	0.0
Rhythm change	51	1.8	303	10.8	343	11.9	217	7.4	21	0.7
Unforced error	35	1.2	100	3.5	69	2.4	68	2.3	15	0.5
Totals	267		1059		920		543		59	

Table 3. Consequences of the inside out forehand by zones and direction.

		4C		3I+1		3I+2		3I+3		3I-Ext	
Direction	Consequence	*n*	(%)	*n*	%	*n*	(%)	*n*	(%)	*n*	(%)
INSIDE IN	Winners	12	4.5	51	4.8	47	5.0	40	7.5	9	15.3
	Transition	43	16.1	203	19.3	133	14.5	53	9.9	2	3.4
	Approach	11	4.1	25	2.4	29	3.2	15	2.8	2	3.4
	Rhythm change	16	6.0	103	9.8	152	16.6	98	18.3	10	17.0
	Unforced errors	8	3.0	44	4.1	31	3.4	23	4.3	8	13.6
Totals		90	33.7	426	40.4	392	42.7	229	42.8	31	52.7
INSIDE OUT	Winners	25	9.4	65	6.2	78	8.5	56	10.4	7	11.8
	Transition	78	29.2	290	27.5	192	21.0	73	13.6	3	5.1
	Approach	12	4.5	25	2.4	28	3.0	10	1.9	0	0.0
	Rhythm change	35	13.1	190	18.0	191	20.8	123	22.9	10	17.0
	Unforced errors	27	10.1	57	5.4	38	4.0	45	8.4	8	13.4
Totals		177	66.3	627	59.5	527	57.3	307	57.2	28	47.6

The backhand shot in the rally is the previous stroke that in the most number of occasions precedes the use of the inside out forehand with a 25.5%. This is followed by the forehand shot in the rally with 17.5%, the backhand return with 14.9% and the defensive backhand with 14.1% of the total.

The values obtained shows that the inside out forehand shot is more used than the inside in forehand, 58.8% versus 41.2%, respectively.

Data analyse the consequence of the use of the inside out forehand throughout a match when hit from zones 4C and 3I. According to the 5 items aforementioned: winner, rally, approach, rhythm change and unforced error.

From the data it can be concluded that in the majority of the cases the inside out forehand is not used as an attacking shot from the baseline but as a neutral shot during a rally (37.6%) or as a shot to change the rhythm of the rally (32.8%). Winners were 14%.

In general, the consequences of the inside out forehand (rally and rhythm change) are the most common in all zones except of 3I-Ext, in which change of rhythm and winners are predominant (Table 2).

Results of contingency analysis reveal that there is a significant relationship between the zones in which they are played and consequences (χ^2: 167.11; p: 0.000). The values of the typified residuals indicate that the inside out forehand winners are mostly played from zones 3I + 3 and 3I-Ext and less from zone 3I + 1. Transition shots are mostly played from zone 3I + 1 and to a lesser extent from zones 3I + 3 and 3I-Ext. Approach shots are mostly played from zone 4C and less from zone 3I + 1. The change of rhythm shots are mostly played

from zones 3I + 2 y 3I + 3 and less from zones 4C y 3I + 1. Finally, unforced errors with the inside out forehand are more common from zones 3I-Ext y 3I + 3 and less from zone 3I + 2.

In zone 4C, the highest percentage of the inside out forehands is played in the direction "out" (66.3%) versus 33.7% played in the direction "in" and, in both cases, the highest percentage of shots is transition/approach (29.2 and 16.1%, respectively). Winners and change of rhythm shots are more frequent in the direction "out" (9.4 and 13.1%, respectively) than in the direction "in" (4.5 and 6%, respectively) (see Table 3).

In zone 3I + 1 the highest percentage of the inside out forehands is also played in the direction "out" (59.5%) versus 40.4% and, in both cases, the highest percentage of shots is transition/approach (27.5 y 19.3%, respectively. Winners and change of rhythm shots are more frequent in the direction "out" (6.2 y 18%, respectively) than in the direction "in" (9.8 and 4.8%, respectively) (see Table 3).

In zone 3I + 2 the highest percentage of the inside out forehand is played in the direction "out" (57.3%) versus 42.7% and, in both cases, the highest percentage of shots is transition/approach (21 y 14.5%, respectively). Winners and change of rhythm shots are more frequent in the direction "out" (8.5 y 20.8%, respectively) than in the direction "in" (5 y 16.6%, respectively) (see Table 3).

In zone 3I + 3 the distribution of inside out forehands is similar to the one in the rest of the zones with more played in the direction "out" (57.2%) versus 42.8% and, in both cases, the highest percentage of shots is transition/approach (22.9 y 13.6%, respectively). Winners and change of rhythm shots are more frequent in the direction "out" (10.9 y 22.9%, respectively) than in the direction "in" (7.5 y 18.3%, respectively) (see Table 3).

In zone 3I-Ext the distribution of inside out forehands differs from the rest of the zones since in this case the highest percentage is played in the direction "in" (52.7%) versus 47.6% played in the direction "out". The highest percentage of shots is change of rhythm with 17% in both directions. Winners are more frequent in the direction "in" (15.3%). Finally, errors sum a percentage of 13.6% for both directions.

The relationship between the direction in which the shot is played (in-out) and the zone from which it is played is not significant. Chi Square values obtained for shot direction and consequences were 4.23 in zone 4C (p: 0.376); 6.41 in zone 3I + 1 (p: 0.170); 3.81 in zone 3I + 2 (p: 0.432) and 5.55 in zone 3I + 3 (p: 0.235). It has been impossible to calculate these values in zone 3I-Ext due to the fact that less than 20% of the cells had values lower than 5.

4. Discussion

The results obtained show that the inside out forehand shot is mostly used from the left zone of the baseline (98% of all inside out forehands of a match). It is the zone comprised from the centre of the court (zone 4C) up to the doubles alley (3I-Ext), a total of 5.45 m, subdivided in four sub-zones of 1.37 m each one (Figure 1).

Regarding the results obtained, the impact zone corresponds to the left side of the baseline. Which is the space in which also a higher number of displacements of the players. According to Pieper, Exler, and Weber (2007), 60–80% of the displacements of the players throughout a match are side to side and occur on the baseline zone, data that coincide with the results of our study.

In a more detailed analysis according to the zone identified above, the inside out forehand is mostly played from zones 3I + 1 and 3I + 2 (69.3% of the total). This data means

that the player hits with the forehand from the left zone of the court at a distance between 1.37 and 2.74 m. From the centre of the court, with zone 3I + 2 the one from which more inside out forehands are played.

These data are similar to those found by Brabenec (2000) who pointed out that the inside out forehand allows the players to cover 65% of the court easier.

Regarding the direction of the shot, the inside out forehand is played towards two directions: crosscourt and down the line. When played crosscourt, the ball is directed to the left-hand side zone of the opponent, which coincides with his backhand. According to our data, this happens 59.9% of the shots. As per the technical execution of the crosscourt inside out forehand, Crespo (1995) suggests that the player should move around the ball so that the shoulder line exaggerates the rotation adopting a semi-open lateral position. The down the line inside out forehand is less common than the crosscourt one this is due to the fact that, after the shot, the player leaves around ¾ of the court open, and the opponent can counter attack with a forehand shot to the open court.

However, with the crosscourt inside out forehand, the counter attack from the opponent is more difficult due to the angle of the direction of the shot, and the down the line backhand from the opponent is the best response to this as is suggested by Farrell (1998). As per the technical literature, the execution of the down the line inside out forehand implies a higher technical difficulty than the crosscourt one, due to the fact that the player needs to rotate the shoulders and the hips more placing more demands on the footwork. Another aspect that is highlighted from the data obtained is that the use of the inside out forehand provides a high number of points won; 5.8% down the line and 8% crosscourt.

Another important question is related to the previous shots of opponents. The analysis of the shot previously hit to the inside out forehand shows the cause-effect relationships among two shots: the previous shot and the inside out forehand. The results show that the speed of the ball is a determining factor. In fact, when the previous shots are slower, the player has got enough time to run around his backhand and play the inside out forehand.

Another determining factor is the direction from where the previous shot comes, as indicated by the experts interviewed. When the direction is diagonal, when it comes from the opponents backhand, the player leaves the most part of the court open and playing an inside in forehand (down the line), could be a good option to counter that previous shot.

When the previous shot comes from the forehand of the opponent, the use of the inside out forehand is determined by the lack of time to position due to the fact that the space of the open court is smaller than in the previous option, so that the use of the inside out forehand would be less recommended.

These two factors, speed and direction, are linked to the more usual shots that precede the use of the inside out forehand: the defensive backhand and the neutral backhand. Both shots are characterised by having less speed than the rest of the shots. These data are similar to those presented by Brabenec (2000) who indicated that when the ball is slower, the player moves to the left side to avoid playing with the backhand and to play with the inside out forehand.

The inside out forehand is mainly associated to a situation in which the player tries to cover his backhand and, to a lesser extent, to a shot associated with the change of rhythm or direction. Brabenec (1996) suggests that when the opponent directs a slow shot to the backhand zone, as much as possible, the player should move towards his left-hand side and play with an attacking forehand. Regarding another circumstances in which the inside out

forehand should or not be played, Martínez Cascales (2002) emphasises the use of this shot when the player receives a ball directed to the middle of the court. Farrell (1998) on another hand, points out that when the incoming ball has a higher bounce, the inside out forehand should be used as an attacking shot. Dent (1996) already considered it as an attacking shot.

Finally, when analysing the use of the inside out forehand in the return of serve, according to our data, this shot is used as a return when the serve is directed towards the left zone of the service box, mostly during the second serves and in break-point situations in order to return the serve with an offensive tactical intention.

From the tactical point of view, the data obtained indicate that the main tactical consequences derived of the use of the inside out forehand are firstly, the transition shots, secondly the change of rhythm, and thirdly the winning shots. As per the errors and the approach shots, they do not reveal to have a relevant consequence.

The transition shot is the main tactical consequence derived from the use of the inside out forehand. Our data are similar to those obtained by Miller, Carré, Dixon, and Starbuck (2015) who indicate that the inside out forehand has both an objective related to the transition of the point and to protect the backhand.

On the other hand, the rhythm changes are the second tactical consequence derived from the use of the inside out forehand. The positioning of the player on the back of the court allows him to hit the ball at a higher speed in order to change the rhythm of the rally and a possible unbalance in the exchange of shots to his advantage. This result mirrors the opinion of Baiget (2011) who also refers to the relevance of both the positioning of the player on court and the quality of the shot as crucial aspects in the change of direction and acceleration of the forehand.

These data are also consistent with the views of Dent (1996) who stresses the inside out forehand as an excellent option to be aggressive during a match and with the French Tennis Federation (2001) that believes that in the 80s the inside out forehand starts to be used with an attacking tactical intention. Our results confirm the influence of this shot in the attacking game, both as a winning shot and as a shot used to change the rhythm of the rally. Other authors such as De Subijana and Bielsa (2010) point out the importance of using the forehand from ¾ of the court, as often as possible, in order to attack.

Our data show that there are significant differences between the impact zone of the inside out forehand and the derived tactical consequence, so that the position of the player on the left-hand side of the court determines different tactical consequences of the use of the inside out forehand. As mentioned in the Methodology section, the process of recording data related to the impact zone and the tactical consequences derived from the shots has followed the proposal of the different zones of the tennis court.

Regarding the percentage of winning shots, it is observed that the more the player hits the inside out forehand to the outer zone of the court (3I-Ext), the higher is the percentage of winning shots with the inside out forehand. On the contrary, the winning shots are reduced when the player hits the inside out forehand from an inner court zone (4C). This situation is similar with the relationship of the use of the inside out forehand and the errors percentage, since the percentage of errors is higher when the inside out forehand is played from the outer zone of the court (3I-ext) and lower from the inner zone (4C).

It is important to emphasise that the error margin of the inside out forehands played from the outer zones of the court is higher than when played from the centre of the court due to the fact that the shot angle is reduced. This tactical action produces, on the one hand, an

increase in the percentage of errors but, at the same time, if the shot is accurate, it becomes a winner. On the other hand, from the centre of the court the margin of error is lower with the number of errors being lesser as compared to the one from the outer zones of the court.

As per the relationship between the percentages of the transition shots and the change of rhythm shots, it is relevant to point out that as the player hits the inside out forehand from positions that are closer to the centre service mark, the percentages of transition shots obtained are higher than those of change of rhythm.

On the contrary, the more the player is far from the centre of the court, the higher are the percentages of the change of rhythm shots and the lower the percentages of the transition shots.

Zone 3I + 2 can be highlighted from the rest as the zone from which the higher number of transition and change of rhythm shots are played. This result is similar to the one obtained by Ferrauti and Weber (2001) who observed that around 80% of the total number of shots played during a match are hit at a distance shorter than 3 m from the centre service mark.

Data obtained by Kovacs (2009) support our results since this author found that the majority of ATP players usually move laterally from the centre service mark of the tennis court up to 0.90–1.50 m to their left. The zone 3I + 2 implies a lateral displacement of the player between 1.27 and 2.54 m from the centre service mark. Due to this, the zone 3I + 2 seems to appear as a favourable space to play the inside out forehand.

5. Conclusions

Data obtained in our study show that the inside out forehand is used as a tactical weapon to counter the shots directed to the left-hand side zone of the court. The inside out forehand counts up to 14% of the total shots of a tennis match. Specifically, these shots are mostly used as a stroke that provokes a change of rhythm.

Regarding the use of the inside out forehand as an attacking shot, it has been shown that it has a determining influence on the game due to the fact that, even though this tactical intention is less common than the transition and change of rhythm shots, it has a high percentage of success. This is shown by the fact that the use of the inside out forehand as a winning shot implies one out of each three winning shots in the match. Due to this, we consider that the use of the inside out forehand is crucial to the implementation of a game tactical pattern from the baseline.

As per the consequence of the use of the inside out forehand according to the direction in which the shot is played we have been able to find that the higher number of inside out forehands is played crosscourt. However, the higher number of inside our forehand winners is played down the line.

Finally, when analysing the influence of the use of the inside out forehand on the result of the match, our data have shown that the players that hit the higher number of inside out forehands are the ones that win the match. Likewise, the players that hit a higher number of winning shots with the inside out forehand, win the match.

This last data could be used as valuable information to predict match results. However, it should be confirmed with a wider sample of matches using a validation process through the appropriate statistical analyses in order to establish the possible relationship between the number of inside out forehand shots in a match and the possibility of being the winner of the match.

6. Practical applications

The results show that the use of the inside out forehand has multiple consequences and, especially, the relationship between the use of the inside out forehand and the impact zone since it has been shown that as the player moves away laterally from the centre of the court, the percentage of transition shots is reduced, while the percentage of winners and errors increases.

These data have derived in the proposal of a *spatial framework,* which will be called the *inside out forehand quadrant*, that establishes the relationships between the inside out forehand and the tactical consequence derived of its use (transition shot, approach shot, change of rhythm shot, winners and/or errors).

With this goal in mind, based on the five zones analysed beforehand in the Methodology section, five subzones were established taking as reference the court width (10.97 including the doubles alley). As the observed zone is the left side of the baseline, the total distance has been divided into two halves, left and right, resulting a zone of 5.48 m.

Moreover, the observable zone (5.48 m) has been subdivided into 4 equidistant zones at 1.37 m, being 4C the first one and, from this zone, the following zones have been established: 3I + 1, 3I + 2, 3I + 3 and 3I-Ext, being 1.37 m the distance among the zones.

The observations of the study have allowed us to establish a cause-effect relationship between the impact zone of the inside out forehand and its consequence. According to the data obtained, the relationship between the impact zone of the inside out forehand and its consequence is the following:

Zone 4C: transition shots

Zone 3I + 1: transition shots

Zone 3I + 2: approach shots

Zone 3I + 3: change of rhythm shots

Zone 3I-Ext: winners /errors

The spatial quadrant of the inside out forehand proposes the possibility that this same relationship between the use of the inside out forehand and its consequence, could also happen when moving towards the net. Thus, the relationship would be:

Zone 4C: transition shots

Zone C + 1: transition shots

Zone C + 2: approach shots

Zone C + 3: change of rhythm shots

Zone C-Ext: winners /errors

Regarding the graphic representation, the centre of the court has been determined (4C) and the left side zones are: 3I + 1, 3I + 2, 3I + 3 and 3I-Ext, for the lateral movements and the zones C + 1, C + 2, C + 3 and C-Int., for the movements towards the net. The naming used refers to the inside out forehand shots from the left zone, in which the number refers to the zone of the court, the letter refers to the side of the court, and the digit refers to the

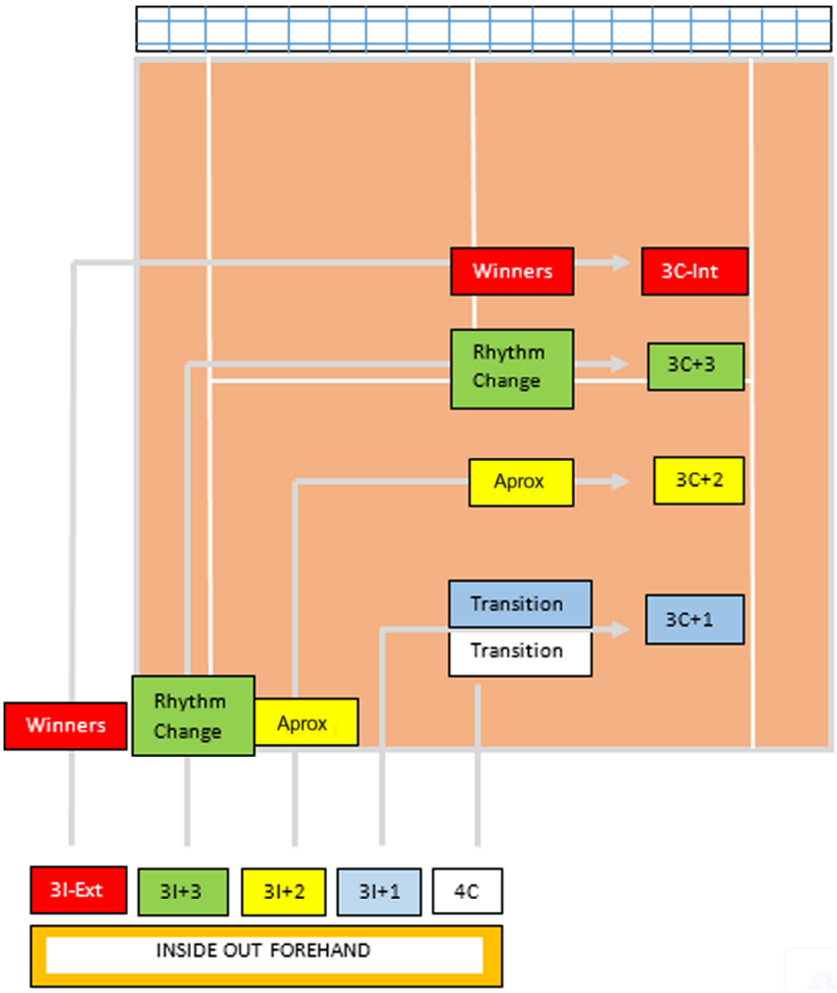

Figure 3. Distribution of the impact zones according to the consequences of the use of the inside out forehand.

distance from the centre of the court. Thus 3I + 1 means an inside out forehand player from zone 3, left, at 1.37 m from the centre.

As per the movements towards the net, C + 1 means an inside out forehand from the central zone at 1.37 m from the centre of the baseline (Figure 3).

In summary, this spatial framework of the inside out forehand allows to establish that

> when the inside out forehand is played from central zones, the player tends to play a less risky shot, but as the player moves away from the centre of the court, there is a more attacking intention in the use of the inside out forehand. Thus, the zone of the centre of the court would be related to a so called "safety zone" and the zones further away from the centre would be a "risky zone".

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Altman, D. G. (1990). *Practical statistics for medical research*. New York, NY: RC Press.

Baiget, E. (2011). Strength training for improving hitting speed in tennis. *Journal of Sport and Health Research, 3*, 229–244.
Blandón, A. (2008). *Diccionario ilustrado del tenis* [Illustrated tennis dictionary]. Colombia. Ed. Todográficas Ltda.
Bolletieri, N. (2000). *Killer forehand, ballistic backhand and tenacious net play* [Video]. Champaign, IL: Human Kinetics.
Brabenec, J. (1996). If a player knows how, then when is the important question. *ITF Coaching and Sport Science Review, 10*, 7–8.
Brabenec, J. (2000). Why the forehand is a key stroke? *ITF Coaching and Sport Science Review, 21*, 11–13.
Campos, J. (2013). Field Athletics. In T. McGarry, P. O'Donoghue, & J. Sampaio (Eds.), *Routledge handbook of sports performance analysis* (pp. 464–474). London: Routledge.
Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*, 37–46.
Crespo, M. (1995). Tactical goals for different skill levels: A step by step plan. *ITF Coaching and Sport Science Review, 6*, 8–10.
Dent, P. (1996). Coordinate to accelerate. *ITF Coaching and Sport Science Review, 8*, 6–7.
De Subijana, C., & Bielsa, R. (2010). *El entrenador personal del tenis*. Madrid: Pila Teleña.
Farrell, P. (1998). The short ball. *ITF Coaching and Sport Science Review, 16*, 4.
Federation Français Tennis. (2001). *Le coup droit* [Vidéo]. Paris: DTN FFT.
Ferrauti, A., & Weber, K. (2001). Stroke situations in clay court tennis. Unpublished data.
Haberman, S. J. (1973). The analysis of residuals in cross-classified tables. *Biometrics, 29*, 205–220.
Huys, R., Cañal-Bruland, R., Hagemann, N., Beek, P. J., Smeeton, N. J., & Williams, A. M. (2009). Global information pickup underpins anticipation of tennis shot direction. *Journal of Motor Behavior, 41*, 158–171.
Huys, R., Smeeton, N., Hodges, N. J., Beek, P. J., & Williams, A. M. (2008). On the dynamic information underlying visual anticipation skill. *Attention, Perception and Psychophysics, 70*, 1217–1234.
Kovacs, M. (2009). Movement for tennis: The importance of lateral training. *Strength and Conditioning Journal, 31*, 77–85.
Martínez Cascales, A. (2002). Táctica para tenis avanzado sobre tierra. *ITF Coaching and Sport Science Review, 27*, 9–11.
Miller, S., Carré, M. J., Dixon, S. J., & Starbuck, C. (2015). The influence of tennis court surfaces on player perceptions and biomechanics response. *Journal of Sports Sciences,* 1–10.
Pieper, S., Exler, T., & Weber, K. (2007). Running speed loads on clay and hard courts in world class tennis. *Medicine Science Tennis, 12*, 14–17.
Reid, M., Elliot, B., & Crespo, M. (2013). Mechanics and learning practices associated with the tennis forehand: A review. *Journal of Sports Science and Medicine, 12*, 225–231.
Roetert, E. P., & Groppel, J. L. (2001). Mastering the kinetic chain. In E. P. Roetert, & J. L. Groppel (Eds.), *World class tennis technique* (pp. 99–113). Champaign, IL: Human Kinetics.
Smeeton, N. J., Huys, R., & Jacobs, D. M. (2013). When less is more: Reduced usefulness training for the learning of anticipation skill in tennis. *PLoS ONE, 8*, e79811. doi:10.1371/journal.pone.0079811
Taylor, M., & Hughes, M. (2002). A comparison of patterns of play between the top under 18 junior tennis players in Britain and in the rest of the world. In A. Lees, I. Maynard, M. Hugues, & T. Reilly (Eds.), *Science and racket sports II* (pp. 260–264). London: Blackwell Science.