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Original article

Biomechanical differences of the technical gesture of the flight in professional and amateur archers

Diferencias biomecánicas del gesto técnico del vuelo en arqueros profesionales y amateur

Diferenças biomecânicas do gesto técnico de voo em arqueiros profissionais e amadores

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ABSTRACT

The archery flight technique is one of the fundamental defensive actions, its improvement depends on specialized methodologies based on studies of high-level athletes, which serve as a theoretical basis to strengthen the process of sports training management. In this sense, the objective of the research was to biomechanically analyze the technical gesture of flight in professional and amateur soccer goalkeepers. The research is of descriptive-explanatory type of correlational order. Under a non-probabilistic intentional sampling, 30 athletes (male; 16-18 years old) classified into two independent groups (Group 1: Professionals: 15 subjects; Group 2: Amateur: 15 subjects) are studied, 5 variables are biomechanically compared (AS : upper body angle; AI: lower body angle; VM: maximum speed; AM: maximum acceleration; TV: flight time). The variable "AS" did not present significant differences (Group 1: 141.4°; Group 2: 150.3°; $p=0.747$), nor the variable "AI" (Group 1: 141.62°; Group 2: 150.3°; $p=0.161$), nor the variable "VM" (Group 1: 4.62m/s ; Group 2: 4.96m/s; $p=0.601$), nor the variable "AM" (Group 1: 2.54m/s² ; Group 2: 3.26m /s² ; $p=0.202$), nor the variable "TV" (Group 1: 1.86s ; Group 2: 1.56s; $p=0.535$), although there are variations in the average ranges. There are no significant variations within the execution of the technical gesture of the flight of the soccer goalkeepers studied. However, it is recommended to extend the study to a larger sample, comparing results with categories of lower age range.

Keywords: Flight technique; Goalkeeper; Professionals; Amateur.

RESUMEN

La técnica del vuelo en arqueros es una de las acciones defensivas fundamentales, su perfeccionamiento depende de metodologías especializadas basadas en estudios de atletas de alto nivel, las cuales sirven de base teórica para fortalecer el proceso de dirección del entrenamiento deportivo. En tal sentido, el objetivo de la investigación consistió en analizar biomecánicamente el gesto técnico del vuelo en arqueros de fútbol de nivel profesional y amateur. La investigación es de tipo descriptiva-explicativa de orden correlacional. Bajo un muestreo intencional no probabilístico, se estudian 30 deportistas (género masculino; 16-18 años) clasificados en dos grupos independientes (grupo 1: profesionales: 15 sujetos; grupo 2: amateur: 15 sujetos), se comparan biomecánicamente cinco variables (AS: ángulo del tren superior; AI: ángulo del tren inferior; VM: velocidad máxima; AM: aceleración máxima; TV: tiempo de vuelo). La variable "AS" no presentó diferencias significativas (grupo 1: 141.4°; Grupo 2: 150.3°; $p=0.747$), ni la variable "AI" (grupo 1: 141.62°; grupo 2: 150.3°; $p=0.161$), ni la variable "VM" (grupo 1: 4.62m/s; grupo 2: 4.96m/s; $p=0.601$), ni la variable "AM" (grupo 1: 2.54m/s²; grupo 2: 3.26m/s²; $p=0.202$), ni la variable "TV" (grupo 1: 1.86s; Grupo 2: 1.56s; $p=0.535$), aunque hay variaciones en los rangos promedios. No existen variaciones significativas dentro de la ejecución del gesto técnico del vuelo de los arqueros de fútbol estudiados. No obstante, se recomienda ampliar el estudio a una muestra mayor, comparando resultados con categorías de menor rango etario.

Palabras clave: Técnica de vuelo; Arquero de fútbol; Profesionales; Amateur.



RESUMO

A técnica de voo em arqueiros é uma das ações defensivas fundamentais, o seu aperfeiçoamento depende de metodologias especializadas baseadas em estudos de atletas de alto nível, que servem de base teórica para reforçar o processo de gestão do treino desportivo. Neste sentido, o objectivo da investigação consistiu numa análise biomecânica do gesto técnico de voo em guarda-redes profissionais e amadores de futebol. A investigação é do tipo descritivo-explicativo de ordem correlativa. Sob uma amostragem não-probabilística, 30 atletas (sexo masculino; 16-18 anos de idade) classificados em dois grupos independentes (grupo 1: profissionais: 15 sujeitos; grupo 2: amador: 15 sujeitos) foram estudados. Cinco variáveis foram comparadas biomecanicamente (AS: ângulo superior do corpo; AI: ângulo inferior do corpo; VM: velocidade máxima; AM: aceleração máxima; TV: tempo de voo). A variável "AS" não apresentou diferenças significativas (grupo 1: 141,4°; grupo 2: 150,3°; $p=0,747$), nem a variável "AI" (grupo 1: 141,62°; grupo 2: 150,3°; $p=0,161$), nem a variável "VM" (grupo 1: 4,62m/s; grupo 2: 4,96m/s; $p=0,601$), nem a variável "AM" (grupo 1: 2,54m/s²; grupo 2: 3,26m/s²; $p=0,202$), nem a variável "TV" (grupo 1: 1,86s; grupo 2: 1,56s; $p=0,535$), embora haja variações nos intervalos médios. Não há variações significativas na execução do gesto técnico de voo dos guarda-redes de futebol estudados. No entanto, recomenda-se alargar o estudo a uma amostra maior, comparando os resultados com categorias de faixa etária inferior.

Palavras-chave: Técnica de voo; Guarda-redes de futebol; Profissional; Amador.

INTRODUCTION

The goalkeeper is a fundamental player in the defense of a football team, (Chicharro & Ikarán, 2018), since he is the element that prevents the opponent from scoring goals. The goalkeeper requires various qualities to form a high-performance team, qualities that guarantee their sports performance and that, moreover, are controlled elements as part of the sports search and selection process (León, Morales, Chávez, 2016, Bergkamp, *et al.*, 2019; Calero-Morales, 2021).

As part of the qualities that a soccer goalkeeper must possess, sports technique is one of the fundamental elements to develop from the sports initiation process (Faicán-Arroyo, 2022); these make up the technical actions, the basis for decision-making, and serve as a technical-tactical complement of strategic importance to catch or deflect balls, within the techniques of the goalkeeper's flight. The good performance of a goalkeeper is the product of correct formation and training, where the coach is nothing more than a means for him to develop his maximum potential (Otte, *et al.*, 2020).

Within the actions of the goalkeeper's flight, it is highlighted that he must move to get full possession of the ball or make a clearance in a single action. The flight can be lateral or frontal (Ibarrola, 2011; Vizcaíno, Cortizo, 2020). Actions in which the goalkeeper blocks the ball imply a situation of contact with the ground, either by frontal or lateral fall.

The flight technique is extremely essential when complementing the functions of the goalkeeper, which is to save the ball. Hence the importance of comprehensive biomechanical analysis in said specific motor movement of the archer (Arguz, *et al.*, 2021). Comparative studies indicate that the most important thing about the goalkeeper is his natural physical and technical condition, (Ruano, Losa, 2021; Carbo, *et al.*, 2019;



da Silva Junior, *et al.*, 2019). For this, the two axes must be taken into account based on an elite goalkeeper approach, since flight is one of the aspects where the quality of the goalkeeper is best valued. This is the most convenient way to use all parts of the body to dominate or deflect the ball, effectively performing each of the actions that the specific position requires.

The soccer goalkeeper's flight begins by shifting the center of gravity downwards and laterally over the attack leg (Vizcaíno, Cortizo, 2017). That is to say, that the body, at the moment of performing, generates an impulse of tension, which accumulates energy, which is released during the jump. Moving other parts of the body towards the ball contributes to the increase in power; a wrong movement can cause a rotation in the center of gravity. This prolongs the trajectory of the body in an unwanted direction. It should be emphasized that the archer's body and the elastic parts are part of the chain of movement, in which the latter, coordinated from different parts, increases acceleration and range.

The sequence of the technical movement of the flight is an individual defensive technical action of the goalkeeper who pursues full possession of the ball. Hence, its speed is totally reduced through the upper limbs, it is done with the hands, arms and chest and is distributed in three phases:

1. First phase: preparatory, it is the initial position of the goalkeeper with respect to the ball in the game. This can be static or dynamic, as required by the trajectory of the ball.
2. Second phase: dynamic or contact with the ball, is the one where the ball is stopped by executing the flight technique.
3. Third phase: post-flight, is that where the starting position is taken and a defensive orientation is shown for further action.

It should be noted that these phases are not the only ones that exist, since they vary depending on the trajectory of the ball depending on the perspective in which it is handled. The front flight phase requires the phases already mentioned, but there are different positions within the archer's flight that are adjusted to the width of the shoulders, knees, arms, hands, hips and elbows.

However, in the present research a basic biomechanical analysis of the technical performance of the flight in archers will be carried out. The study will be carried out in response to the need to find methodologies to develop amateur-level soccer players, since error correction is a process that derives from an ideal pattern of specific motor movement. This can be analyzed by describing a perfected technical gesture, such as that which occurs in professional-level athletes, whose purpose is normally oriented towards development based on comparison (Andrade, Villarroja-Aparicio, Morales, 2017). In this sense, the purpose of this research is proposed: to biomechanically analyze the technical gesture of flight in the professional and amateur soccer goalkeeper.



MATERIALS AND METHODS

The present research is of a descriptive-explanatory type of correlational order, based on an intentional non-probabilistic sampling, a total of 30 male athletes are studied. The age range is between 16 and 18 years old, classified into two independent groups (Group 1: Professionals: 15 subjects; Group 2: Amateur: 15 subjects). These athletes belong to teams from the Independent High-Performance Sports Club of the Valley and the Quito Sports Society, in the Republic of Ecuador. The inclusion criteria to be followed for amateur level athletes were:

1. Range age mentioned
2. Have a history based on soccer schools and neighborhood championships.
3. No any type of disability that prevents their participation.

The inclusion criteria to be followed for professional athletes were:

1. Range age mentioned
2. Career of more than three years in an elite club.
3. Athletes who are still active and with national championships.
4. No any type of disability that prevents their participation.

For both groups, their consent was taken into account to carry out this research. The variables analyzed are upper body and lower body angles, which are described below:

1. Angle: at this point, the opening of the joints for the execution of the technique measured in degrees is observed; this helps to find the differences between professional and amateur archers. Upper Body Angle (AS) and Lower Body Angle (AI) are measured.
2. Maximum Speed (VM): it is a physical magnitude that expresses the relationship between the space covered by an object, the time used for it and its direction for the archer; this implies how quickly it is performed the technique.
3. Acceleration (AM): it is the change in speed in a short time, as it is important to measure it, since at the time of performing the technique its variation must be known.
4. Flight Time (TV): the execution time is the one where the reaction capacity of the archer is observed when performing the flight technique.

Student's t-test was applied for independent samples ($p \leq 0.05$). In this test, the data that presented normality in the distribution and the Mann-Whitney U test ($p \leq 0.05$) were processed. Two independent samples were applied for the data that did not present a normal distribution. The data distribution was identified from the Shapiro-Wilk Test.



RESULTS AND DISCUSSION

Table 1 shows the data recorded in the five variables analyzed as part of the study of the technical flight gesture of the professional soccer goalkeeper, where the last row shows the average values analyzed in the subsequent paragraph (Table 1).

Table 1. - Compilation of data in Excel from professional goalkeepers

No	AS Ángulo tren superior	AI Ángulo tren Inferior	VM Velocidad máx, de vuelo	AM Aceleración máx, de vuelo	TV Tiempo
1	122,0	166,4	3,19	1,47	2,17
2	133,1	137,9	4,45	2,02	2,20
3	136,9	172,1	4,82	2,58	1,87
4	149,1	175,7	5,19	2,93	1,77
5	154,0	167,7	4,09	2,60	1,57
6	165,2	124,6	3,54	1,69	2,10
7	169,3	134,1	4,63	2,57	1,80
8	91,9	132,7	5,43	3,39	1,60
9	127,5	129,1	4,15	2,27	1,83
10	139,8	143,6	5,36	3,35	1,60
11	153,7	175,5	5,03	2,75	1,83
12	156,7	112,2	5,34	2,97	1,80
13	146,2	102,7	4,23	2,19	1,93
14	158,8	96,7	4,21	2,75	1,53
15	117,4	148,7	5,66	2,54	2,23
□	141,4	141,3	4,62	2,54	1,86

The variables analyzed (Table 1) presented a lower mean than those established in the variables that analyze amateur soccer players (Table 2), with the exception of the variable "Flight time" (TV). A mean in the variable "Angle of the upper body" (AS) of 141.4° and a mean in the variable "Angle of the lower body" (AI) of 141.62.

Was obtained. On the other hand, a mean or average is established in the variable "Maximum flight speed" (VM) of 4.62m/s and a mean in the variable "Maximum flight acceleration" (AM) of 2.54m/s², in addition to an average in the variable "Time of flight" (TV) of 1.86s.

In the case of Table 2, the data recorded in the five variables analyzed as part of the study of the technical gesture of the flight of the amateur soccer goalkeeper is evidenced. Likewise, the last row shows the average values analyzed in the subsequent paragraph (Table 2).



Table 2. - Compilation of data in Excel of amateur goalkeepers

	AS	AI	VM	AM	TV
No	Ángulo tren superior	Ángulo tren Inferior	Velocidad máx, de vuelo	Aceleración máx, de vuelo	Tiempo
1	135,8	159,8	4,97	3,25	1,53
2	161,7	129,2	3,28	1,70	1,93
3	144,4	174,6	4,25	2,71	1,57
4	166,5	176,6	3,71	2,09	1,77
5	164,7	170,4	4,59	2,92	1,57
6	162,2	163,8	4,34	3,10	1,40
7	172,6	147,5	5,55	4,63	1,20
8	164,6	163,6	4,76	3,24	1,47
9	149,3	74,2	5,71	4,39	1,30
10	144,6	177,1	5,40	3,05	1,77
11	172,2	166,9	5,62	3,25	1,73
12	126,1	170,5	5,81	3,95	1,47
13	124,1	1168,5	6,87	4,80	1,43
14	121,5	40,0	4,65	2,73	1,70
15	144,5	172,4	4,96	3,04	1,63
<input type="checkbox"/>	150,3	150,3	4,96	3,26	1,56

In the case of amateur level soccer players (Table 2), the mean established in the "AS" variable was 150.3°, lower than that established in the professional soccer players analyzed. It was shown in the way described above, although there was no significant difference ($p=0.747$), as determined by Student's t-test (Table 3). This is an indication of less efficient arching in the lower limbs in amateur soccer players, in which there is no need to expand the study sample to establish more solid conclusions. The same case was established in the "AI" variable, given the presence of a lower mean in amateur soccer players (150.3°), which also did not present significant differences ($p=0.161$; Table 5). These results are evidenced, as evidenced by the Mann-Whitney U Test for two independent samples.

In the case of the "VM" variable, the mean established in amateur soccer players was 4.96m/s, which lacks significant differences ($p=0.601$; Table 3). This is compared with the data obtained from professional soccer players and a higher maximum speed where it is not necessarily an indicator of greater technical richness. Likewise, with a higher maximum acceleration (MA), the amateur level soccer players presented an average of 3.26m/s², which was higher than that established in the professional soccer players, although there were no significant differences ($p=0.202$).



On the other hand, in the "TV" variable, the average presented by the amateur soccer players was lower (1.56s) than that established in group 1 (1.86s). Hence, no significant differences are perceived ($p=0.535$; Table 3). The foregoing shows that the goalkeepers with the highest sports performance (Group 1) have a longer flight time in the analyzed technical gesture, an aspect that allows greater maneuverability in the air to catch or deflect balls or shoot at goal.

Table 3 established the significant differences between the variables analyzed (with the exception of the angle of the lower body "AI"); as previously described, none presented significant differences, although they did have different mean values (Table 3) and (Table 4).

Table 3. - Student `s t test for independent samples

Estadísticas de grupo					
	Grupos	N	Media	Desv. Desviación	Desv. Error promedio
Ángulo.TrenSuperior	Profesionales	15	141,4400	20,63557	5,32808
	Amateur	15	150,3200	17,59964	4,54421
Velocidad Max. Vuelo	Profesionales	15	4,6213	,72698	,18771
	Amateur	15	4,9647	,90461	,23357
Aceleración Max. Vuelo	Profesionales	15	2,5380	,54400	,14046
	Amateur	15	3,2567	,87102	,22490
Tiempo	Profesionales	15	1,8553	,23241	,06001
	Amateur	15	1,5647	,19552	,05048

Table 4. - Independent samples test

		Levene's test for equality of variances				t-test for equality of means				
		F	Next.	you	gl.	Next (2-sided)	Mean difference	Standard error difference	95% confidence interval of the difference	
									lower	Superior
Angle.Upper body	Equal variances are assumed	.106	,747	-	28	.215	-8.88000	7,00273	-23.22445	5.46445
	Equal variances are not assumed			-	27,320	.215	-8.88000	7,00273	-23.24056	5.48056
Max. Flight Speed	Equal variances are assumed	.279	,601	-	28	.262	-.34333	.29965	-.95713	.27047
	Equal variances are not assumed			-	26,761	.262	-.34333	.29965	-.95842	.27175
Acceleration Max Flight	Equal variances are assumed	1,703	.202	-	28	.011	-.71867	.26516	-1.26181	-.17552
	Equal variances are not assumed			-	23,479	.012	-.71867	.26516	-1.26656	-.17077



Time	Assume n equal variances	.395	.535	3,707	28	.001	.29067	.07842	.13004	.45130
	Equal variances are not assumed			3,707	27,203	.001	.29067	.07842	.12982	.45151

For the case of Table 5, the Mann-Whitney U Test determined the lack of significant differences in the data obtained in the Angle of the lower body (Table 6).

Table 5. - Mann-Whitney U test

	Rangos			
	Grupos	N	Rango promedio	Suma de rangos
Ángulo. Tren Inferior	Elite	15	13,20	198,00
	No Elite	15	17,80	267,00
	Total	30		

Table 6. - Test statistics^a

	Angulo.TrenInferior
U de Mann-Whitney	78,000
W de Wilcoxon	198,000
Z	-1,431
Sig. asintótica(bilateral)	,152
Significación exacta [2*(sig. unilateral)]	,161 ^b

The general analysis establishes few differences between the variables studied in comparison with other studies carried out in this field. It is evident that for the age range of the studied sample (16-18 years) the specialized motor habit is already solidly fixed. Although there is always room for improvement from a technical point of view, the improvements marked by biomechanical differences are usually not noticeable after several years of scientific training; thus they are consolidated in the juvenile category, as is the case of this research.

However, the small differences established through the average ranges in some sports can be decisive in different categories, emphasized in the initiation categories according to studies by (Sánchez, *et al.*, 2018; Viñachi, Guerrón, 2019; Saransig, López, Aldaz, 2021).



On the other hand, it is recommended, as a part of this research, to establish further analyzes to design a methodology for the improvement of the soccer goalkeeper's flight technique, based on the data obtained here. Specifically, this study is fundamentally addressed to the formation categories, where technical and technical-tactical actions require a greater comparative range with higher-level athletes (juveniles and seniors) and, therefore, a greater process of error correction.

CONCLUSIONS

The goalkeeper's flight technique was biomechanically determined in professional and amateur soccer players belonging to the teams of the "Independiente del Valle" High Performance Sports Club and the "Sociedad Deportivo Quito"; with this, it is possible to determine that there are no significant variations within the execution of the technical gesture analyzed. However, it is recommended to extend the study to a larger sample, comparing results with categories of lower age range.

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The authors have participated in the writing of the work and analysis of the documents.



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