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Comparative biomechanical analysis of mid-height reception between professional and amateur soccer players

Análisis biomecánico comparativo de recepción a media altura entre jugadores profesionales y amateurs de fútbol

Análise biomecânica comparativa da captura em meia altura entre jogadores profissionais e amadores de futebol

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ABSTRACT

Soccer is a sport of various motor actions, where the reception of the ball is classified as a control action at different heights, speeds and angles. The player must have the ability to receive the ball in order to generate a different action: a pass, shot or dribble; its optimization implies greater probabilities of technical-tactical performance. In this sense, the objective of the research was to biomechanically analyze the mid-height reception technique in professional and amateur soccer players using video analysis as a measurement method. The research was descriptive-explanatory of correlational order, four variables of the motor movement (D: distance covered; AM: maximum acceleration; VM: maximum speed and AF: amplitude of the femorotibial joint) are analyzed through video-analysis with Kinovea . Five professional players (group 1) and 15 amateur players (group 2) were studied. The amateur soccer players presented a higher mean in all the variables studied, "D" (group 1: 72.17cm; group 2: 101.27cm; p=0.001), "AM" (group 1: 61.84m/s ^{2} ; group 2: 101.73m/s ^{2} ; p=0.000), "VM" (group 1: 8.18m/s; group 2: 12.55m/s; p=0.000) and "AF" (group 1: 62.6°; group 2 : 75.2°; p=0.002), which behaves significantly different in all cases. The biomechanical analysis carried out on professional and amateur soccer players, in the technique of receiving the ball at mid-height, concludes that amateur players require greater technical improvement, regardless of their experience in competitions.

Keywords: Biomechanical analysis; Half height reception; Professional soccer; Amateur soccer.

RESUMEN

El fútbol es un deporte de varias acciones motrices, donde la recepción del balón se clasifica como una acción de control a diferentes alturas, velocidades y ángulos. El jugador debe tener la capacidad de receptar el balón para poder generar una acción diferente: un pase, tiro o driblar; su optimización implica mayores probabilidades de rendimiento técnico-táctico. En tal sentido, se planteó como objetivo de la investigación analizar biomecánicamente la técnica de la recepción a media altura en futbolistas profesionales y amateurs a partir de video análisis como método de medición. La investigación fue descriptiva-explicativa de orden correlacional, se analizan cuatro variables del movimiento motriz (D: distancia Recorrida; AM: aceleración máxima; VM: velocidad máxima y AF: amplitud de la articulación femorotibial) a través de video-análisis con Kinovea. Se estudiaron a cinco jugadores profesionales (grupo 1) y 15 de nivel amateur (grupo 2). Los futbolistas de nivel amateur presentaron una mayor media en todas las variables estudiadas, "D" (grupo 1: 72.17cm; grupo 2: 101.27cm; p=0.001), "AM" (grupo 1: 61.84m/s^2; grupo 2: 101.73m/s^2; p=0.000), "VM" (grupo 1: 8.18m/s; grupo 2: 12.55m/s; p=0.000) y "AF" (grupo 1: 62.6°; grupo 2: 75.2°; p=0.002), lo cual se comporta significativamente diferentes en todos los casos. El análisis biomecánico realizado a futbolistas profesionales y amateurs, en la técnica de recepción del balón a media altura, concluye que en los jugadores amateur requieren un mayor perfeccionamiento técnico, independientemente de su experiencia en competencias.

Palabras clave: Análisis biomecánico; Recepción media altura; Fútbol profesional; Fútbol amateur.

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RESUMO

O futebol é um esporte de várias ações motoras, onde a recepção da bola é classificada como uma ação de controle em diferentes alturas, velocidades e ângulos. O jogador deve ter a capacidade de receber a bola para poder gerar uma ação diferente: um passe, um chute ou um drible; sua otimização implica em maiores probabilidades de desempenho técnico-tático. Neste sentido, o objetivo da pesquisa era analisar biomecanicamente a técnica de recepção em meia altura em jogadores profissionais e amadores de futebol utilizando a análise de vídeo como método de medição. A pesquisa foi descritiva-explicativa de ordem correlacional, quatro variáveis de movimento motor (D: distância coberta; MA: aceleração máxima; MV: velocidade máxima e FA: amplitude da articulação femorotibial) foram analisadas através de vídeo-análise com Kinovea. Foram estudados cinco jogadores profissionais (grupo 1) e 15 jogadores amadores (grupo 2). Os jogadores de futebol de nível amador apresentaram uma média maior em todas as variáveis estudadas, "D" (grupo 1: 72,17cm; grupo 2: 101,27cm; p=0,001), "AM" (grupo 1: 61,84m/s2; grupo 2: 101. 73m/s2; p=0,000), "VM" (grupo 1: 8,18m/s2; grupo 2: 12,55m/s; p=0,000) e "AF" (grupo 1: 62,6°; grupo 2: 75,2°; p=0,002), que se comportam de forma significativamente diferente em todos os casos. A análise biomecânica realizada sobre jogadores profissionais e amadores de futebol, na técnica de recepção de bola em altura média, conclui que os jogadores amadores requerem um maior aperfeiçoamento técnico, independentemente de sua experiência em competições.

Palavras-chave: Análise biomecânica; Recepção em altura média; Futebol profissional; Futebol amador.

INTRODUCTION

In sports biomechanics, the application of mechanics has been determined as an study of the movements made by the athlete in the execution of technical gestures, which becomes one of the essential premises of the sports training management process, and is included in the specific soccer process (Vizcaíno, Cortizo, 2020; Da Silva *et al.,* 2019). Its objective is to evaluate the competitive technique, which optimizes its performance and generates new forms of training (Perdomo *et al.,* 2018).

In the last decades of this century, soccer and its form of training have achieved constant evaluation; this has made the methodologies more in line with the needs of increasing or maintaining high sports performance (Calero, 2019; Morales, 2014; Morales, 2018). This evolution has largely been a reflection of what is happening with the new world and new body movement research, where soccer as a university sport is often studied with high intensity. This leads to improving the processes of acquisition and improvement of the specific motor habit, such as the improvement of driving technique, hitting and reception. These processes are based on biomechanical analysis or the improvement of determining physical capacities (Carbo *et al.,* 2019; Silva, Ayala, 2021; Flores, Ramírez, 2019; Ruano, Losa, 2021).

When studying soccer, it must be considered that performance is determined by the multifactorial structure of elements that interact in very complex ways (Scharfen, Memmert, 2019). These factors in isolation are not decisive in the performance of the equipment, but as each of the different elements influence the performance in an integral way; is that sport improvement can reach its maximum expression.

All those technical executions where there is a predominance of power capacity, speed and optimal quality are decisive to provide effective solutions when facing the different game situations posed by the competition (Lucas, 2020). It will also be necessary to consider that it is a socio-motor sport; therefore, the performance will not only depend on the actions of the team itself, but also on the type of actions of the opponent (Calero, 2019; Barrero, Lazarraga, 2020).

The reception in soccer is the action of controlling the ball completely. In competition, the player will receive the ball numerous times at different heights, speeds, and angles (Carbo *et al.,* 2019). A player must be able to receive the ball quickly, being able to generate a new action: pass, shot or dribble . Players within the field of play can use different parts of the body to receive the ball, players use their feet, thighs, chest and head (Rodríguez, 2021).

In the teaching-learning process based on explanatory-demonstrative methods, as is the case with sports, there is a need to have ideal motor patterns, which is the basis for error correction, and therefore the optimal acquisition of motor habits specific. In this sense, the purpose of this research is to biomechanically analyze the mid-height reception technique in professional and amateur soccer players.

MATERIALS AND METHODS

The present research has a descriptive-explanatory orientation of correlational order, selecting under a non-probabilistic intentional sampling five professional soccer players from the *SD Aucas reserve team* (group 1: professionals; five subjects), in addition to five players from the soccer team from the University of the Armed Forces-ESPE, and ten players from the soccer *Angamarca Neighborhood League* (group 2: amateurs; 15 subjects). The age range of the study is considered to be between 20-30 years.

The studied variables were evaluated with the Kinovea program, its dual screen mode is used for this purpose, which allows the simultaneous comparison of two executions. The video-analyses must be synchronized, which makes a common movement comparison possible. Movements of the coxofemoral joint during mid-height reception were recorded . The five professional soccer players and all amateur soccer players practiced this discipline for several years and uninterruptedly, with experience in different competitions.

The procedure used in the research for data collection was the video-graphic method, with the biomechanical analysis program mentioned, for subsequent statistical analysis of the data, the SPSS v.15.0 software for Windows was used.

The biomechanical variables studied will be:

1. Distance traveled (D): the total distance traveled by each of the soccer players, both amateur and professional, will be studied. It is determined that the distance to be analyzed will be from the moment the player takes off his foot from the ground, until the first contact with the ball. With this, it will be possible to identify at what distance the technical action is most effective.

2. Maximum acceleration (AM): the acceleration exerted by the professional soccer player and the amateur will be studied; the technical action of receiving the ball at medium height is performed.

3. Maximum speed (VM): the speed used between professional and amateur soccer players at the first contact with the ball will be compared, and its relationship with the optimal training of the technique of receiving the ball at mid-height.

4. Articular amplitude of the femorotibial joint (AF): the first contact with the ball will be assessed by the movement of the femorotibial joint which, depending on its flexion and external rotation; It is taken into account that this joint is the main one when performing an effective technique.

5. The data collected in each of the analysis variables did not present a normal distribution according to the Shapiro-Wilk test. In this sense, a non-parametric statistician will be used for two independent samples, denoted as the Mann-Whitney U Test ($p \leq 0.05$).

RESULTS AND DISCUSSION

Table 1 shows the results achieved in each variable analyzed, both in the professional and amateur groups, obtaining the mean values for later comparison (Table 1).

Table 1. - General data

No.	Distance	Acceleration	Speed	Angle	Group
1	62.15	65.65	7.49	63°	Professional
2	87.27	44.62	8.64	54°	Professional
3	74.73	73.46	9.15	68°	Professional
4	65.43	68.41	8.37	70°	Professional
5	71.30	57.09	7.25	58°	Professional
PROFESSIONAL SOCCER PLAYER VALUES					
Max. s	87.27cm	73.46m/s2	9.15m/s	70°	
Min. s	62.15cm	44.62m/s2	7.25m/s	54°	PROFESSIONAL
Half	72.17cm	61.84m/s2	8.18m/s	62.6°	
6	110.34	97.45	15.14	71°	Amateur
7	97.72	110.34	13.67	80°	Amateur
8	80.25	105.35	12.80	67°	Amateur
9	107.25	113.67	9.64	82°	Amateur
10	113.67	104.57	8.70	73°	Amateur
11	97.34	115.60	13.15	82°	Amateur

12	94.78	95.45	12.57	81°	Amateur
13	112.68	101.45	11:30	79°	Amateur
14	110.45	89.95	14.09	70°	Amateur
15	98.04	113.47	12.45	75°	Amateur
16	105.34	90.45	15.56	71°	Amateur
17	85.25	106.35	12.34	77°	Amateur
18	109.67	101.57	9.71	63°	Amateur
19	92.78	90.35	12.60	84°	Amateur
twenty	103.45	89.93	14.50	73°	Amateur
AMATEUR FOOTBALL PLAYER VALUES					
Max. s	113.67cm	115.60m/s2	15.56m/s	84°	
Min.s	80.25cm	89.93m/s2	8.70m/s	63°	AMATEUR
Half	40"	101.73m/s2	12.55m/s	75.2°	

Table 1 shows the different individual values regarding the execution of the reception technique at mid-height, where the mean or average value obtained in the group of professionals for the variable "maximum acceleration" (MA) was established in 72.17cm. Meanwhile, the Acceleration (A) obtains an average of 61.84m/s^2 and the speed (V) an average of 8.18m/s. On the other hand, the angle of the femorotibial joint (FA) establishes an average of 62.6° .

On the other hand, the mean values achieved as part of the group of amateur soccer players in the mid-height reception technique established a value of 101.27cm for the "distance" variable. So, it is inferred that it is higher than the average established in group 1; therefore, the Mann-Whitney U Test (Table 2) determined significant differences in the data obtained by the independent groups (p=0.001). The foregoing shows that the distance traveled by the professional player is in consideration and in relation to the other components of the technical-tactical action, an aspect related to the precision and optimization of the motor component.

In the case of acceleration, group 2 obtained an average of 101.73m/s^2, much higher than the average established by the group of professionals; hence it prevails, with a significant difference (p=0.000). This difference is also seen in the "speed" variable (p=0.000), since the mean of group 2 was established at 12.55m/s; which is much higher than that established in the professional soccer players studied. The foregoing is indicative of a better control of the body segments in professional players, given that speed and acceleration are mainly conditioned to motor improvement. This shows an increase in accuracy and energy savings. On the other hand, the speed exerted by an amateur soccer player is inadequate, since it exerts a damping force on the ball that does not allow it to be fully controlled, an aspect that can affect a new technical-tactical action.

In the case of the articular amplitude of the femorotibial joint, the group of amateur soccer players established a mean of 75.2°, an amplitude also higher than that established in professional soccer players; which is significantly different (p=0.002). The foregoing shows that the angle formed by the femorotibial joint must be in a range of 50 to 65°; It is considered that professional players, by maintaining this range of angles, achieve better control of the ball. As a consequence, a more effective reception is obtained in the mid-height of the ball (Table 3).

Table 2. - Mann-Whitney U test for the variables analyzed

	groups	N	Rank average range	sum of ranks
Distance	Professionals	5	3.40	17.00
	amateur	fifteen	12.87	193.00
	Total	twenty		
Acceleration	Professionals	5	3.00	15.00
	amateur	fifteen	13.00	195.00
	Total	twenty		
Speed	Professionals	5	3.20	16.00
	amateur	fifteen	12.93	194.00
	Total	twenty		
Angle	Professionals	5	4.00	20.00
	amateur	fifteen	12.67	190.00
	Total	twenty		

Table 3. - Test statistics[a]

	Distance	Acceleration	Speed	Angle
Mann–Whitney U	2,000	,000	1,000	5,000
W for Wilcoxon	17,000	15,000	16,000	20,000
Z	-3,099	-3,273	-3,186	-2,842
Asymptotic sig.(bilateral)	.002	.001	.001	.004
Exact significance [2*(one-sided sig.)]	.001b –	,000b	,000b	.002b –

a. Grouping Variable: Groups.
b. Not corrected for ties.

The results found in the study reveal that the maximum acceleration with which a professional soccer player exercises the reception technique at mid-height reaches 73.46 m/s^2. The acceleration of an amateur soccer player reaches a maximum of 115.60 m/s^2, for which we refer to the statements on the Barca Innovation website (2018). Acceleration is one of the metabolic activities that places a demand that increases the energy expenditure of the competing activity, and therefore increases muscle fatigue. This is an aspect that is referred to when this acceleration is compared with a displacement at constant speed (Barca Innovation, 2018).

It can be also found references regarding the classification of sports, and how acceleration influences technical action in team and team sports. Acceleration, deceleration and direction changes occur with a very high frequency. Specifically, the literature has determined in soccer how acceleration in 85 % fails to reach a high displacement speed (Miller *et al.,* 2016).

The speed exerted by a professional soccer player is one of the most studied multifactorial abilities. This variable is made up of the speed of reaction and the fast processing of all the information received, of the fast *sprints.* The player, when controlling the ball, evidences his gestural speed with which he exercises the technique of receiving the ball, short sprints and stops (Palau, 2009).

In the tables analyzed using the SPSS program, it is valued in the average ranges how the speed between professional and amateur players has a considerable range of difference. (Group 1: 12.92; Group 2: 3.20) Professionals have more effective control of their gestural speed, as well as the speed of movement of the body segment, used for the execution of the reception technique at medium height of the ball.

It is understood that each of the analyses of movements in professional soccer carried out by each member in competition highlights the great importance of each action within the competition. In this way, practical applications are achieved against training and sports performance. According to the classification of the joints, the spherical joints (which are in the form of a sphere), are characterized by having a free movement in the direction in which an action is desired. An example of this is the coxofemoral joint and the shoulder-scapular humerus. For this reason, once the average angular of the professional player has been determined, which is 62.6°, importance must be placed on the care of injuries, and how one must work in training to have a better efficiency in carrying out the technique.

Finally, it is considered that the technique of receiving the ball at medium height accompanied by the execution of other techniques (pass, shot, dribble, etc.) could be considered as a set of techniques aimed at the team's offense. In addition, it is recognized as a means by which the tactical part is improved. In this sense, it is proposed to expand the research of the reception technique at medium height in competition; thus, other variables of motor performance that intervene in performance, such as biological maturation, are taken into account. This is an aspect that will allow the study of the technique under study in its full dimension (Pesantez *et al.,* 2020).

CONCLUSIONS

The biomechanical analysis carried out on professional and amateur soccer players in the technique of receiving the ball at mid-height, concludes that amateur players require greater technical improvement, regardless of their experience in competitions.

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