Motion Streamline Evaluation of Individual Jumps Through Acceleration Variables in Show Jumping Horses

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ABSTRACT

This study evaluates the motion streamline shape of Qatari equestrian team players through acceleration variables. Six (66.6%) of the nine players were selected, and the experiment was performed in the hall of Qatari Union of Equestrian. With the use if a camera that takes 50 pictures per second, the most important bio-automatic variables were determined to be the acceleration variables (speed/time). The performance stages were then analyzed by the program Dartfish Pro Suit 5.5. The researcher presented the data as arithmetic mean and standard deviation. The results showed that all of the participants had a range of streamline. That is, the performance of the players did not significantly change in direction. Participant 6 exhibited the best streamline because he performed the easiest landing during stages 3 and 4. Participants 1 and 5 showed great slow-down between stages 3 and 4, which affected their streamline. The streaming levels of all the participants were in the order of 6 > 4 > 3 > 2 > 5.

Keywords: acceleration, jump horse, streamline, evaluation.

1. Introduction

Motion appearance indicates the energy spent during required movements. (Talha, 1994) showed that the most efficient movement is the one with the least effort. The feasibility of a movement can be determined by its constant rhythm in accordance with individual characteristics and high streamline. Biomechanical variables serve as bases not only for motion appearance improvement but also for movement qualification.

The proficiency stage of any movement should be strongly connected to motion appearance and kinematics variables. (Abdullah Hussein, 2007) stated that “motion appearances look for a relation between outer form of the movement and its goal, so these appearances are connected with the motion system and mechanism and body physiology.” Streamline pertains to the continuality and flexibility of a movement without exerting much effort.

Therefore, coaches focus on training individuals to get used to muscle tightening and loosening, so that a harmonic and continuous movement appears as arches when a graph is considered. Movement scope, time, and dynamics are important factors that should be considered when studying streamline. According to (Adel Abdul, 1998), “streamline can be judged through speed/time statistic whereas speed is changed gradually either increasingly or decreasingly keeping in mind that there is no stage when the body or a part of it is constant.” (Bastawiss, 1998) assured that “streamline forms are non-stopping of moving parts and no cute angles in moving line and ideal moving line or in the form of arches.” Streamline is used as a basis to evaluate skill level by analyzing the horse’s movement and specifying which stage causes a slow-down. Coaches who do not evaluate streamline only depend on observations through the naked eye and cannot analyze motion appearance. In equestrian show jumping, the rider and the horse jump over different barriers in curved ways. This sport requires the rider and horse to master the skills involved in fence jumping to reach the best success rate with the least effort. Show jump activities consist of stages. Braking or slowing down is important to change body direction during the main stage of movement.

The evolution of motion horse jumping performance in many views, which are found a high or very high genetic correlation between free jumping results and results of jumping competitions (Ducro et al. 2007). The horses were designated for either a good group or a poor group based on a qualitative evaluation; good horses throw variables kinematics (powers and Harrison, 2000). The influence of sex being insignificant and an influence of the height of the jump were statistically important only (Marsalek et al., 2010). Evaluate, through biometric, the forelimb hoof of horses participating in showing, jumping (Sampaio et al., 2013). In this study, the researcher gathers digital data to demonstrate motion trend and measure streamline by considering the acceleration variables and evaluating the motion streamline appearance of Qatari riders in equestrian fence jumping.

2. Methodology

The experiment was conducted on July 14, 2013 in the sport hall of Qatari Union of Equestrian. The researcher captured photos of a rider attempting to make a single barrier jump to recognize work obstacles, to test the efficiency of the equipment, and to specify the participating staff (•). The photo was taken by Sony camera with a speed of 50 pictures/second. The camera was placed vertically on the performance path 10 m away, and the lenses were 1.55 m high from the field ground figure (1).

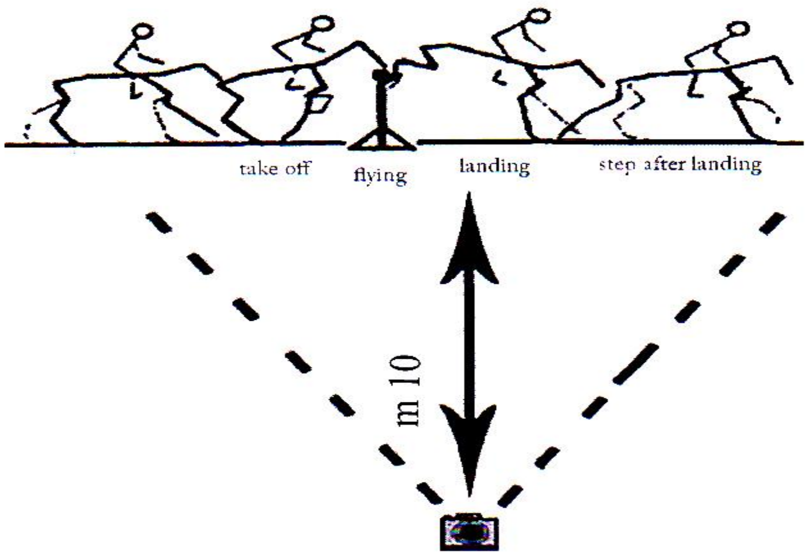

Figure 1. Camera place for a individual fence jump

The main experiment was conducted on July 16, 2013 in the hall of Qatari Union of Equestrian. Six players of the national Qatari team were selected as participants. Each player was given three attempts before the best was selected on basis of the least errors and best time. Data were obtained using the program Dartfish Pro Suit 5.5. The Research Biokinematic Variables were calculated depending on a specific gravity of the horse. The variables of fence jump step were measured by following the procedure in (Hilary, 1989).

- Step time before leaning to take off: the time between the collisions of front limbs during the step until the moment just before the raise of back limbs in the rush
- Step length before leaning to take off: the distance between the collisions of front limbs during the step until the moment just before the raise of back limbs in the rush
- Flying time: the time from the raise of back limbs to the highest point the horse can reach over the fence
- Landing time: the time from the highest point to the collision of front limbs after the fence
- Landing length: the distance between the highest point and the collision of front limbs after the fence
- Step time after landing: the time from when the back limbs touch and leave the ground until they touch the ground again
- Step length after landing: the distance from when the back limbs touch and leave the ground until they touch the ground again
- The last step speed: the result of dividing the last step length and leaning to take off on the last step time
- Flying speed: the result of dividing flying length on flying speed

- Landing speed: the result of dividing landing length on landing time
- Step speed after landing: the result of dividing step length after landing on step time after landing.

Figure 2. Shows the total movement trend

3. Results and Discussion

Table (1)
Shows Distance, Time, Speed variable of fence jump stages

Performance	Variable	Participant						Statistical	
		1	2	3	4	5	6	mean	Std
Take off stage (first)	distant	3.67	2.50	3.08	2.95	2.64	2.35	2.86	0.47
	Time	0.64	0.46	0.52	0.50	0.44	0.46	0.50	0.07
	speed	5.734	5.434	5.923	5.900	6	5.108	5.68	0.34
Flaying stage (second)	distant	1.03	0.95	1.05	1.04	1.18	0.91	1.02	0.09
	Time	0.18	0.18	0.18	0.18	0.20	0.18	0.18	0.008
	speed	5.722	5.277	5.833	5.777	5.900	5.055	5.59	0.34
Landing stage (third)	distant	1.51	1.78	1.85	1.74	1.81	1.75	1.74	0.11
	Time	0.28	0.36	0.34	0.32	0.32	0.36	0.33	0.03

	speed	5.392	4.944	5.441	5.437	5.656	4.861	5.28	0.31
After landing stage(foruth)	distant	1.33	1.21	1.41	1.40	1.39	1.42	1.36	0.08
	Time	0.28	0.26	0.28	0.28	0.28	0.30	0.28	0.01
	speed	0.750	4.653	5.034	5	4.964	4.733	4.85	0.16
Racetrack total	distant	7.54	6.44	7.39	7.13	7.02	6.43	6.99	0.46
	Time	1.38	1.26	1.32	1.28	1.24	1.36	0.32	0.03
	speed	5.46	5.11	5.59	5.57	5.66	4.64	5.40	1.12

Table (2)
Speed/time rate (acceleration) of fence jump stages

Participant	Speed/time rate (acceleration) of fence jump stages(m/s^2)		
	Step after landing	Landing stage	Flying stage
1	0.066 –	1.178 –	2.293 –
2	0.872 –	0.925 –	1.119 –
3	0.500 –	1.153 –	1.454 –
4	0.683 –	1.075 –	1.560 –
5	0.500 –	0.762 –	2.470 –
6	0.294 –	0.539 –	2.306 –
mean	0.485 –	0.938 –	1.897 –

As shown in table (2), the arithmetic mean of speed/time (acceleration) as an indicator for streamline between the step before leaning to take off and flying is –0.485 m/s, the arithmetic mean of speed/time (acceleration) as an indicator for streamline between flying and landing stages is –0.938 m/s, and the arithmetic mean of speed/time (acceleration) as an indicator for streamline between landing and step after landing is –1.897 m/s^2.

Table (2) shows a declining trend in the speed/time of jumping individual fences (stage of step before learning to take off, flying stage, landing, stage and step after landing). This result clearly indicates a difference in the streamline of movement stages as shown in table (1). Thus, acceleration variable is considered a criterion of streamline.

According to (Adel Abdul, 1998), "movement streamline can be determined from a graph of speed with time indicator where speed changes gradually whether increasingly or decreasingly regarding that there is no stage when the body or a part of it is motionless, the sudden change in speed or constancy of part of the body is a proof that there is no streamline, this results from the inaccuracy of skill performance or a mistake in doing it."

Observation of the performance stages showed a gradual decline when the riders did the fence step. This decline is often constant in the research sample, thereby assuring that skill performance is highly streamline. The researcher ascribed this streamlining to the nature of performance the riders did through the efficiency of the sample riders. (Sareeh Abdul Karim, 2010) confirmed that the movement scope is directly related to the time periods and the harmony of their application with motion performance, which is characterized by a good speed obtained from the preliminary steps of the horse before crossing the fence.

These steps give the body a great deal of movement because of the low inertia. That is, the preliminary movements reduce the inertia and eventually increase speed. (Samir Muslit,1990) stated that "a better movement performance can be achieved if its movement was after a certain number of approaching steps" (Raisan and Najah, 1992) assured that "The approaching run has an important benefit, i.e., it serves the sportsman by giving him a momentum which pushes him forward in order to cover a large horizontal distance." The speed was greater during the step before leaning to take off because the approaching steps of the horse before the last step to take off gave it a positive acceleration in stage (1). During this stage, acceleration was measured [table (2)] based on the decline in body inertia.

This speed increases the power in the push, which raises the specific gravity of the horse body in the flying stage. According to (Kamal and Sulaiman, 1999), "every body keeps constant or moving regularly unless a force obliges it to change its condition." One of the factors that affect self-default is body moving condition before performance starts, which explains the existence of a preparatory part in most sport movements (Samir, 1990). This part was clearly observed through the increase in the last step length before the take off according to the research sample from table (1).

The acceleration variable was the highest in the flying stage because the horse body obtained better force results and greater speed. (Hussein and Ayad, 2011) described acceleration as " the speed the body get due to outer force to move and it is increasing during movement then it decreases because speed tends constancy." The flying time was shorter than the landing time; thus, the flying speed exceeded the landing speed. Speed can be affected by either distance or time. Thus, in the flying stage, the horse uses the motion amount to jump over the fence and then contract the time of this stage.

This phenomenon explains why the flying speed is greater than the landing speed, and this is followed by motion amount decline, Similarly, (Hilary, 2004) studied each stage depending on momentum rule (momentum = speed × mass) because landing stage is when the body returns to the ground after doing the main part. Landing does not require that amount of muscle strain, and the body is almost in a state of relaxation. This condition is clearly indicated by the higher landing time than flying time. As shown in table (1), acceleration was less than in the previous stage, indicating streamline.

The speed and acceleration between the landing and the subsequent step declined table (2). This result indicates that the movement of the participant was harmonic and streamline, showing flow, beauty, and harmony. It can be attributed to the mutual relation between the outer and inner power. As stated by (Abdullah, 2007), "research the relation between outer form of the movement and its goal, these forms are connected with motion system of living creatures and with mechanical rules of movements and body physiology."

The proper utilization of power and energy saves effort and time. Evaluating sport movements through motion forms like streamline is important to develop and raise the technical performance level. Biomechanics and streamline are closely related because they both seek to make the movement economic. According to (Eman, 1992), "researches the movement and attempts to study the features of its trend graph in a way to show the technical performance as integral motion system through finding most proper motion solutions to exploit power and effort spent for more economic performance." figure (3) shows the trend of horse specific gravity during the performance stages of the participants.

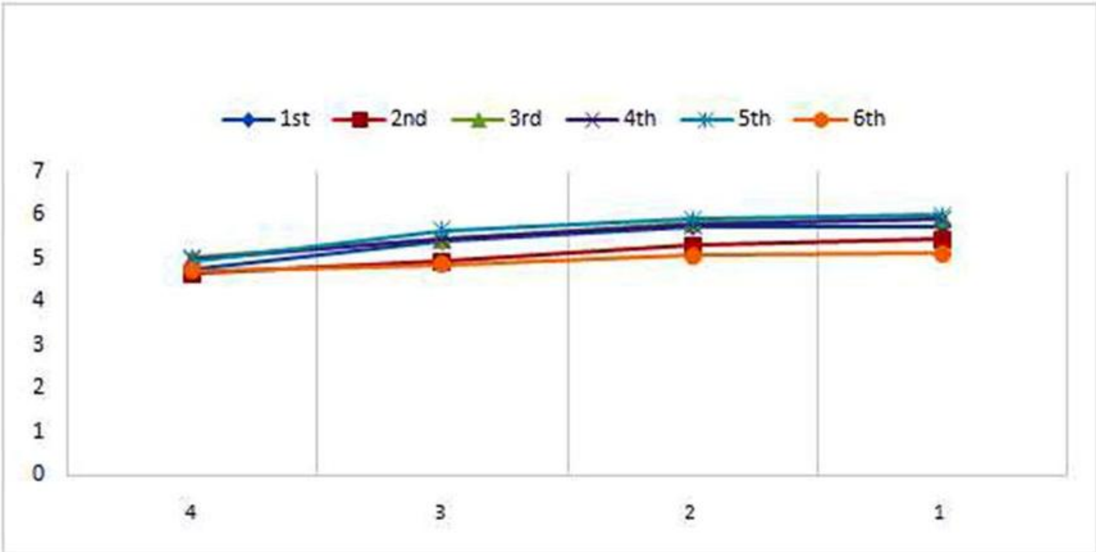

Figure 3. Speed trend of participants for the four stages (research sample)

As shown in figure (3) and table (1), the participants differed in speed during performance stages. For all participants, the speed differences between stages 1 and 2 are (0.012, 0.09, 0.157, 0.123, 0.1, 0.053), those between stages 2 and 3 are (0.33, 0.333, 0.392, 0.244, 0.34, 0.194), and those between stages 3 and 4 are (0.642, 0.291, 0.407, 0.437, 0.692, 0.128).

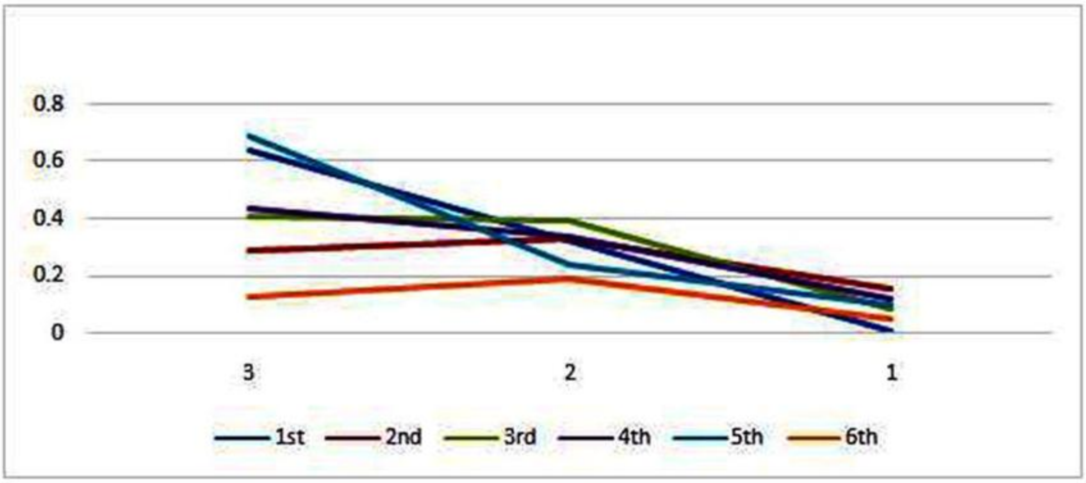

Figure 4. Sketch of the differences in speed among stages

Figure (4) shows the differences in speed among participants in all stages:

Between stages 1 and 2, participants 6 (0.053) and 2 (0.157) achieved the best and worst streamline from the difference, respectively. Between stages 2 and 3, participants 6 (0.194) and 2 (0.392) achieved the best and worst streamline from the difference, respectively. Between stages 3 and 4, participants 6 and 2 achieved the best (0.128) and worst (0.692) streamline from the difference, respectively.

These results show a clear level of streamline for all participants despite the differences in speed and acceleration values during the performance stages. This result can be attributed to the connection and harmony among the participants' performance as observed through the movement harmony of both rider and horse. That is, the required movements of the horse were harmonic with the instructions of the rider. (Hussein and Muhammad, 2007) assured that the harmony in the rider performance can be achieved by reducing the horse height over the fence. This means increasing horizontal movement and consequently obtaining a firm connection among fence jump stages. The connection between the step before and after the jump definitely helped achieve a good streamline in the participants' performance.

4. Conclusions

All of the participants showed a level of streamline because their performance did not contain sharp changes (stopping or stumbling) in direction. Participant 6 had the best streamline (0.128) in speed average because he demonstrated the least landing in stages 3 and 4. Participants 1 and 5 displayed a great decline in speed between stages 3 and 4, which affected their level of streamline as compared with the other participants. The streaming levels of all the participants were in the order of 6 > 4 > 3 > 2 > 5. The least difference in the speed of the participants from stages 1 to 4 was (0.984, 0.781, 0.889, 0.900, 1.036, 0.375).

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