Exploring Game Dynamics in Padel: Implications for Assessment and Training

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Abstract

Courel-Ibáñez, J, Sánchez-Alcaraz Martinez, BJ, and Muñoz Marín, D. Exploring game dynamics in padel: implications for assessment and training. *J Strength Cond Res* 33(7): 1971–1977, 2019—A better understanding of in-game competition demands potentially improved coaching strategy and quality. However, there is very limited information about game patterns in padel, a very modern racket sport born in the 70s. The purpose of this study was therefore to quantify and classify game dynamics during the match in professional padel players through a multivariate decision tree approach including technical, spatial, and effectiveness indicators. The results determined 3 main game styles strongly defined by the court zone (net, middle, and baseline). In addition, particular technical, spatial, and effectiveness indicators were identified in each zone. In net and middle areas (offense) stood the use of volleys and overhead strokes on the center lane to both keep a positional advantage and solve the point. Conversely in the baseline (defense), the use of corner side walls and the domain of lobs showed to be relevant. The high rate of backhand groundstrokes, involving over 4 of 10 actions, is also remarkable. This information may have relevant implications for coaches working in padel by providing a novel hierarchically organization of game dynamics, which helps in designing training and conditioning programs close to real competitive situations.

Key Words racket sports, match analysis, behavior, tactics

Introduction

Padel is an intermittent, doubles racket sport played in pairs (2 vs. 2) into a small-sized grass court (20 × 10 m) surrounded by glass and mesh walls in which the ball can bounce on. Previous investigations in padel reported rally durations of 9 seconds in average, in which players hit the ball once per second in frequency (7,8). In this context, match activity increases by means of long rallies and great number of groundstrokes. However, the low intensity of actions and the short resting interval time results in lower effort index in padel compared with similar racket sports (5,16).

In just a few decades since its creation, padel has risen to the top-10 most practiced sports in Spain and counts with more than 4 million regular practitioners (9). Nowadays, this sport is continuously spreading in Europe, with international presence in 27 countries around the world (19). Evidence of this impact is the presence of professional tournaments in Spain, Portugal, Holland, Andorra, Sweden, Belgium, Argentina, USA, Italy, Monaco, and United Arab Emirates (34). This growth of interest can be explained because padel combines a high-interactivity between players with a low-intensity of actions (7,8). As a consequence, players are more involved in the game and so enjoyment and motivation increases, which leads to a greater adherence to practice in both recreational and competitive environments (10).

Previous researches have examined game performance in professional padel competitions to detect technical-tactical actions that result in more effective outcomes (7,8,31). Authors suggest that offensive-defensive aims in padel are strongly defined according to players' spatial location (net, middle, and baseline). More specifically, offensive effectiveness is related with a high scoring rate from the net while the defense is focused on sending the opponents at the baseline (7). In this fight for a positional advantage, players are constantly moving from the back (defensive phase) to the net (offensive phase) passing through the middle (transition), and vice versa, and so a variety of specific displacements and behaviors emerged (26,31). However, the identification of effective game patterns in padel is an issue still to be addressed for practical purposes.

A better knowledge of players' performance adaptations and game dynamics during the match is extremely useful for optimizing the training process, as it assists coaches in setting up specific targets, provides supporting data for the load adjustment and improves feedback quality (11,13). There is, however, a limited practical applicability of current padel performance reports as rely mainly on the final action (the

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Table 1. Criteria used to conduct the analysis of actions regarding technical, spatial, and effectiveness indicators.

Performance indicator	Criteria
Technical action	
Groundstroke type	Direct: hit after bouncing in the ground
	Volley: hit before bouncing in the ground
	Wall: hit after bouncing in the back or side walls
	Smash: overhead shot with the racket facing the ground
	Bandeja: a sliced smash with the racket facing up
Groundstroke swing	Forehand: hit with the fore side of the paddle
	Backhand: hit with the back side of the paddle
Groundstroke height	Straight: regular stroke where the ball is lifted above the net
	Lob: stroke where the ball is lifted high above the net
Spatial location	
Depth	Net: from the net to the grille zone (4 m long)
	Middle: from the 4-m grille zone to the baseline (3 m long)
	Baseline: from the baseline to the back wall (3 m long)
Laterality	Right side: closest area to the right wall (3 m width)
	Center: central lane (4 m long width)
	Left side: closest area to the left wall (3 m width)
Effectiveness	
Outcome	Winner: the action solves the point by a direct score
	Continuity: the action maintain the ball in game
	Forced error: the opponent's action forced the attacker to miss after hitting the ball in unbalance, hitting back a high-speed ball, or hitting very close to the wall.
	Unforced error: the action is missed

groundstroke that solves the point) regardless of explaining the chain of previous events that led to it (6). Therefore, what is now required is to provide solid descriptions of players' game patterns and dynamics to a better understanding of what and why is happening during the match (23). This information should be subsequently used in designing competition-specific practice environments to improve players' conditioning, skills, and responses in the match (2,3).

In this task of extracting data from real competitive situations to the design of applied and specified prevention and conditioning sports programs, it is desirable developing automated classification methods such as decision trees analyses (14). These techniques yield a hierarchical estimative model of significant interaction between performance-related factors and grouped then in roots and nodes (21). This classification allows generating action plans (if-then rules) by following the paths from the model (27). For instance, if the opponent is on the baseline and hits the ball in the backhand zone then the probability of using lobs increases; hence, if our players are near the net and the opponent uses a lob then overhead groundstrokes from the net/middle enhance winning chance. A proof of its feasibility is that researches are successfully performing these methods in the recent years for sports training and performance assessment purposes (29).

Despite understanding in-game competition demands potentially improves coaching strategy (18,32), there is very limited information about technical-tactical patterns during a padel match. To this purpose, we aimed to quantify and classify game dynamics in professional padel players through a multivariate decision tree approach including technical, spatial, and effectiveness indicators. Such knowledge may have implications in designing accurate training drills and conditioning programs close to real competitive situations.

Methods

Experimental Approach to the Problem

To comprehend players' performance in different game settings would help coaches in improving periodization, training, and competition management. Thus, technical, spatial, and effectiveness indicators were assessed through systematic observation of the competition. These methods provide an objectively assessment of emerging players' responses within a natural competitive environment. The data obtained were processed using an automated classification method such as the decision tree analysis, which provides an insightful explanation of the data and its usefulness in practical settings.

Subjects

Four professional male padel players participated in this study (mean [*SD*] age: 31.5 [4.5] years; height: 179.7 [3.5] cm; mass: 77.8 [2.3] kg) and voluntarily provided written informed consent. Participants had more than 5 years of

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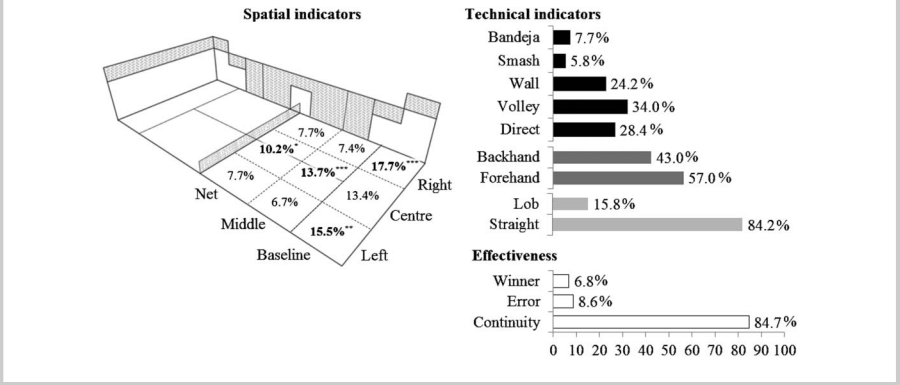

Figure 1. Distribution of actions regarding technical and spatial indicators. Adjusted standardized residual significant positive association = *little (1.96–2.58); **weak (2.58–3.29); ***strong (over 3.29).

experience competing in the professional level, the World Padel Tour (WPT 2014) and were in the competitive period at the time of the study. Matches contested the same 2 pairs of players ensuring a similar competitive level (i.e., no more than 1 ranking position of difference between). Groundstroke-by-groundstroke actions were registered from 3 matches following the official rules of the International Padel Federation (https://www.padelfip.com/documentacion). The matches took place in June in the late afternoon in an indoor padel club. Players ate a high-carbohydrate meal approximately 3 hours before the match. During the matches, water intake was allowed ad libitum in the resting periods as specified in the rules. No injuries were reported. The Ethics Board of the University of Murcia reviewed and approved the study.

Procedures

Game dynamics were analyzed regarding the technical (groundstroke type, swing, and height), spatial (depth and laterality), and effectiveness indicators (7,16,31) as described in Table 1.

Data were collected through systematic observation using the Lince video analysis software (15). The Kinovea software (V.0.8.15; Kinovea open source project, www.kinovea.org) was used to place a 9-square grid over the image to ensure

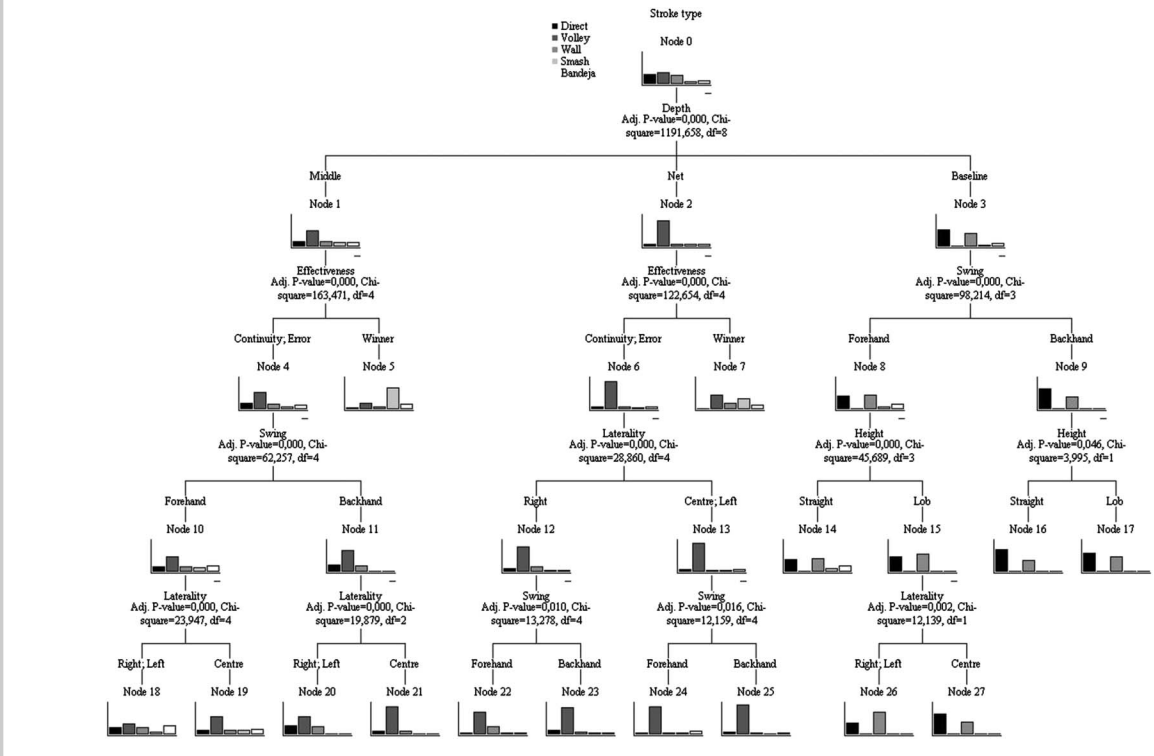

Figure 2. Classification tree model of game dynamics in padel according to technical, spatial, and effectiveness indicators.

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Table 2. Distribution of actions in nodes regarding groundstroke type (direct, volley, wall, smash, and bandeja), court depth (net, middle, baseline), court laterality (left, center, and right), swing (forehand and backhand) and stroke height (straight and lob).*†

			Groundstroke type (%)					
	Node/Category	*n*	Direct	Volley	Wall	Smash	Bandeja	Total
1	Middle	545	14.9	48.3‖	13.9	11.7‖	11.2‖	27.7
4	+Continuity/error	490	16.3§	51.8‖	14.9	5.9	11.0	24.9
10	++Forehand	303	14.5	44.2	13.9	9.6‖	17.8‖	15.4
18	+++Right/left	128	18.8§	31.2	18.8‡	6.2	25.0§	6.5
19	+++Center	175	11.4	53.7‖	10.3	12.0‡	12.6	8.9
11	++Backhand	187	19.3	64.2‖	16.6	0.0	0.0	9.5
20	+++Right/left	120	25.8§	52.5	21.7‡	0.0	0.0	6.1
21	+++Center	67	7.5	85.1‖	7.5	0.0	0.0	3.4
5	+Winner	55	1.8	16.4	5.5	63.6‖	12.7	2.8
2	Net	503	4.4	80.3‖	6.4	4.4	4.6	25.6
6	+Winner	51	0.0	41.2	17.6‖	31.4‖	9.8‡	2.6
7	+Continuity/error	452	4.9	84.7‖	5.1	1.3	4.0	23.0
12	++Right	134	7.5	75.4	12.7‖	2.2	2.2	6.8
13	+++Forehand	61	3.3	68.9	23.0‖	3.3	1.6	3.1
22	+++Backhand	73	11.0	80.8	4.1	1.4	2.7	3.7
23	++Center/left	318	3.8	88.7‖	1.9	0.9	4.7	16.2
24	+++Forehand	142	3.5	84.5	1.4	2.1‡	8.5§	7.2
25	+++Backhand	176	4.0	92.0‡	2.3	0.0	1.7	9.0
3	Baseline	916	49.6‖	0.0	40.1‖	3.1	7.3	46.6
8	+Forehand	529	63.6‖	0.0	42.7‡	5.3‖	12.7‖	26.9
14	++Straight	381	37.0	0.0	38.1	7.3‖	17.6‖	19.4
15	++Lob	148	43.3	0.0	54.7‖	0.0	0.0	7.5
26	+++Right/Left	87	33.3	0.0	66.7‖	0.0	0.0	4.4
27	+++Center	61	62.3‖	0.0	37.7	0.0	0.0	3.1
9	+Backhand	387	39.3	0.0	36.4	0.0	0.0	19.7
16	++Straight	276	66.7‖	0.0	33.3	0.0	0.0	14.1
17	++Lob	111	55.9	0.0	44.1‖	0.0	0.0	5.7

*Nodes divisions: +first root, ++second root, +++third root.
†Values expressed in percentages.
‡Adjusted standardized residual (ASR) significant positive association = little (1.96–2.58).
§ASR significant positive association = weak (2.58–3.29).
‖ASR significant positive association = strong (over 3.29).

proper encoding of players' spatial location. The court lines and walls (2 m width each) were used as visual references. Six observers specialized in padel were specifically trained for these tasks during 4 weeks, accumulated a minimum of 20 hours of experience through 10 sessions of 2 hours each one.

Data reliability was calculated by computing interrater and intrarater kappa measures. Free-marginal kappa for multiple raters (28) was used to test technical and effectiveness indicators, obtaining a minimum score of $k = 0.83$. Weighted kappa (30) was calculated to test spatial indicators, counting disagreement in continuous borders as a third of an agreement (e.g., middle-center vs. middle-right zone). Values obtained raised from $k = 0.77$ to $k = 0.84$. Intraobserver evaluation at the end of the observation process was done by Cohen's Kappa calculation to guarantee consistency of data obtained, obtaining a minimum score of $k = 0.88$. According to Altman (1), kappa values obtained were considered as very good strength of agreement ($k > 0.80$).

Statistical Analyses

Decision tree analysis was conducted to classify game actions according to technical, spatial, and effectiveness indicators. Groundstroke type was considered the dependent variable with the resting indicators (groundstroke swing, groundstroke height, court depth, court laterality, and effectiveness) as predictors. Significance of if-then rules was identified using the exhaustive CHAID algorithm. Pruning technique was executed to ensure results consistency (27), considering following inclusion criteria: (a) nodes with more than 100 iterations, (b) minimum change in expected cell frequencies of 0.001, and (c) Pearson χ^2 significance level set at $p \leq 0.05$. Strength of associations was studied recurring adjusted standardized residuals (ASRs),

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considering values from 1.96 to 2.58 as little, 2.58 to 3.29 as weak and over 3.29 as strong associations. Effect size (ES) was estimated by calculating Cramer's V correlation coefficients, considering 0.10 = small effect, 0.30 = medium effect, and 0.50 = large effect. Statistical analyses were conducted in IBM SPSS v. 20.0 for Macintosh (Armonk, NY: IBM Corp.).

Results

A total of 1963 stroke-by-stroke actions were registered regarding technical, spatial, and effectiveness indicators, distributed as shown in Figure 1. The most common groundstroke types were volley, direct, and wall (86.6%). Forehand hits stood out over backhand. Lobs accounted for less than 2 of 10 groundstrokes. Interestingly, almost half of the actions (46.6%) occurred at the baseline, whereas the rest of the game was equally distributed between the middle (27.7%) and the net (25.6%). Lateral space was similarly used in the sides (30.5% and 32.1%), with a slight majority in the center (37.4%). More precisely, side corners had a significant relevance in the baseline, whilst the center predominates in middle and net areas.

A summary of the classification tree analysis is displayed in Figure 2. A total of 27 nodes from 14 divisions were significantly classified the groundstroke types according to technical, spatial, and effectiveness indicators. The most powerful classification came from the court depth (node 0: $p < 0.001$; ES = 0.55), branching the tree main roots: middle, net, and baseline. First, middle area groundstrokes (node 1) were associated with effectiveness (nodes 4–5: $p < 0.001$; ES = 0.39), swing (nodes 10–11: $p < 0.001$; ES = 0.36), and laterality (nodes 18–19: $p < 0.001$; ES = 0.22; nodes 20–21: $p < 0.001$; ES = 0.24). Second, net area groundstrokes (node 2) were associated with effectiveness (nodes 6–7: $p < 0.001$; ES = 0.36), laterality (nodes 12–13: $p < 0.001$; ES = 0.25), and swing (nodes 22–23: $p = 0.010$; ES = 0.32; nodes 24–25: $p = 0.016$; ES = 0.20). Finally, baseline area groundstrokes (node 3) were associated with swing (nodes 8–9: ES = 0.33), height (nodes 14–15: $p < 0.001$; ES = 0.29; nodes 16–17: $p = 0.046$; ES = 0.21), and laterality (nodes 26–27: $p = 0.002$; ES = 0.34).

Table 2 shows the distribution of actions in nodes according to the classification tree model displayed in Figure 2. Three main game styles were distinguished regarding the court depth and the groundstroke type. The middle game (transition) was characterized by a greater use of backhand volley in the center, direct, and bandeja in the sides and smash to solve the point. In the net (offensive area), volley accounted for the vast majority of actions, mainly in the center and the left side. The baseline (defensive area) included most lobs, mainly by direct (in the center) and wall groundstrokes (sides).

Discussion

The purpose of this study was to quantify and classify game dynamics in professional padel players according to technical, spatial, and effectiveness indicators. As expected, CHAID approach was able to identify multiple patterns capable of explaining players' performance in padel. The findings showed 3 main game styles strongly defined by the court zone (net, middle, and baseline). In addition, technical, spatial, and effectiveness indicators were successfully identified in each zone. This information may have relevant implications for coaches working in padel by providing a novel hierarchically organization of game dynamics, which helps in designing training and conditioning programs close to real competitive situations.

Consistent with previous studies (7,24,31), we found a prevalence of volley, direct, and wall groundstrokes along the match (>85%). More specifically, the CHAID classification determined that the vast majority of winners (i.e., direct point) were scored by overhead groundstrokes (smash and bandeja), both in middle (76.3%) and net (41.2%) areas. This is notably considering that improvements on players' smashing capability from far distances (up to 7 meters from the net) would increase winning options in padel. Recent researches in tennis underlined the importance of training and testing overhead groundstrokes velocity and strength- and power-related variables (upper body), as well as keeping constant speed and accuracy over the match and overcome fatigue in professional stages (22,33). Among others, this implies high velocities of joint rotation that are the main causes of injury in racquet sports such as padel (25). In light of current results, future studies about conditioning programs and fitness interventions in padel are warranted.

The high effectiveness rate in overhead groundstrokes is in line with the reduced use of lobs observed (<16% during the match), as may represents a risk if bad performed so the opponent can easily smash. Specifically, the CHAID model revealed 2 particular offensive strategies to minimize the opponents' scoring options. On the one hand, sending lobs to the baseline corners, close to the walls, will keep the rivals far from offensive areas. This is important given that wall groundstrokes imply particular turns and pivoting movements aimed at facing and following the ball before the hit (26). Thus, conditioning programs in padel should include CORE, bilateral trunk rotation, and lower back motions exercises to both prevent injuries and increase performance (12). On the other hand, using volleys to protect the center lane weakness (common space between players) will impede deep balls that would force them to move back to the baseline and lose the positional advantage. Previous studies have emphasized the importance of the net-game as over 80% of points in padel are scored from there (7). In addition, our results suggest coaches taking special care on net-game actions to keep an offensive position particularly defending the center lane.

A novel contribution of the current study is the analysis of the use of the space in padel. According to our finding, the defense should be focused more attention to the side back corners (33% of the game), while the center lane gained

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relevance during the offense, in middle and net areas (25% of the game). This seems to confirm motion-analysis results of Priego et al.(26), who reported the highest occurrence in lateral and diagonal displacements in padel. In addition, our results suggested that this players' central approaching to the net responds to the double aim of protecting the weakness space between players and taking advantage of the wider angle from the center to increase scoring chance, similar to the doubles tennis strategy (4). Thus, a better ability of volleying in the center lane will allow players to spend more time at the net, enhancing scoring and winning options.

In regard to the swing, our findings showed a prevalence of forehand actions along the game (13% more) compared with the backhands, probably as forehand groundstrokes increase drive speed maintaining a great level of control (17). What seems to be more interesting is the greater use of backhand strokes in padel (47%) particularly in volley and wall groundstrokes. A greater effectiveness of the backspin in backhand volleys, linked with a particular strategy to send the ball to the opponents' backhand sides in the baseline (center lane for the right player and left corner for the left player) may explain these findings. Nevertheless, future research should examine this relationship in more detail and consider potential risks of wrist and elbow injuries due to an overuse of backhand actions (20).

Some limitations to the study should be noted. First, we did not take into account the volume of actions per players, which makes difficult to make individualize data interpretations. Second, we are not able to provide information of players' reactions to specific situations (e.g., how to defend a deep ball in the center lane). These issues are required to be addressed in near future to solve competition problems in line with the current development of research methods in sports performance analysis (18).

Practical Applications

This adds novel insights into the growing body of knowledge of in padel training and assessment, providing for the first time a multivariate classification of game dynamics. Such knowledge may have implications in enhancing quality and accuracy of training drills and conditioning programs based on specific match activity and technical-tactical demands. In this sense, our findings suggest coaches to include at least a 40% of backhand strokes exercises, particularly involving volleys (on the net) and balls bouncing on the walls (on the baseline). Regarding the use of space, the center lane gain importance during the offense phase both to approach and keep the positional advantage near the net. On the other side, the lateral corners should be specially trained during the defense. The domain of overhead strokes (smash and bandeja) to increase the scoring rate is remarkable. This implies special attention to upper-body power and strength in padel conditioning sessions, both to prevent injuries and increase performance.

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