World Journal of Sport Sciences 7 (4): 173-180, 2012
ISSN 2078-4724

DOI: 10.5829/idosi.wjss.2012.7.4.1181

Study of Some Kinematic Variables That Control the Performance of the Back Grand Circle on the Horizontal Bar and Ring in Men's Gymnastics

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Abstract: This study aims to identify the most important kinematic variables that control the performance of the back grand circle on horizontal bar and ring in gymnastics. The research sample was selected by intentional way for the best player in the Arab Republic of Egypt (national team). He performs the skills under study excellently on the opinions of experts and referees in the sport of gymnastics in that time and basing on his results and his winning of the Republic Championship. Many attempts were filmed, the best attempt for every machine and suitable for analysis was selected. Motion Track program has been used of kinetic analysis, a system of TV cameras and computers (installation time in seconds) for the phases of the technical skills of research and the horizontal distance and vertical (m) of the center of gravity in the skills of research and the shoulders angles (degree) of the studied skills and resultant velocity (m / s) to the center of gravity of the skills of research and to identify the kinematic characteristics controlling the performance of back grand circle skill on horizontal bar and ring and to identify the similarities and differences of the characteristics of kinematic controlling the performance of back grand circle skill on horizontal bar, ring and that within the community of this research and the tools used. In the light of the objectives and results of the biomechanical analysis, the researchers reached the following conclusions through the biomechanical analysis: The performance time of back grand circle on the horizontal bar was greater than the performance time of the back grand circle on the ring and equal to the performance the second quarter and the third quarter in the performance of back grand circle on the horizontal bar and the ring. The performance time of the fourth quarter in the performance back grand circle was bigger than the performance time of the first quarter in the performance of back grand circle on the horizontal bar and the ring. The path center of gravity for the player in the performance of back grand circle on the horizontal bar draw a circular shape around the axis of rotation (horizontal bar), while the path of the center of gravity for the player in the performance of back grand circle on ring draws a liner form (down to the bottom and up to the top) and is closing angle of the shoulders with the trunk when the performance of back grand circle on the ring was more than in the performance of back grand circle on the horizontal bar so as to overcome the pendulum movement that occur from the ring machine and the performance of back grand circle on the horizontal bar recorded more velocity from when the performance of back grand circle on the ring.

Key words: Biomechanics · Gymnastic · Horizontal Bar · Ring

INTRODUCTION

Each motor performance has special constructive characters from other motor performances and this construction specifications take specific arrangement and consists of a set of motor procedures, which accomplish the duty of the motor specific in its area time and has its own dynamism. Kinematic characteristics are identified through programs of motor analysis in order to analyze the performance skills of various sports skills to identify the variables that control the motor mechanical construction of each of them, considering that any motor skill depends on a set of dynamic parameters that constitute the entirety of motor skill building [1].

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The characteristics curve of the optimized performance technique for the sport reflects the optimal use of the mechanical laws on the basis of the biomechanical conditions that means available mechanical commitments and the characteristics of the human musculoskeletal system. The primary objective of most types of sporting activities is to achieve the fastest and the most powerful and highest and this means from the standpoint of biomechanics making greatest mechanical work trends in anti-external conditions (jump to a longest or height of the top), it also means utilization of mechanical capacity to make the movement of the highest degree (for example: achieving a certain distance in less time when doing movements of turns or maximum mechanical effort [2].

The kinetic analysis is the ideal way to solve the problems associated with skill performance as this analysis helps to the study of human performance by describing the skill; detecting errors and suggesting ways to correct them [3].

The process of kinetic analysis for the biomechanical characteristics is the important properties things to understand how to perform sports skills and to identify the nature of the work parts and joints of the body, as well as the variables to the status of the center of gravity, displacements and velocities by describing the skill and developing appropriate solutions for the treatment of performance mistakes and access to the best results [4-6].

The availability of a great deal of information about the motor analysis and the biomechanics to who works in the training field is an impact significant to identification of physical activity in which they work. It makes them more confident in their work which helps them to develop training programs, correct the mistakes, develop technical performance and prevent injuries among players [7, 8].

The meaning of the word analysis differs according to human knowledge that it logically means searching phenomenon under study after dividing them into elements of basic primary constituent where looking at these elements separately to achieve a deeper understanding of the phenomenon as a whole as the fragmentation is not a goal in itself but a mean to the possibility of totalitarian perception of the phenomenon as a whole, especially if this phenomenon is concerned with the movement of the organism, which cannot be achieved only through collection the parts and elements in an integrated unit [9].

The sport technique played by the athletes is a state of relative and does not have an integrated model of the sport technique for any player and through the biomechanical laws an ideal level technique can be reached, which is through complete knowledge and accurate essence of movement through the motor analysis of integrated and accurate for this movement, so the biomechanics is the basis of sporting technique in various sports with the link individual characteristic of Athletic [10].

The biomechanics see the sporting technique as a dynamic complex system of actions and elements of motor associated with each other, based on the optimal use and the leader of the potentials and motor skills of the player and the ideal technique has been reached through the biomechanical research and studies which is formed between the laws of the natures the biomechanical installation of the dynamic behavior as well as the individual characteristics of champions [11].

All gymnastic movements teaching and training is according to the specific form the law of arbitration and stating instructions and rules shape the motor performance of the skill. The principle of consuming effort is an important principle until the achievement all the movements required in the form of sentences motion, with no access to the fatigue stage, coming through consensus performance and controlled rhythm between the body parts and performance skill smoothly and the natural laws including for example: Newton's laws of motion and action of levers for the joints of the body and its particular importance in the achievement of the good duty motor which makes it easier to the extent the larger process of saving effort [12].

This study is an attempt to provide workers in the field of gymnastics training with some knowledge and information that will help in teaching youth to perform on back grand circle devices horizontal bar and ring by displaying and characterization of some of the kinematic variables to this skill of displacements, velocities, angles of the shoulders and the path of the center of gravity for the body during the performance of the back grand circle on both machines and it summed up the research problem in being a scientific attempt to study and conduct the biomechanical analysis to the back grand circle on horizontal bar and ring devices to identify the most important characteristics and try to explain some kinematic variables resulting from the player during the performance of this skill on both machines.

The research study skills that occur around the transverse axis that are reported by Elsabagh and Alaaeldin [9] as the axis that passes from side to the other side of the body breaking lateral plane and this axis either be a placebo also occurs when curved trunk baking or

bend frontal and either be true as it happens when the performance of a grand circle on the horizontal bar and either be true of timing and then turns into an placebo axis, as in the front somersault on the hands.

The researchers believe that during the performance of the back grand circle on a horizontal bar, the axis is constant and real during the performance, but during the performance of the back grand circle to the ring the axis is moving or roving.

Hence, the researchers wanted to identify the kinematic characteristics of back grand circle skill on horizontal bar and ring and the movement of the center of gravity in drawing a circular path around the transverse axis that the skill is performed around it.

Objectives:

- To identify the kinematic characteristics that control the performance of the skill of the back grand circle on horizontal bar and ring.
- To identify the similarities and differences of kinematic characteristics that controls the performance of the skill of the back grand circle on horizontal bar and ring.

Questions:

- What are the most important kinematic characteristics that control the performance of the skill of the back grand circle on horizontal bar and ring?.
- What are the main similarities and differences for kinematic characteristics that control the performance of the skill of the back grand circle on horizontal bar and ring?.

Previous studies have cast light on the many monuments that benefit current research in several respects (sample - tools used - results that have been reached in such research).

MATERIALS AND METHODS

Research Sample: The sample was selected in the intentional way for the best player in the national team of Arab Republic of Egypt. He performs skills under study perfectly based on the opinions of experts and referees in gymnastics at this time, as well as his results through winning the Republic Championship.

Methodology: The researchers used the descriptive method using video filming due to the suitability of the nature of the research.

The Researchers Identified the Kinematic Variables Extracted for the Study Skills Namely:

- Installation time (s) for the technical phases for the study skills.
- Horizontal and vertical distance (m) of the center of gravity for the study skills.
- Right shoulder angles (degrees) for the study skills.
- Resultant velocity (m / s) to the center of gravity for the study skills.

RESULTS AND DISCUSSION

The Percentages of Time Performance Study Skill on the Horizontal Bar and Ring: Table 1 shows the percentages of the performance time of the circle grand back skills on horizontal bar and ring machines.

Results of Table 1 show that the time of the performance of the second quarter and the third quarter performance of the circuit grand back grand device horizontal bar were equally in time of 0.36 s by 16.7% of the total time. In the first quarter, time was 0.60 s recording 27.7% less than the time of the fourth quarter (0.84 s) by 38.9% since the first quarter of rotation goes with gravity unlike the fourth quarter, which leads against gravity which makes the fourth quarter takes more time and be a negative acceleration against gravity.

Time of the second quarter and the third quarter performance of the back grand circle on ring equals 0.36 s at percentage of 17.65% of the total performance time as well as the time of the performance of the first quarter was 0.60 s at percentage of 29.4% of the total time less than the time of the performance of the fourth quarter (0.72 s) at percentage of 35.3% of the total performance time and the high time of fourth quarter is attributable to that negative acceleration against gravity.

Fig. 1 illustrated stick figure for the player's body during performing the grand back circle on horizontal bar. Fig. 2 shows the path of the center of body gravity during the performance and shows that the player is doing a full. Position circular shape around the horizontal bar.

It is clear from Fig. 3 the stick figure for the player's body during performance of the grand back circle on ring, as well as is clear from Fig. 4 the path of the center of

Table 1: The percentage of the performance time for the study skills

Machine		First quarter	Second quarter	Third quarter	Fourth quarter	Total
Horizontal bar	Time (s)	0.60	0.36	0.36	0.84	2.16
	Percentage	27.7 %	16.7 %	16.7 %	38.9 %	100 %
Ring	Time (s)	0.60 %	0.36 %	0.36 %	0.72 %	2.04 %
	Percentage	29.4 %	17.65 %	17.65 %	35.3 %	100 %

Table 2: Horizontal and vertical displacement of the center of gravity for the bodyin the grand back circle on (horizontal bar - ring)

		Horizontal bar		Ring	
Frames	Time	Horizontal displacement	Vertical displacement	Horizontal displacement	Verticaldisplacement
1	0.00	0.08	1.02	-0.01	1.01
2	0.12	-0.06	1.01	0.00	0.97
3	0.24	-0.22	0.98	-0.04	1.00
4	0.36	-0.39	0.93	-0.04	0.98
5	0.48	-0.58	0.88	-0.06	0.84
6	0.60	-0.81	0.71	-0.03	0.62
7	0.72	-1.00	0.39	-0.06	0.16
8	0.84	-1.13	0.04	-0.05	-0.38
9	0.96	-1.00	0.64	-0.08	-1.02
10	1.08	-0.51	1.12	-0.08	-1.19
11	1.20	0.16	1.27	-0.02	-0.64
12	1.32	0.81	1.00	0.01	-0.20
13	1.44	1.02	0.34	-0.03	0.24
14	1.56	1.02	0.20	-0.06	0.59
15	1.68	0.84	0.63	-0.06	0.80
16	1.80	0.61	0.91	-0.08	0.94
17	1.92	0.38	1.03	-0.12	1.03
18	2.04	0.13	1.04	-0.17	1.04
19	2.16	-0.07	0.97		

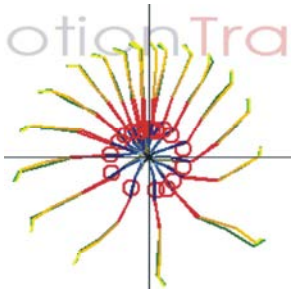

Fig. 1: Stick Figure of the body during the performance the grand back circle on horizontal bar

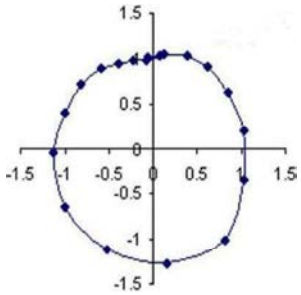

Fig. 2: The geometrical path to the player's center of gravity during the performance of the grand back circle on horizontal bar

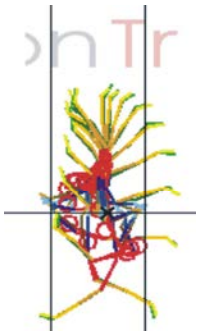

Fig. 3: Stick Figure of the body during the performance of the grand back circle on ring

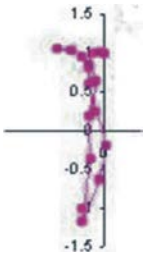

Fig. 4: The geometrical path to the player's center of gravity during the performance of the grand back circle on ring

Table 3: Shoulder angles in the back grand circle on horizontal bar and ring

		Shoulder angles	
Frames	Time	Horizontal bar	Ring
1	0.00	158.14	163.67
2	0.12	177.71	178.60
3	0.24	178.86	155.98
4	0.36	171.72	151.01
5	0.48	178.70	162.70
6	0.60	173.90	163.55
7	0.72	172.89	160.86
8	0.84	173.22	151.78
9	0.96	162.80	160.10
10	1.08	166.06	145.25
11	1.20	168.24	88.20
12	1.32	174.49	44.43
13	1.44	146.64	69.74
14	1.56	129.88	97.26
15	1.68	136.91	143.07
16	1.80	155.13	164.49
17	1.92	156.83	143.26
18	2.04	176.21	164.06
19	2.16	174.00	

body gravity during the performance and it is clear that although the player is doing full circle center of gravity on horizontal bar as well as the performance of grand back circle on the ring, the player does not make a full circle on ring because the ring may move forward and backward and the player must perform to control it in a certain limit, otherwise the performance will not be perfect by the forces that dominate the player during the performance.

Although the axis of rotation is real in horizontal bar and ring not placebo axis like that occurs during rotations in the air, so the player cannot do the full rotation circle as in on horizontal bar because the movement of the ring forward and backward in pendulum. Elsabagh and Alaaeldin [9] pointed out that the axes of rotation either true axes during the entire performance or real axes then transformed into placebo axes when start the rotations on the floor or on machine and completed in the air then changed to placebo axes and in last placebo axes when performing whole rotations in the air.

Table 2 shows horizontal and vertical displacement of the center of gravity for the body during the performance of the grand back circle on horizontal bar and ring machines.

Table 3 shows the shoulder joint angles during the performance of the grand back circle on horizontal bar and ring.

Table 3 shows the resultant velocity for the body's center of gravity in the grand back circle (horizontal bar - ring).

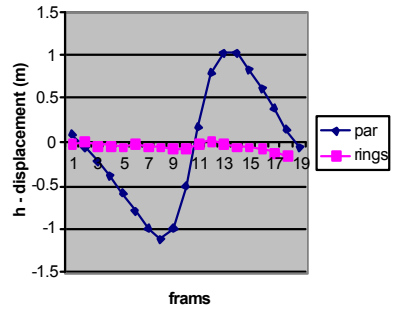

Fig. 5: Horizontal displacement of the center of gravity for the body during the performance of the grand back circle on horizontal bar and ring

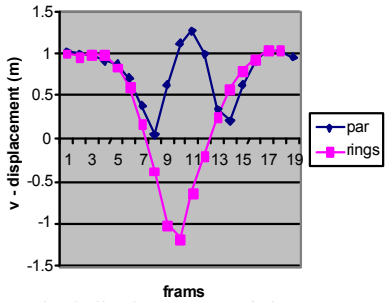

Fig. 6: Vertical displacement of the center of gravity for the body during the performance of the grand back circle on horizontal bar and ring

It is clear from Table 2 and Figs. 5 and 6 the horizontal and vertical displacement for the player's center of gravity during the performance of the back grand circle on horizontal bar and ring. in the horizontal bar, the horizontal displacement reached -1.13 m in the frame number 8 which is located in the second quarter of rotation as well as the total horizontal displacement reached 1.02 m in the frame number 14 which is located in the fourth quarter of rotation while the vertical displacement in less value recorded 0.04 m in the frame number 14 which is located in the second quarter of rotation. The vertical displacement was 0.20 m in the frame number 14 which is located in the fourth quarter of rotation and the back grand circle on ring reached maximum horizontal displacement (- 0.17 m) in the frame number 19 at the end of the movement, while the vertical displacement in frame number 10 reached -1.19 m ??at the end of the movement the vertical displacement reached maximum value (1.04 m) and this shows that the movement in the ring were not circular shape around the axis while came like back somersaults due the fulcrum hands instability when the rotation axis.

Appears to us from Table 3 and Fig. 7 the angular change of shoulder joint in the back grand circle on horizontal bar and ring, where it is clear that the player

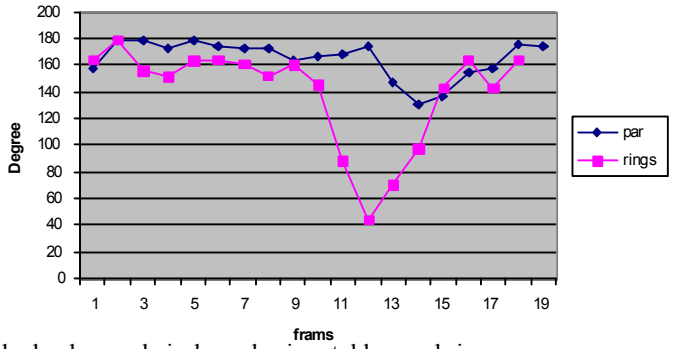

Fig. 7: Shoulder angles in the back grand circle on horizontal bar and ring

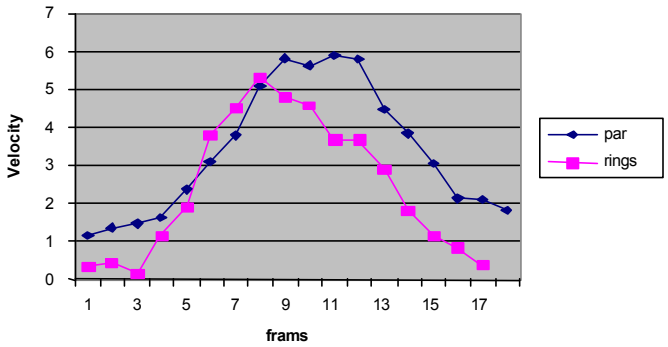

Fig. 8: Resultant velocity for the body's center of gravity in the grand back circle (horizontal bar - ring)

Table 4: Resultant velocity for the body's center of gravity in the grand back circle (horizontal bar - ring)

Frames	Time	Horizontal bar	Ring
1 -> 2	0.00	1.15	0.35
2 -> 3	0.12	1.36	0.44
3 -> 4	0.24	1.46	0.16
4 -> 5	0.36	1.66	1.17
5 -> 6	0.48	2.37	1.91
6 -> 7	0.60	3.13	3.82
7 -> 8	0.72	3.78	4.52
8 -> 9	0.84	5.06	5.32
9 -> 10	0.96	5.80	4.80
10 -> 11	1.08	5.64	4.58
11 -> 12	1.20	5.87	3.69
12 -> 13	1.32	5.79	3.68
13 -> 14	1.44	4.48	2.91
14 -> 15	1.56	3.86	1.81
15 -> 16	1.68	3.04	1.15
16 -> 17	1.80	2.13	0.83
17 -> 18	1.92	2.09	0.40
18 -> 19	2.04	1.83	

was able to maintain during the performance of the back grand circle on horizontal bar to be the angular changing for shoulders are very few and approaching preservation on the straight angle with a trunk 180 degrees during the performance of the rotation, but from frame 13 to frame 17 near the end of the fourth quarter the player closed shoulder angular to resist the gravity, as well as to stop the movement to complete the back grand circle access to stand on the hands of the horizontal bar (return to the primary status of the movement). In the back grand circle on the ring, the player closed the shoulder angle beginning from frame 11 to frame 14 from the middle movement, perhaps the ring machine according to the combination makes the player faces the challenge of controlling the machine during the performance, which makes the player difficult to an extended in his arms straightness with the body which leads the ring move forward and backward in pendulum movement and it works the player as much as possible the closure of the shoulders angle with the trunk and this makes the grand back circle on ring like back somersaults.

And it is clear from Table 4 and Fig. 8, the resultant velocity for the center of body gravity in the back grand circle on horizontal bar and ring. The results show us that the maximum velocity of the center of gravity of the player in the back grand circle on horizontal bar were among the frame 11 and frame 12 in terms of 5.87 m / s after the middle of the movement to overcome the continuity of gravity. In this regard, El-Hariri [13] mentioned that the quick bending works to increase the velocity of the body in the direction of rotation in the period up where the body to the highest against the resistance of gravity in completing

duty motor. The maximum velocity of the center of gravity of the player in the back grand circle on ring between frame 8 and frame 9 reached 5.32 m / s in the middle of the movement, which explains the movement of change velocity the center of gravity of the player when he fall to the lowest level in the direction of the ground to re-rise to the top in the direction of same linear rather than circular.

CONCLUSION

- The time of the performance of back grand circle on horizontal bar is greater than the time of the performance of back grand circle on the ring.
- Equality of the time of the performance of the second quarter and the third quarter in the performance of the back grand circle on horizontal bar and ring.
- The time of the performance of the fourth quarter in the performance of the back Grand circle is greater than the time of the performance of the first quarter in the performance of the back grand circle the on horizontal bar and ring.
- The path of the center of gravity of the player in the performance of the back grand circle on horizontal bar draws a circular shape around the rotation axis (horizontal bar), while the path of the center of gravity of the player in the performance of the back grand circle on the ring draws a liner shape (down to the bottom and up to the top).
- The shoulder angle with the trunk closed when the performance of the back grand circle on the ring larger than in the performance of back grand circle on horizontal bar so as to overcome the pendulum movement which occur from ring machine.
- The performing of back grand circle on horizontal bar machine more quickly them when the performances of the grand back circle on the ring machine.

Recommendation:

- Necessity to use the resulting data from the motor analysis of the research skills on the horizontal bar and ring when training and teaching gymnastics.
- Taking into account skills makeup in both machines (horizontal bar and ring)when submitting exercises for training and teaching because of the different form of performance and different form of kinetic path to the center of gravity during the performance of skill on both machines.
- Proceeding similar research and comparisons between similar skills on same machine or on different machines and thus saving time and effort for the player and the coach as well as working on transition of the training effect between different skills after understanding the performance form and the mechanical variables affecting them.
- Attention to kinetic analysis in studying and interpretation of the motor skills to reach the best possible performance in the light of the particular conditions of performance.
- Necessity to provide a laboratory for the biomechanical analysis in all educational and training institutions that are interested teaching and training of the technical performance of the various sports skills.

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