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RELATIONSHIP BETWEEN PASSING AND BALL CONTROL IN SOCCER: ANALYSIS OF VARIATIONS OF KINEMATIC MEASURES

UDAY HASAN[1], FILIPE MANUEL CLEMENTE[2]

[1]Al-Kitab University, Department of Physical Education and Sports Sciences, Kirkuk, Iraq
[2]Instituto Politécnico de Viana do Castelo, Escola Superior Desporto e Lazer, Rua Escola Industrial e Comercial de Nun'Álvares, Viana do Castelo, Portugal

Mailing address: Uday Hasan, Al-Kitab University, Department of Physical Education and Sports Sciences, Altun Kupri 36015, Kirkuk, Iraq, e-mail: dr_udayhusan@yahoo.com

Abstract

Introduction. A soccer player with good ball control is the one who is able to perform complex coordinated situational motor actions in a certain space and in as short time period as possible. The analysis included variations in the angle of the knee joint of the leg receiving a ball (AKLR), angle of the knee joint of the supporting leg (AKLS), angle between thighs (ABT), trunk bending angle (TBA), hip joint point height (HPH), and ball distance after controlling the ball (BDAC) between effective and ineffective passing in soccer. ***Material and Methods.*** A total of 12 university soccer players (age: 20.8 ± .83 years old, experience: 4.7 ± .78 years) voluntarily participated in the study. The players made five attempts to control the ball with the inside foot. The best attempt was analysed for each case (effective and ineffective). ***Results.*** The degrees of AKLR, AKLS, ABT, TBA and HPH were significantly greater in effective passing than those in ineffective passing; the observed effect sizes were 4.87, 2.53, 1.77, 3.98, and 3.40, respectively. BDAC was meaningfully greater at ineffective passing (effect size: 2.03). ***Conclusions.*** There were significant differences in the values of kinematic variables used to test ball control by effective and ineffective passes ($p < 0.05$). The research sample, in terms of the values of kinematic variables, achieved noticeable progress during the performance of ball control for effective passing, which showed its effectiveness in reducing the distance after controlling the ball.

Key words: biomechanics, football, performance, motion analysis, ball control

Introduction

Determining which technique to use (i.e., skills involved in controlling a ball) is a very important ability of a soccer player [1]. A soccer player with good ball control is the one who is able to perform complex coordinated situational motor actions in a certain space and in as short time period as possible [2].

If players are not able to perform this skill, it will be difficult for them to carry out tactical activities [3, 4]; there will be an expenditure of physical effort by the players [5, 6] in addition to the negative impact on their psychological aspects [7].

Perfect ball control can be divided into four phases, i.e., preparation for the first touch (e.g., perception, release, adoption of the body position required by the game situation), first touch, actions with the ball (e.g., dribbling, feints), and final action (e.g., pass, cross, shot at the goal) [8]. Many studies have focused on the relationship between some variables and the level of ball control. Specifically, Malina et al. found that maturity and years of training in skilful ball control were essential in adolescent 13-15-year-old footballers; in addition, the researchers have determined that there was no relationship between ball control and player position [9]. Singh found that mid-fielders had the best ball control [10]. Scharfen and Memmert concluded that working memory capacity was positively related to ball control (Rs = 0.669) [11]. Furthermore, football players require many physiological and physical abilities because these abilities are considered to be important for the successful completion of technical actions (e.g., passing, shooting, and ball control), which ultimately determines the match outcome [12, 13, 14].

Regarding the studies that evaluated the issue of controlling the skills, Augustus et al. tried to determine whether technique refinement intervention, which was designed to produce stated hip displacement during the kicking stride, could develop maximal instep kick performance and identify differences between the two kicking techniques during the entire kicking movement [15]. Marqués–Bruna et al. used the structural principle component analysis of the kinematics of soccer kick using various types of rating scales and examined the accuracy of rating scale type (e.g., analogue, numerical analogue, Likert, and numerical Likert) for the rating of kinematic variables [16]. Scurr and Hall tried to determine the effect of approach angle on kicking accuracy and on three-dimensional kinematics of penalty kicks [17]. Therefore, qualitative and quantitative methods facilitated the identification of general features. The application of qualitative methods to the skill of kicking a ball helped to identify many characteristics of kicking from multiple aspects of participation and control skill [18]. Although there are many studies that tried to determine the nature of participation in kicking skill, these studies used specific conditions or restrictions. For example, for kicking, the emphasis was on accuracy vs. speed [19], before vs. after fatigue [20, 21], the use of dominant vs. non-dominant leg [22, 23], male vs. female [24, 25], kicking to move the ball vs. static ball, and skilled vs. beginner players [26, 27, 28, 29].

Davids et al. concluded that it was necessary to coordinate the movement and control by football players to describe them

as dynamical movement systems. These researchers focused on two aspects: (1) coordination between important limb parts to ensure the proximodistal temporal series of joint segment movements of the lower limb during the kicking state to simplify the development of high velocity in the distal part; (2) coordination between moveable ball and the effectors to satisfy the spatiotemporal constraints of objection with a controlled amount of force [30].

To our knowledge, there are no studies on the biomechanical analysis of the ball control skill under the conditions of effective passing before ineffective passing. Various conditions and restrictions have been used in the previous studies. However, these studies did not address the issue of ball control skill. Thus, there is a lack of evidence on the kinematic patterns of controlling ball procedures during effective and ineffective passing. Therefore, we focused on this important topic to provide appropriate kinetic solutions to increase the level of players, who are exposed to different types of situations during the match. Thus, coaches can use these actions to identify the key elements to improving the effectiveness of a player's technique. On the basis of this reasoning, the aim of this study was to analyse the skills of controlling the ball and to identify variations in the angle of the knee joint of the leg receiving a ball (AKLR), angle of the knee joint of the supporting leg (AKLS), angle between thighs (ABT), trunk bending angle (TBA), hip joint point height (HPH), and ball distance after controlling the ball (BDAC), What is meant by the ball distance, after controlling the ball, is the horizontal distance of the ball centre between the moment the player's foot touches the ball and the moment of leaving it in two cases. The first case is when the ball is well passed as far as the distance and the speed of the ball are concerned; this is what we call effective passing. The second case is when the good performance of passing the ball is ignored; this is what we call ineffective passing. It was hypothesised that the kinematic variables for the skill of controlling the ball were affected by the passing type used.

Material and Methods

Participants

A total of 12 university soccer players (age: 20.8 ± .83 years old; experience: 4.7 ± .78 years; height: 175.6 ± 6.01 cm; body mass: 68.63 ± 5.06 kg) voluntarily participated in the study. The players belonged to the same team that trained 3 times per week (a total of 6 hours of training per week) and had one official match per week. The study was conducted 4 weeks after the beginning of the 2018-2019 academic year. The players made 5 attempts to control the ball with the inside foot. The best attempt was analysed for each case (effective and ineffective). The best attempt was determined by the ball's distance variable after controlling the ball BDAC. When the ball's distance between the moment of the player's foot touching the ball and the moment of leaving it was short, then the attempt was the best.

All players preferred to control the ball with their right leg, and none of the participants reported any previous injury. All participants were informed about the study design and protocol. Then, they signed a free informed consent prior to the testing procedure. The study protocol was approved by the ethics committee of Al-Kitab University, and all procedures followed the ethical standards of the Declaration of Helsinki for the study on humans.

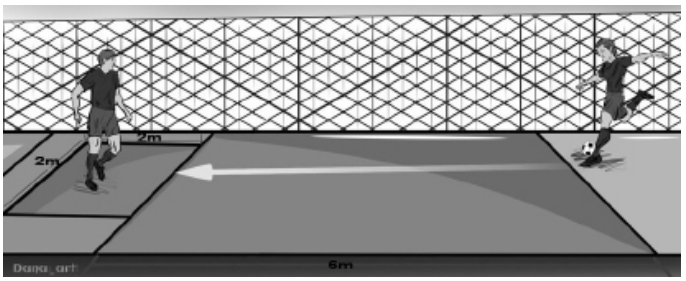

Figure 1. Method and dimensions of the ball control test

Testing procedure

Before the basic test, the players warmed up for 10 min by running on a treadmill at 5 km/h; several stretching exercises were also conducted. Participants wore soccer boots and all sports equipment for soccer players, as determined by FIFA. During the main session, each participant performed five frequent attempts to control the ball in the case of an effective pass. One of the most important test procedures was to pass the ball by a player who was positioned 6 m away from the control area; the player had to pass the ball to the ground level at the same speed that he was moving at; if the player did make mistakes in passing the ball, the attempt had to be repeated.

The participant advanced to the test area (2 m × 2 m), as shown in Figure 1, trying to stop and control the ball with the inside foot; then, the player returned to the starting line and repeated the process again; thus, the participant repeated five attempts in a row. The attempt was not considered if the participant failed to control the ball or if he passed the line in the specified area [31]. After the process was completed by all participants, the test was repeated under the same conditions; however, passing was made not effective by increasing the speed of passing the ball (from approximately 10 m/s to 15 m/s) without paying attention to the distance between the player who was passing the ball and the player who was attempting to control the ball.

The best attempt was chosen (for effective and ineffective passing attempts) depending on the lowest value that the participant achieved for the distance variable after controlling the ball.

Video camera

The researchers used mobile number 3 (type Huawei Y9 prime 2019, Chinese-made) frequency of 120 FPS. The first and second mobiles were placed 8 m away from the middle of the test area and from the player's field of movement and at a vertical angle to the point from which the ball was received on the right side of the player for the first mobile; the second mobile was positioned behind the player. The height between the centre of the lens and the surface of the ground was 140 cm, while the third mobile was placed 7.23 m from the field of movement of the other player (who was passing the ball) at a vertical angle and on the right side of it, and the height between the centre of the lens and the ground surface was 1.27 m. Third mobile imaging was used to measure the speed of the ball when passing. The kinematic analysis was carried out using the Kinovea software program (2D motion analysis software under the GPLv2 license, version 0.8.27).

Kinematic variables

Kinematic variables 2, 4, 5 and 6 were measured by using camera 1, while variables 1 and 3 were measured by using camera 2. The angles that will be mentioned are absolute angles.

(1) Angle of the knee joint of the leg receiving a ball (AKLR): It is the angle between the thigh and leg during the moment of controlling the ball, measured from the back.
(2) Angle of the knee joint of the supporting leg (AKLS): It is the angle between the thigh and leg during the moment of controlling the ball, measured from the back.
(3) Angle between thighs (ABT): It is the angle between the two thighs at the moment of controlling the ball, measured from the bottom.
(4) Trunk bending angle (TBA): It is the angle between the horizontal line parallel to the ground from the point of the hip joint with the line passing through the trunk at the moment of controlling the ball, measured from the front.
(5) Hip joint point height (HPH): It is the length of the vertical distance between the hip joint point at the moment when the ball is controlled by the surface of the ground.
(6) Ball distance after controlling the ball (BDAC): It is the horizontal distance between the centre of the ball when controlling it and the centre of the ball after controlling it.

Data analysis

The statistical package for Social Sciences (SPSS for Windows, version 22.0, IBM Corp., Armonk, NY, USA) was used for statistical processing to calculate the mean, standard deviation (SD), coefficient of variation (CV%) and to perform the t-test of paired samples. Significant statistical changes were set at $p < 0.05$. Practical differences were assessed by calculating the Cohen's d effect size (ES) [32]. The interpretation of inference's magnitudes was used as follows [33]: < 0.2 = slight; 0.2-0.6 = small; 0.6-1.2 = moderate; 1.2-2.0 = large; 2.0-4.0 = very large; and > 4.0 = extremely large.

Results

Table 1 shows the mean values and standard deviations of the kinematic variables of ball control for both effective and ineffective passing. It was determined that there was a considerable effect of the pass type on the kinematic variables to control the ball if the calculated values of T were limited to – 7.026 and 16.857, which were significant values ($p < 0.05$). To ensure that this effect was due to each research sample, it was determined that there was a significant correlation between the kinematic variables to control the ball between the two pass types because correlation coefficients ranged from .682 to .910, which were significant values ($p < 0.05$). To determine the effect size of these differences, Cohen's values were as follows. Extremely large ES was determined for differences in (AKLR) (d = 4.866). Very large ES was determined for differences in (i) (TBA) (d = 3.976); (ii) (HPH) (d = 3.404); (iii) (AKLS) (d = 2.526); (iv) (BDAC) (d = 2.028). Large ES was determined for differences in (ABT) (d = 1.774).

Figure 2 clearly shows that the coefficient of variation between the subjects was the highest for BDAC in effective passing control (16%) and ineffective passing control (17%). The lowest coefficients of variation for TBA in effective and ineffective passing control were (2%) and (3%), respectively.

Discussion

Through the statistical processing of the kinematic variables of the skill of controlling the ball with effective and ineffective passes, it was determined that there were significant differences in ball control with effective passing. Effective actions had larger values of AKLR, AKLS, ABT, TBA, and HPH compared to ineffective ones. However, ineffective actions presented greater values of BDAC than effective ones.

These differences in the values of measured kinematic variables were possibly due to the variation in the values of variables when performing ball control with effective and ineffective passing owing to the skill of controlling the required force, which is an important factor for accuracy. Then, the dynamic duty to kick the ball with the maximum force possible to pass it to the farthest distance, when the position of play requires it, is much easier than passing the ball to a teammate. The player may increase the strength of the pass, which makes it difficult for the teammate to receive the ball. This is the result that we observed among the members of the research sample during the test of controlling the ball when passing was ineffective. Thus, the success of the process of controlling the ball depends on how much accuracy in the level of muscle strength control is required to complete ball control. Therefore, the best players can bring the ball under their control in an instant, regardless of how it arrives to them [34]. The optimal realization of a motor task is associated with the highest levels of position and movement sense of the body, which ensure both economy and smoothness of motion

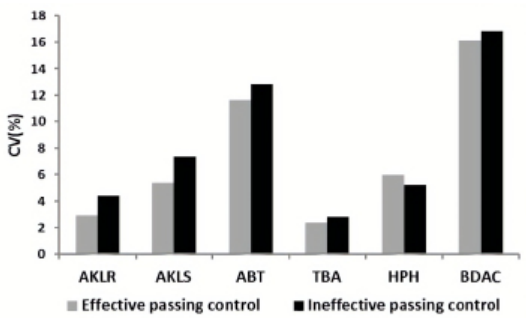

Figure 2. Coefficient of variation for the kinematic variables of the ball control skill

Table 1. Kinematic parameters (mean ± standard deviation, T and R values, and effect size) during ball control

Kinematic variables	Effective passing control	Ineffective passing control	T(p)	R(p)	Effect Size	Magnitude
AKLR (degree)	167.51 ± 4.89	152.63 ± 6.74	16.86(.001)	.91(.001)	4.87	Extremely large
AKLS (degree)	169.05 ± 9.13	155.60 ± 11.48	8.75(.001)	.89(.001)	2.53	Very large
ABT (degree)	27.55 ± 3.21	23.17 ± 2.97	6.15(.001)	.68(.015)	1.77	Large
TBA (degree)	85.97 ± 2.04	79.55 ± 2.23	13.77(.001)	.72(.009)	3.98	Very large
HPH (cm)	67.66 ± 4.05	59.73 ± 3.12	11.79(.001)	.82(.001)	3.44	Very large
BDAC (cm)	20.09 ± 3.24	24.84 ± 4.18	−7.03(.001)	.83(.001)	2.03	Very large

[35]. Thus, it is necessary for the players to have a perception of the movement and adopt an appropriate situation for the body according to the game situation to prepare for the first touch of the ball. The player needs to deal with the ball in a clever way to keep his body balanced to perfectly control the ball [8]. The player needs to reduce the angle of the knee joint of the supporting leg and reduce the angle of trunk bending at the moment of controlling the ball in ineffective passing to maintain the centre of gravity in front of his body and to decrease the centre of gravity as much as possible to achieve stability and balance to be consistent with the high speed of the ball. Greve et al. stated that balance is defined as the process of maintaining the centre of gravity within the body's support base and that this process requires constant adjustments, which is provided by muscular activity and joint positioning [36]. The more dynamic and static the balance of the player is, the better his field experience to deal with game situations [37]. One-leg standing should be viewed as a dynamic rather than a static task [38].

Thus, by gradually lowering the speed of the ball, the push from the movement will be lower, which prevents rebounding of the ball. We observed this effect when the players controlled the ball when passing effectively. The methods used by the research sample when controlling the ball during effective passing were designed to achieve balance when controlling the ball (receiving the ball in a way that prevented it from bouncing back a long distance) and absorbing its movement in a streamlined motion. This observation is consistent with Davids, Lees, and Burwitz, who defined control as the ability to accurately change the direction of movement (according to the final situation), speed, and acceleration of parties or some of the parties during the performance. In addition, control means the strategy of skilful performance; skilful performance correlates with accuracy [18].

To our knowledge, this is the first study that emphasized that there were differences in the kinematic variables of ball controlling skill in accordance with the passing method used. This study has some limitations. Specifically, the test related to the ball controlling skill does not cover all game situations that a player is exposed to during the match. Thus, future studies should evaluate the majority of imitation tests of the events at the stadium. There is no doubt that 2D studies have set the basis for evaluating this skill. Despite that, we cannot be so sure that the 2D analysis can describe the whole body movement without losing the important characteristics. Therefore, further studies can be conducted by using other technique such as 3D analysis. Through this study, we advise football coaches to adopt the basics and mechanical laws necessary in the training process of football players and to provide an environment that is similar to that during the match.

Conclusions

There were significant differences in the values of kinematic variables used to test ball control by effective and ineffective passes ($p < 0.05$); the effect size was either extremely large or large. The research sample, in terms of the values of kinematic variables, achieved noticeable progress during the performance of ball control for effective passing, which showed its effectiveness in reducing the distance after controlling the ball. Therefore, skilled players adopt strategies to help them overcome the contrast or difference (in the level and passing type) of the movement without diverting their attention from their responsibilities.

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