Original Article

An offense without verbal signals: decision-making skills of a ball handler in a pick and roll offense in the basketball champions league

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Abstract
Pick and roll is an offense without verbal signals. The present work attempts to investigate the decisions taken by the ball handler in the direction of the motion in different type of pick, re-screen, screener body placement (chest-back), finishing at top-of-key, right, and left side, in four different variations (roll, pop, slip, stretch the trap). The sample consisted of the 16 teams that participated in the 2016-2017 season of the FIBA Basketball Champions League (BCL). Analyses of the ball handler in a total of 2507 pick-and-roll plays were performed in the regular season, play-offs and final four. The software Synergy Sports Systems was used to analyze the data. Classification tree analysis was used to identify which combination of variables better predict effectiveness by the ball handler in a pick-and-roll offense. Results indicated that, when the ball handler choosing to the left direction of motion after a slip pick, pick and pop and stretch the trap at the top of the key and left side of the court achieve better effectiveness comparing to the right side. Finally, it was made apparent that the ball handler affects the offense, which in turn affects the effectiveness of the teams.
Key words: team sports, performance indicator, performance analysis, classification tree analysis

Introduction

In basketball, the strategy in offense has been characterized by the continual motion of the players and their cuts toward the basket, which lead to countless picks among the players. Coaches, at all levels, having the full responsibility for the performance of the team, confront a number of challenges regarding the designation of the type of offense they should use during a season of competition. One of the main challenges for the researchers and coaches is the detection and prediction of effective team cooperation or individual behaviors, aiming at more effective execution against the opponent (Garganta, 2009). Thus, performance indicators are used for the estimation of the performance of an individual or team (Drust, 2010; Hughes & Bartlett, 2002) and the assessment of performances on selected indices of the offense or defense helps coaches identify the successful or failed executions, at an individual or team level (Sampaio & Janeira, 2003).

Pick and roll is an offense without verbal signals. This kind of offensive tactic is used at every level of expertise in basketball: from youth basketball games (Ortega, Cárdenas, Sainz de Baranda, Palao, all the way up to high class professional teams (van Maarseveen, Savelsbergh, & Oudejans, 2018; Lorenzo Calvo, Menéndez García, & Navandar, 2017; Vaquera, García-Tormo, Gómez Ruano, & Morante, 2016; Gómez, Battaglia, Lorenzo, Lorenzo, Jiménez, & Sampaio, 2015; Lamas, Junior, Santana, Rostaiser, Negretti, & Ugrinowitsch 2011; Wang, Liu, & Moffit, 2009). The most important offensive cooperation in the last decade is the action in which an offensive player (" screener") sets up a pick to another offensive player who has control of the ball ("ball handler") (Lamas et al., 2011; Remmert, 2003). However, an interesting question is how the "ball handler" communicates, cooperates, and decides the offensive movements and penetrations without the use of verbal signals, in a restricted time frame and in a relatively small space of execution, with many supporting and defending players in the same region.

Decision-making by the ball handler is a dynamic process, in which it is necessary that mental and physical effort is combined. The decisions that the ball handler makes usually comprise either executing a quick shot, or penetrating the defense toward the basket. Marmarinos, Apostolidis, Kostopoulos, & Apostolidis, (2016), observed that the ball handler is more effective while drives to the basket (10, 85%) rather than shooting a 2 or 3-point shot, (7,33%). In addition, Gomez et al., (2015) stated that the ball handler is more successful while he uses penetrations to the basket, (26, 1%). The perception, prediction, and execution are essential features, of equal value in offensive cooperation (van Maarseveen et al., 2018; Gorman, Abernethy, & Farrow, 2013; Roca, Ford, McRobert, & Williams, 2011; Knight, 1989). When the ball handler focuses on an image, this doesn't imply that he will react according to it (Knight, 1989). The ball handler's role is to have the opportunity

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to respond in great speed and to make quick and accurate decisions, leading to the effectiveness of his team (Brown, 1995).

Ever since basketball was introduced, there have been three main types of offense: (a) Patterned offense, post up plays (Ociepka & Ratermann, 1995); stack set (Reiter, 1995), post-up plays (Ociepka & Ratermann, 1995); (b) Passing game offense (Knight, 1989; Calipari, 1996) and (c) Continuity offense, shuffle offense (Smith, 1981), back-dooring into a motion offense (Stavropoulos, 2002), simple-motion, double-motion (Kuchar, 2005), triangle offense (Jackson & Winter, 2009), However, if for some reason, the offensive players committed an error in the basketball cuts toward the basket, or the defenses forced the offenses to miss their positions, there appeared the cooperation of two players in pick-and-roll to complete the offense. Almost all offenses have pick-and-roll actions at the end of the attack on basketball (Huciñski & Tymañski, 2006).

Pick-and-roll and its variations (pop, slip, stretch the trap) create such confusion to the defense that hardly any other offenses create, the result of which is that spying by opponent coaches becomes difficult. This is due to the differing sides of positioning of the pick to the defender while guarding the ball handler. There are two very important elements in this offense, which are: the motion of the ball handler (right-left), and the motions of the players without the ball. Obviously, this offensive action is characterized by continuous motion (Perše, Kristan, Kovačič, Vučkovič, & Perš, 2009). Action in pick-and-roll is very fast, and for this reason the synchronization of the moves of the offensive players is very important, so that the defensive players are not given enough time to react. It is also worth mentioning that it does not suffice that the players are effective in their roles, but that there is communication and cooperation among them, and also with the rest of their team-mates (Krause, 1991). It is necessary that the players who participate in the pick-and-roll offense know the weaknesses of each other (Calipari, 1996) and to be able to change roles, if needed. In regard to area of execution, Mattheos, Evangelos, Georgios, & Georgios, (2010), noticed that the majority of the Greek National team created pick-and-roll actions at the top of the key, (55,5%). According to Marmarinos et al. (2016), the ball handler finishes at the end of offensive positions (43%). A defensive mismatch situation can be created when the ball handler accepts a correct pick from his team-mate and penetrates from the right or left side toward the basket (Lorenzo Calvo et al., 2017). According to Remmert (2003), the use of direct pick provides more space and better shooting opportunities. Necessary also is that ball handlers and cutters realize what is happening in each phase of the game, and it is important that players recognize the role they play in a pick-and-roll offense (Ociepka & Ratermann, 1995). The difference between a good ball handler and a very good player is the ability of the latter to create by himself the best conditions for a shot or penetration toward the basket, as well as to create favorable offensive situations for his team-mates (Hill, 1999).

In basketball the pick-and-roll action is described as a frequent, effective, and interesting option in offense. The present research attempts to examine the decisions made by a ball handler who participate in pick-and-roll under pressure, without using verbal signals. Did they choose the correct direction toward the basket? Were the offensive movements correct after the screen? What was the use of the screen, re-screen in the offense? Were the preferred offensive finishing moves effective? Did the ball handler affect the outcome of his team?

Materials and Methods
Participants
The sample consisted of the 16 best teams that participated in the 2016-2017 season of the FIBA Basketball Champions League (BCL). Analyses of the ball handler in a pick-and-roll plays were performed for all games in the regular season, play-offs and final four. The teams that participated in the league and analyzed in our research were: 1) Tenerife, 2) Monaco, 3) Banvit, 4) Venezia, 5) Karsiyaka, 6) Vilerban, 7) Ludwigsburg, 8) Besiktas, 9) Sassari, 10) Neptunas, 11) AEK, 12) Oldenburg, 13) Avelino, 14) Le Mans, 15) Aris, 16) PAOK.

Measure
The software Synergy Sports Systems (Synergy Sports Technology, San Antonio, Texas, USA, 2013) was used for the analysis of the data. This software company owns the exclusive rights to offer to FIBA details on all games, in which various data and details are analyzed regarding the play of a team or the tendencies and statistics of its players.

Procedure
The study was designed to examine the effectiveness of ball handler in pick-and-roll offense in the FIBA Basketball Champions League (BCL). A total of 2507 pick-and-roll plays were analyzed. The analysis was based on the scoring outcome of success or failure of every offensive possession for the ball handler, with pick and roll plays classified into the following categories: (a) pick-and-roll, (b) pick and pop, (c) slip the pick (d) stretch the trap. For each of the four categories listed above, the ball handler movement was categorized into the following sub-categories: (1) Side of execution: top-the-key, right, left side. (2) Ball handler's movements after re-screen at top-the-key, right, left side. (3) Scoring outcome of the ball handler: lay up, 2, 3-point shot.(4) Ball handler direction of motion after: (i) re-screen at top of the key, right, left side; (ii) screener body placement (chest-back); (iii) direct right pick (DRP), direct left pick (DLP), back pick (BP) at top-the-key; (iv) side left pick

(DLP), back pick (BP), down pick (DP) at the right side of the court: (v) side right pick (DRP), back pick (BP), down pick (DP) at the left side of the court (Figure 1).
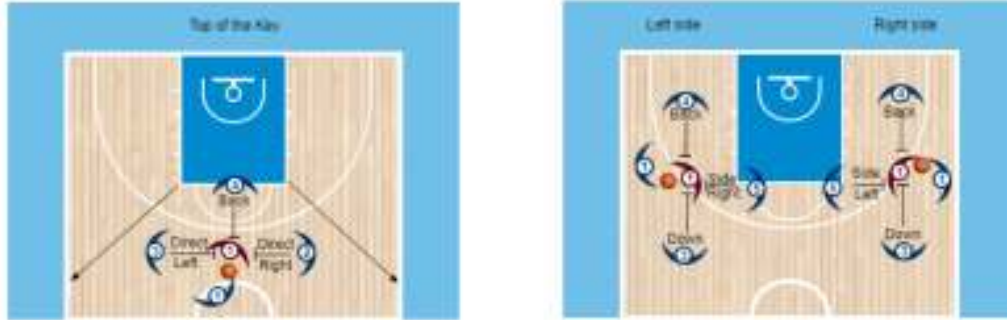

Figure 1. Side of execution and different type of pick

Statistical Analysis

For the statistical analysis, chi-square analysis was used in order to examine the decisions taken by the ball handler in the direction of the motion in different type of pick, re-screen, screener body placement (chest-back), finishing at top-of-key, right, and left side, in four different variations (roll, pop, slip, stretch the trap). Moreover, chi-square analysis was used in order to investigate if the different types of pick and the direction of motion of ball handler depend on the side of execution. Also, chi-square analysis was used in order to examine the effectiveness regarding side of execution, re-screen, ball handler direction of motion, set pick, picker body placement, variations of pick and roll and type of finishing. Finally, classification tree analysis used in order to predict the effectiveness regarding factors such as: side of execution, set pick, direction of the motion of motion, re-screen type, screener body placement, different variations of pick and roll. The CHAID method was used to define the classification tree. For all analyses, SPSS 24.0 was used and the level of significance was set at $p<0.05$.

Results

Side of execution

A total of 2507 pick and rolls were recorded (Table I). The majority of pick-and-roll executing at the top-the-key (n=1479, 59%) while 21.9% (n=550) executing in the right side and 19.1% (n=478) executing in the left side. The results of the chi-square goodness of fit test showed that there is significant variation in the preference of the side that the pick-and-roll is performing; χ^2 (3)=1817.7, p<.01. Of the 1479 attempts at the top-the-key, 43.9% (n=650) concerned a DRP, 30.3% (n=444) concerned a DLP, and 25.8% (n=650) concerned a BP. Additionally, of the 550 attempts on the right side of the court, 37.1% (n=381) was BP, 33.1% (n=182) was DP and 29.8% (n=164) was SP. Finally, of the 550 attempts on the left side of the court, 43.5% (n=208) was DP, 35.4% (n=169) was BP and 21.1% (n=101) was SP.

The chi-square test for independency showed that the pick type depends on side of execution; χ^2 (4)=15.365, p<.01. In the 2507 case of pick-and-roll was observed 373 (14.9%) cases that a re-screen used. The results of chi-square test for independency regarding the re-screen and the pick-and-roll side showed that top-the-key (n=244, 16.5%) and right side (n=96, 17.4%) are more preferred for re-screen than left side (n=33, 6.9%); χ^2 (6)=53.1, p<.001. Moreover, in the 2507 case of pick-and-roll was observed that screener prefer to move chest to the player (n=2121, 84.6%).

The picker movement is not affect by the side of execution; χ^2 (2)=1.637, p=.441. During the pick-and-roll at the top of the key the 60.7% (n=898) of ball handler move to the right. Moreover, in the case of a pick and roll in the right side of the court the 52.7% (n=290) of ball handler move to the left. In the case of a pick and roll in the left side of the court the 58.6% (n=280) of ball handler move to the right. The chi-square test for independency showed that the player direction of motion differs significantly between the three sides of execution; χ^2(2)=10.55, p<.01. Also, the results showed that the finishing style is not differ significant in three sides; χ^2(4)=6.365, p=.173.

Finally analysis regarding, side of execution, re-screen and player direction of motion showed that during the pick-and-roll at the top of the key the 51.9% (n=120) of ball handler move to the left when accepting a re-screen while the 48.1% (n=11) of ball handler move to the right. Moreover, in the case of a pick-and-roll in the right side of the court the 45.6% (n=49) of ball handler move to the left when accepting a re-screen while the 54.4% (n=41) of ball handler move to the right. On the contrary, in the case of a pick and roll in the left side of the court the 52.3% (n=34) of ball handler move to the right when accepting a re-screen while the 47.7% (n=31) of ball handler move to the left. The chi-square test for independency showed that the ball handler movement differs significantly between the three sides when accepting a re-screen; χ^2(1) 20.216, p<.01.

Table I. Frequency distribution (%) of pick and roll characteristics regarding side of execution

	Top		Right side		Left side		χ^2	Df	P
	n	%	N	%	n	%			
Set pick									
BP/BP/BP	381	25.8%	204	37.1%	169	35.4%	15.36	4	.004**
DRP/DP/DP	650	43.9%	182	33.1%	208	43.5%			
DLP/SLP/SRP	448	30.3%	164	29.8%	101	21.1%			
Re-screen									
No re-screen	1235	83.5%	454	82.5%	445	93.1%	53.1	6	.001**
Top	216	14.6%	80	14.5%	21	4.4%			
Right side	12	0.8%	13	2.4%	2	0.4%			
Left side	16	1.1%	3	0.5%	10	2.1%			
Screener body placement									
Chest to the player	1248	84.4%	460	83.6%	413	86.4%	1.637	2	.441
Back to the player	231	15.6%	90	16.4%	65	13.6%			
Ball handler direction									
Right	898	60.7%	290	52.7%	280	58.6%	10.55	2	.005**
Left	581	39.3%	260	47.3%	198	41.4%			
Variations									
P n roll	538	36.4%	229	41.6%	250	52.3%	45.42	8	.001**
Pick n pop	511	34.6%	171	31.1%	134	28%			
Slip pick	257	17.4%	100	18.2%	59	12.3%			
Stretch	173	11.7%	50	9.1%	35	7.3%			
Finishing									
Lay up	539	36.4%	226	41.1%	168	35.1%	6.365	4	.173
2 points	498	33.7%	185	33.6%	167	34.9%			
3 points	442	29.9%	139	25.3%	143	29.9%			

Note: *p<0.05; **p<0.01; df=degree freedom, χ^2=chi-square value

Side of execution, direction of motion and pick choice

The results of chi-square test for independency for the movement player regarding side of execution and pick choice show that ball handler's direction of motion depends on pick choice at the top of the key; χ^2(2)=501.7, p<.01. More in detail, if the pick-and-roll performing at the top-the-key and a DRP was chosen the majority of the players choose to move to the right (n=577, 88.8%). On the contrary, if the pick-and-roll performing at the top of the key and a DLP was chosen the majority of the players choose to move to the left (n=351, 78.3%). Moreover, if the pick-and-roll performing at the top of the key and a BP was chosen the majority of the players choose to move to the right (n=224, 58.8%).

The results of chi-square test for independency for the movement player regarding side of execution and pick choice show that ball handler's direction of motion depends on pick choice at the right side of the court; χ^2(2)=86.2, p<.01. More in detail, if the pick-and-roll performing at the right side and a BP was chosen the majority of the players choose to move to the right (n=160, 78.4%). On the contrary, if the pick-and-roll performing at the right side and a DP was chosen the majority of the players choose to move to the left (n=116, 63.7%). Also, if the pick-and-roll performing at the right side and a DP was chosen the majority of the players choose to move to the left (n=100, 61%).

Finally, the results of chi-square test for independency for the movement player regarding side of execution and pick choice show that ball handler's direction of motion depends on pick choice at the left side of the court; χ^2(2)=161.3, p<.01. More in detail, if the pick-and-roll performing at the left side and a DP was chosen the majority of the players choose to move to the right (n=180, 86.5%). On the contrary, if the pick-and-roll performing at the left side and a BP was chosen the majority of the players choose to move to the left (n=132, 78.1%). Furthermore, if the pick-and-roll performing at the left side and a DP was chosen the majority of the players choose to move to the right (n=63, 37.6%).

Effectiveness of pick and roll

The sample distribution about side of execution, re-screen, ball handler direction of motion, set pick, picker body placement, variations of pick and roll and type of finishing regarding the pick and roll effectiveness is presented in Table II. The mean effectiveness of the pick-and-roll play irrespective of the side chosen to perform is 56.4% (n=1414). The chi-square test for independency showed that the average effectiveness is the same on all three sides regardless of the other options; χ^2(2) .318, p=.853. More in detail, the effectiveness of the pick-and-roll at top of the key was 56.1% (n=830), the effectiveness of the pick-and-roll in right side was 57.5% (n=316) and the effectiveness of the pick-and-roll in left side was 56.1% (n=268). The results for the re-screen showed that effectiveness increased when a top re-screen was used (63.1% compared to 33.3% of right side and

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51.7% of left side); $\chi^2(3)$=12.223, p<.01. Moreover, types of pick and roll was significantly related with effectiveness, being the pick and pop (60.5%), slip pick (57.9%) and stretch the trap (57%) the most effective options; $\chi^2(4)$=12.345, p<.05. Finally, the finishing type was significantly related with effectiveness, being the lay-up (69.6%) the most effective options comparing with 2 points shot (47.6%) and 3 points shot (49.7%); $\chi^2(2)$=105.32, p<.01. The picker movement; $\chi^2(1)$=2.910, p=.088, ball handler movement; $\chi^2(1)$=2.678, p=.102 and set pick; $\chi^2(2)$=2.637, p=268 wasn't significantly related with effectiveness.

Table II. Frequency distribution (%) of pick and roll play effectiveness according to basic indicators.

	Made n=1414		Missed n=1093				
	%	N	%	n	χ^2	df	p
Side of execution							
Top-of-key	56.1%	830	43.9%	649	0.318	2	.853
Right side	57.5%	316	42.5%	234			
Left side	56.1%	268	43.9%	210			
Rescreen							
No rescreen	55.8%	1190	44.2%	944	12.223	3	.007*
Top	63.1%	200	36.9%	117			
Right side	33.3%	9	66.7%	18			
Left side	51.7%	15	48.3%	14			
Ball handler direction							
Right	57.8%	848	42.2%	620	2.678	1	.102
Left	54.5%	566	45.5%	473			
Set pick							
Right	56.3%	598	43.7%	464	2.637	2	.268
Left	54.6%	436	45.4%	363			
Direct	58.8%	380	41.2%	266			
Picker body placement							
Chest to the player	55.7%	1181	44.3%	940	2.910	1	.088
Back to the player	60.4%	233	39.6%	153			
Types							
Pick and roll	52.5%	534	47.5%	483	12.345	4	.015*
Pick and pop	60.5%	485	39.5%	317			
Slip the pick	57.9%	241	42.1%	175			
Stretch the trap	57.0%	147	43.0%	111			
Finishing							
Lay up	69.6%	649	30.4%	284	105.32	2	.001**
2 points	47.6%	405	52.4%	445			
3 points	49.7%	360	50.3%	364			

Note: *p<0.05; **p<0.01; df=degree freedom, χ^2=chi-square value

Classification tree analysis

The results showed that three significant influencing factors on pick and roll effectiveness (three-stage tree). The following factors led to 8 nodes of contrasting groups of pick and roll plays with different effectiveness. The model mainly defined by different variations (level 1), direction of the motion and side of execution (level 2) and side of execution (level 3). In Figure 2 are presented the results regarding the categories for effectiveness and also the 8 nodes defined by the classification tree analysis. At Level 1 the classification tree is split by the different variations of pick. Higher effectiveness was achieved when team choose to play with a pick-and-pop, slip pick or stretch (node 2: n=880, 59.1% effectiveness) comparing with the cases that team choose to play with pick-and-roll (node 1: n=534, 52.5% effectiveness); $\chi^2(1)$=10.555, p<.01. At Level 2, the classification tree analysis identified significant differences in effectiveness in cases of team choose to play pick-and-roll and in case of team choose to play pick-and-pop, slip pick or stretch. More in detail, when the team choose to play pick-and-roll significant factor is the side of execution. Higher effectiveness was achieved when ball handler choose to play at right side of the court (node 4: n=138, 60.3% effectiveness) comparing with the cases that ball handler choose to play at top-of-key or left side of the court (node 3: n=396, 50.3% effectiveness); $\chi^2(1)$=7.127, p<.05. Moreover, when the team choose to pick-and-pop, slip pick or stretch significant factor is the ball handler direction of the motion. Higher effectiveness was achieved when ball handler chooses right direction

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of motion (node 6: n=525, 61.3% effectiveness) comparing with the cases that ball handler chooses left direction of motion (node 5: n=355, 56.1% effectiveness); $\chi^2(4)=4.037$, p<.05.
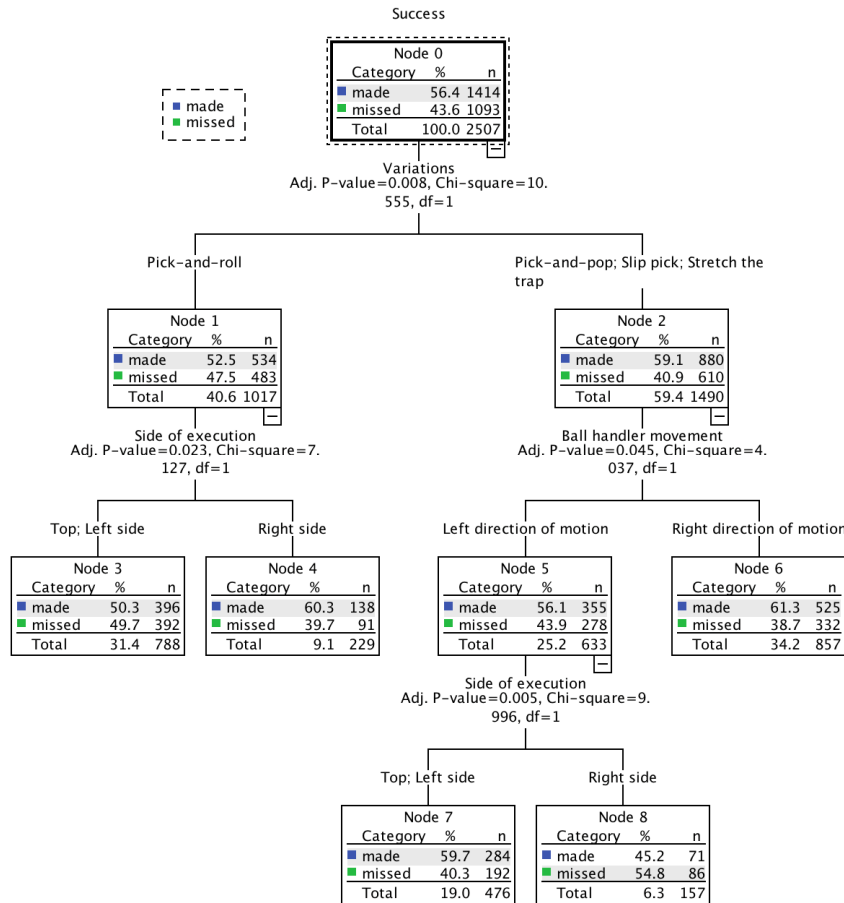

Figure 2. Classification tree analysis of ball handler effectiveness

Finally, at Level 3 the classification tree analysis identified significant differences in effectiveness when the ball handler chooses left direction of motion regarding side of execution. More in detail, the ball handler movement to the left direction of motion is more effectiveness at the top-of-key or left side of the court (node 7: n=284, 59.7% effectiveness) than the right side of the court (node 8: n=71, 45.2% effectiveness); $\chi^2(1)=9.996$, p<.01.

Discussion

The aim of the current study was to examine the decisions taken by the ball handler in a pick-and roll offense in the Basketball Champions League (BCL). The present work attempts to investigate the decisions taken by the ball handler in the direction of the ball handler's motion in different types of pick, re-screen, screener body placement (chest-back), finishing at top-of-key, right, and left side, in four different variations (roll, pop, slip, stretch the trap).

Ball handler related variables

While executing the pick-and-roll offense, it was found that more pick-and-roll plays are set up at the top-the-key than at the two sides, left and right side. This happens because the players who set up the pick-and-roll have more space and a better view of their teammates who participate in the offense. This is in line with Gomez et al. (2015); Mattheos et al. (2010) who claimed that there is more effectiveness by the teams while executing pick-and-roll plays at the top-the-key. It was also observed that the ball handler prefers to move to the right side toward the basket rather than to the left at the top-of-key. Presumably this happens because the majority of the ball handlers use their right-hand as their dominant one. Furthermore, an important finding is that the ball handler prefers to move to the left when he is on the right side. This probably happens because his space is restricted if he moves to the right toward the baseline; additionally, in this restricted space there already are defensive players. For these reasons, if he moves to the left he is given more offensive options. The opposite is true at the left side, where the ball handler prefers to move to the right for the same reasons that apply to the right side. This is in line with van Maarseveen et al. (2018) who claimed that the players use their non dominant hand on the right side of the court and the dominant hand when playing on the left.

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Our findings revealed also that the ball handler, during pick-and-roll, prefers to execute his offense more by using lay-up after a penetration toward the basket, followed by making use of a 3-point shot, whereas the 2-point shot option comes last. The present findings regarding drive are justified by the fact that the ball handler may use both directions to proceed to the basket. This finding is probably true because the ball handler wishes to create space and finish the offense as close to the basket as he can (Marmarinos et al. 2016; Gomez et al., 2015; Lamas et al., 2011).

Task related variables

While executing the pick-and-roll offense, it is observed that re-screen is set up more often at the top-the-key and right side than at the left side. The results suggest that during re-screen at the top-the-key, the first pick is set up on the right side to the defender, whereas the second one on the left side, which is the side that the ball handler moves as well. In executing re-screen on both sides of the court, the first pick is set up on the left side and the second one on the right side, where the ball handler moves as well. Regarding the left side, ball handlers avoid going toward the baseline, where there will be limited space for them to attempt their offensive moves with the non dominant hand. According to Mattheos et al. (2010) the Greek National team execute re-screen (4,4%), while the opposing teams (1,3%).

At the top-the-key, this research revealed that the screener prefers to set up the screen at DRP, DLP or BP to the defender of the ball handler. Thus, from the analysis the ball handler performing a right movement while a DRP was chosen by the screener. Presumably this happens because the majority of the ball handlers move toward the side matching their dominant hand (Maarseveen et al., 2018).Furthermore, if the screener sets up a DLP the ball handler chooses a left movement, since this allows the ball handler to move toward uses the screen by the screener and avoiding the defensive play on his dominant hand. This in line with the results of Gomez et al. (2015), who claimed that this screen is used with great efficiency. Moreover, if the screener executes a BP the majority of the ball handlers choose the right movement.

Additionally, the right side is where BP, DP and SLP is preferred while executing a -and-roll play. If the pick-and-roll performing at the right side and a BP was chosen the ball handler chooses the right movement allowing him to reach the basket faster while at the same time forces the defense to change, resulting in the creation of a mismatch situation. On the contrary, if the pick-and-roll executing at the right side and a DP was chosen the players choose to move to the left. Finally, if the pick-and-roll executing at the right side and a SLP was chosen the ball handler chooses to move to the left, a fact that allows him to avoid moving near the baseline, having more chances to create the appropriate potential scoring situations (Gomez et al., 2015; Ortega et al., 2006). On the left side, picks are set up once more with a frequency as DP, SRP, and BP. If the pick-and-roll executing at the left side and a DP was chosen the ball handler chooses the right movement. This allows the ball handler to move toward in the middle to perform an offensive move. On the contrary, if the pick-and-roll performing at the left side and a BP was chosen the ball handlers choose the left direction of motion. A fact that allows the ball handler to moving near the baseline, having more chances to create the appropriate offensive option. Furthermore, if the pick-and-roll performing at the left side and a SRP was chosen the ball handler chooses to move to the right. Chiefly, this happens because it allows the player to have more space and a better view of their teammates who participate in the offense. In Figure 3, are presented the results regarding the ball handler movement by side of execution and pick choice.
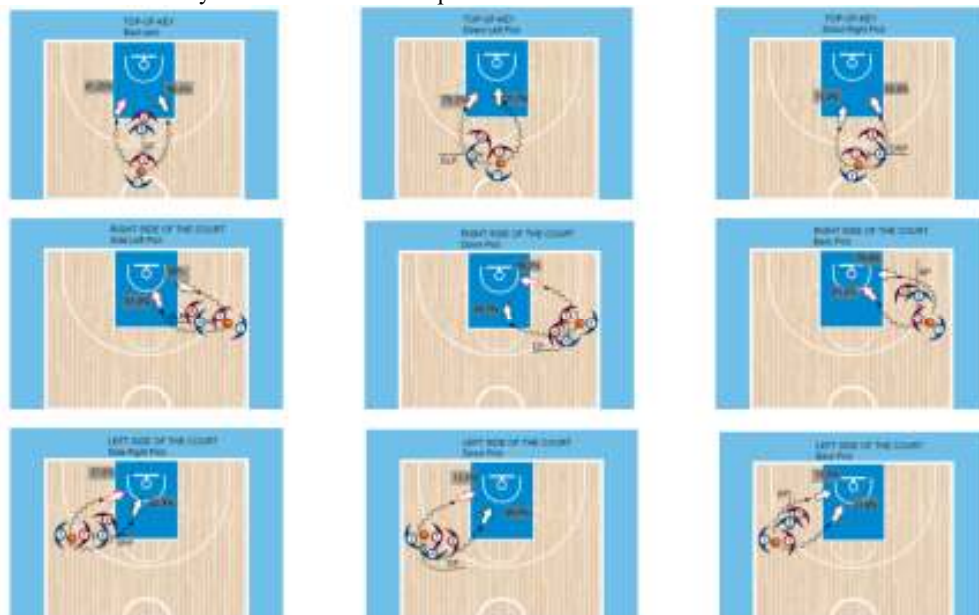

Figure 3. The effectiveness of the ball handler

Regarding the ball handler's effectiveness in the variations of executing the offense, greater success is observed in using pick and pop, followed by slip the pick, then stretch the trap, and finally by pick-and-roll. This in contrast to Mattheos et al. (2010) stated that the Greek National team execute pick and pop (2,7%), while the opposing teams (1,7%). In pick and pop, a cooperation in which the screener, after performing the pick on the defender of the ball handler, opens up away from him, to the perimeter and not toward the key. This results in a large distance between the two players who participate in the screen, and so the screener's defender is unable to give defensive help against the ball handler. Slip the pick appears to be of the greatest importance, being a cooperative offense in which the speed toward the defender for the pick and the screener's change of direction toward the basket is troublesome for the defender who guards the ball handler, resulting in the screener drawing the defenders with him. The ball handler is given the chance to take advantage of that particular moment, so that he is more successful in the offense. In the trap situation, the ball handler, taking advantage of the fact that two players are guarding him without any of the two being solely responsible for the defense, exploits the moment so as to attack. Finally, in pick-and-roll now, in spite of the fact that it appears to be the most common offense, some help may be given from various defensive players who are near the key, which prevents the ball handler from increasing his success percent.

Classification tree analysis

This study explored combined performance indicators through classification tree analysis. This analysis allowed us to get accurate information about the behaviors and interactions of the ball handler in relation to the different type of pick, and different variations of pick-and-roll to improve the use and effectiveness of the pick-and-roll offense in the game of basketball. More in detail, when the ball handler choosing to the left direction of motion after a slip pick, pick and pop and stretch the trap at the top of the key and left side of the court achieve better effectiveness comparing to the right side. Presumably this happens because the majority of the defensive players guarding the ball handlers move toward the side matching their dominant hand.

In conclusion, pick-and-roll is an offense without verbal signals in which the ball handler's and screener's cooperation is of great importance regarding the decisions that the ball handler is about to make. The ball handler must "read" the game and decide in a very short time-span, in a space that changes continuously and includes several defensive and offensive players (van Maarseveen et al., 2018). The rightward direction, and mainly the use of the right-hand that the ball handler employs while performing the pick allows him to execute with great success. The players did make different decisions when handling the ball with the dominant or non-dominant hand. Finally, it was made apparent that the ball handler affects the offense, which in turn affects the team. It is worth noting that the present study offers useful information to coaches, who may have the chance to use it in practice sessions, aiming at individual improvement, but also team improvement and development in their basketball programs.

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Conflict of interest statement

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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