

Biomechanical Indicators Contribution Ratios of the Ball Velocity in Aiming for the Skill of Ball Hitting in Field Hockey

Randa Shawky Said Hassan

Department of Games, Faculty of Physical Education for Girls, Zagazig University, Egypt

Abstract: The aims of this paper are to examine the application of performance indicators the Skill of Ball hitting by the Flat Face of the Stick in Field Hockey. Sample of the research consisted of 4 female players from the Egyptian Field Hockey National Team, as each player performed 2 attempts to improve the skill of hitting the ball by the flat face of the field hockey stick. As such, the number of trials that were subject to analysis was 8 trials. Results were as follows: (a) the left hand is the main factor in holding the stick in the hockey game, which in turns affects the performance of the basic skills especially the skill of hitting with the flat face. (b) The spin-off velocity of the stick handle increases it leads to the occurrence of two things: first, the collision of the stick will be from the upper half of the ball which affects ball not going high from the ground at the spot of the collision of the ball with the stick. Second, the location of the collision will expand over the flat face of the stick and not at the curved area, which in turns affects the ball not going high to form a risk and a foul, which affects the velocity of the ball at aiming. (c) The value of the angle of the elbow decreases, the stick height gets up, which is regarded as a legal error.

Key words: Biomechanical Indicators • Analysis • Field Hockey • Ball Hitting

INTRODUCTION

The world today lives an improvement revolution in every moment and the developed countries are paying attention to all the ways and means that help improve the levels of performance, which in turn will have a direct and positive effect on the individual.

Therefore, the use of the technical aspects of the biomechanics in the athletic field helps identify the characteristics of the skills and obtaining effective mechanical concepts of performance or determining the factors that are linked to the success of the motor performance [1].

Recently, attention has been paid to how to apply the bases, rules and scientific theories of the physical, mechanical and biological sciences on the human movements in general and on the movements of the athletes in particular. Scientists also emphasized that it is the correct way to find the optimum solutions for various problems of the motor, skillful and technical performance in order to reach the best possible ways that may lead the human system to achieve biggest accomplishments and highest possible athletic levels [2, 3].

Scientists emphasize that the biomechanical characteristics and indicators are the measure of the mechanical state of the biological system and the resulting changes into it. The mechanical state is characterized by change. Therefore, the biomechanical features describe the human body as being the subject of the mechanical movement. As such, it allows distinction between various movements of this system when determining the components of the movements system [4].

Hockey game, like team sports, has its own basic skills. However, it is different from other games in its use of the skills of using the hockey stick, in addition to the ball and its velocity. The good technical preparation of the hockey players is achieved through perfecting all skills in addition to the correct use of the stick and feet movements, as well as the careful observation of the movement, velocity and strength of the ball. Therefore, hockey game highly depends on the compatibility and accuracy during performance [5].

The skill of hitting by the flat face of the stick is considered the most used skill during the game and the most important at all. The perfection of this skill is very

important in the preparation and distinction of the hockey player for it is used in the direct aiming at the goal or in passing all over the field. The velocity of the hit makes its effect as to the level of perfection by the player. Therefore, it should be paid attention in all training stages starting from juniors and through the high level players.

The importance of the biomechanical indicators is very apparent for they are one of the distinguishing indicators through which we can study the level of development and the improvement of the skillful performance. This lead the researcher to study these indicators with the target of reaching objective measurements through which we can determine the range of improving skillful performance and reaching the best description of the nature of performance through reaching predictive mathematical equations for the levels of performance.

MATERIALS AND METHODS

Population and Sample of the Research: The researcher utilized the descriptive approach and depended on the mechanical analysis by the fast video analysis method. The sample of the research consisted of 4 female players from the Egyptian Field Hockey National Team, who are enrolled among the Sharkia Sporting Club for Girls. The players were chosen by the intentional method, as each player performed 2 attempts to improve the skill of hitting the ball by the flat face of the field hockey stick. As such,

the number of trials that were subject to analysis was 8 trials. Their age, height, weight, body mass index were 228.25 ± 1.258 months, 1.627 ± 0.0221 meter, 64.00 ± 2.943 kg, 24.167 ± 1.181 kg/m², respectively (Mean \pm SD).

Statistical Analysis: The researcher used the SPSS 15.0, statistical program for data processing.

The Basic Study: The researcher performed the measurements of the basic study one week after the exploring study, on 13/4/2010 at 3pm, in the Hockey Field of the University of Zagazig. The first camera was placed to the right side of the player at 9 meters distance, 90 cm height and an angle of 90° on the player as she was on the 18-meter line. The second camera was placed at 9 meters distance, 90 cm height and an angle of 45° on the path of the ball and perpendicular on the player as she was on the 18-meter line. The velocity of the camera was set at 250 cadres per second. Statistical manipulations were used such as Pearson's simple correlation coefficient matrix and multiple regression analysis.

RESULTS AND DISCUSSION

First Indicator: Tables 1, 2 and Figures 1,2 results show that the indicator of the vertical velocity of the left hand's wrist is the most contributing indicator to the ball velocity in aiming by the skill of hitting with the flat face, as its rate of contribution was 93.65%.

Table 1: The correlation between the anatomical points and the ball vX at the moment the Stick is parallel to the ground

Anatomical points	Left wrist vx	Left wrist vz	Right wrist vy	Left hand vx	Right hand vx	Right hand vz	Ball Z	Ball vx
Left wrist vx								
Left wrist vz	0.7544							
Right wrist vy	0.8800	0.7290						
Left hand vx	0.9009	0.8148	0.9386					
Right hand vx	0.9344	0.8764	0.7706	0.8274				
Right hand vz	0.6063	0.9458	0.6732	0.7311	0.7732			
Ball Z	-0.9830	-0.8590	-0.8760	-0.9200	-0.9670	-0.727		
Ball vx	-0.840*	-0.905*	-0.874*	-0.842*	-0.885*	-0.845*	0.8995*	

R= 0.707

Table 2: Multiple regression analysis of displacements and the horizontal and vertical velocity of the biomechanical indicators at the moment the stick is parallel to the ground

Anatomical points	Average	Standard Error	Residuals	F	p1	p2	p3	p4	%
Left wrist VZ	-1.4875	6.555458	1.855400	103.3	-15.080				93.650
Ball Z	-0.8960	0.895889	0.006003	2949.9	-3.641	-21.10			99.898
Right hand VX	7.3932	0.827570	0.002529	2305.4	-2.063	-33.40	-1.177		99.927
Right wrist VY	2.2082	0.557168	0.000210	3816.2	-1.407	-33.43	-0.805	-0.82	99.973

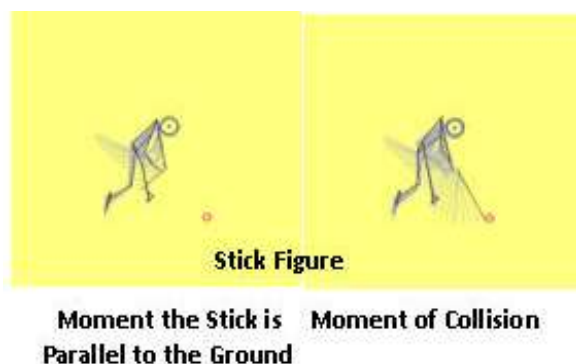


Fig. 1:

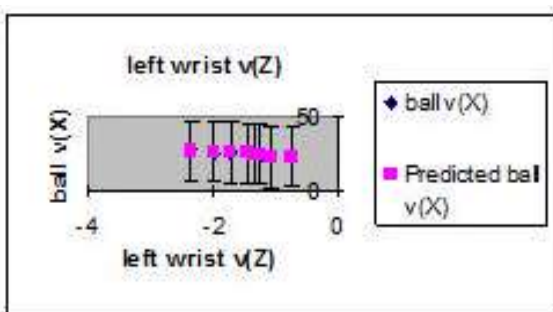


Fig. 2:

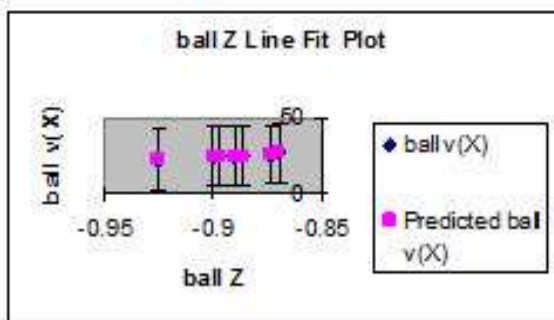


Fig. 3:

The researcher justifies this result such as the left hand is the main factor in holding the stick in the hockey game, which in turns affects the performance of the basic skills especially the skill of hitting with the flat face.

This corresponds with Deepak Jain as the work of the left hand is important in the skill of hitting, especially in the back swinging. The strength of the hit depends on the velocity of the stick during the back swinging to reach a high level provided that its height dose not exceed a higher level than the shoulder the moment the stick is parallel to the ground [6]. From the above, the Predictive Regression Line Equation is: $y = a + b_1 \cdot x_1$.

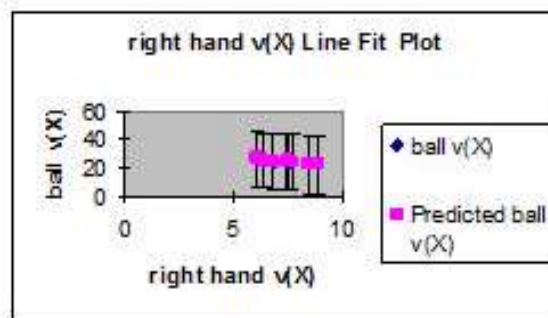


Fig. 4:

Second Indicator: Tables 1, 2 and Figure 3 results also show that the vertical displacement of the ball is the second contributor in the velocity of the ball in aiming by the skill of hitting with the flat face, as it raised the ratio of contribution from 93.65% to 99.90%, i.e. a percentage of 6.25% from the value of the first contributor.

The researcher views the contribution of the vertical displacement of the ball as a natural result of the end of the back resilient swinging stage of the stick and the start of the moment of collision during which velocity is decreasing to reach the moment of collision to provide for the two elements of actual strength and appropriate accuracy [7], emphasize this as the fast back swinging affects the velocity and strength of the ball during aiming and its accuracy. Players have to control very well the back swinging and the direction of the stick so that the ball is hit in the right place, which in turns the ball gets the maximum velocity at the moment of hitting (collision).

From the above, the Predictive Regression Line Equation is:

$$y = a + b_1 \cdot x_1 + b_2$$

Third Indicator: The results of Tables 1,2 and Figure 4 show that the horizontal velocity of the right hand is the third contributor in the velocity of the ball in aiming by the skill of hitting with the flat face, as it raised the ratio of contribution from 99.90% to 99.93%, i.e. a percentage of 0.03% from the second contributor. The researcher attributes the contribution of this point by this little ratio to producing power, as the work of the right hand is only to assist the left hand in holding the stick. Further, during the back swinging, the right hand inches upward the stick below the left hand so that it does not hindrance the movement of the stick during the back swinging and to ease the work of the left hand. This conforms to Podesta [8] that the work of the right hand in the skill of hitting with the flat face is only to assist the stick at the back swinging to maintain the direction of the stick.

Table 3: The correlation between the anatomical points and the ball vX at the moment of collision

Anatomical points	Left elbow vz	Left knee vy	Heel right Z	Racket vy	Horizontal bar vy	Ball Z	Ball vx
Left elbow vZ							
Left knee vY	-0.8720						
Heel right Z	0.8329	-0.9160					
Racket vY	-0.9340	0.7044	-0.7310				
Horizontal bar vY	0.8830	-0.9170	0.7915	-0.820			
Ball Z	0.9364	-0.8660	0.7403	-0.845	0.9318		
Ball vX	0.8405*	-0.809*	0.8127*	-0.832*	0.8831*	0.883*	

R= 0.707

Table 4: Multiple regression analysis of displacements and vertical and horizontal velocity of biomechanical indicators at the moment of collision

Anatomical points	Average	Standard Error	Residuals	F	p1	p2	p3	p4	%
Hand grip vy	0.630	22.167	18.215	2.65	9.66				27.44
ball Z	-0.894	0.914	0.004	2826.70	1.57	-26.05			99.89
Left elbow vz	0.997	0.914	0.002	1891.60	1.04	-25.53	0.80		99.91
Racket vy	2.371	0.996	0.002	1194.60	1.05	-26.21	0.31	-0.05	99.92

From the above, the Regression Line Equation is:
 $y = a + b_1 \cdot x_1 + b_2 \cdot x_2 + b_3 \cdot x_3$

Fourth Indicator: The results of tables 1, 2 and Figure 5 also show that the spin-off velocity of the wrist of the right hand is the fourth contributor in the velocity of the ball in aiming by the skill of hitting with the flat face, as it raised the ratio of contribution from 99.93% to 99.97%, i.e. a percentage of 0.04% from the third contributor. The researcher trace the contribution of the spin-off velocity of the right hand wrist with such ratio as it indicates that the movement of the right hand at the back swinging and the parallelism of the stick to the ground, which moves from the middle of the stick upward the stick and below the left hand, has the effect on the velocity of the ball during aiming [9].

From the above, the Predictive Regression Line Equation is:

$$y = a + b_1 \cdot x_1 + b_2 \cdot x_2 + b_3 \cdot x_3 + b_4 \cdot x_4$$

First Indicator: The results of Tables 3, 4 and Figure 6 had shown that the spin-off velocity of the handle of the stick is the most contributing indicator at the moment of collision, as its contributing ratio amounted to 27.43%. The researcher attributes this result such that as the spin-off velocity of the stick handle increases it leads to the occurrence of two things: first, the collision of the stick will be from the upper half of the ball which affects ball not going high from the ground at the spot of the collision of the ball with the stick. Second, the location of the collision will expand over the flat face of the stick and not at the curved area, which in turns affects the ball not going high to form a risk and a foul, which affects the velocity of the ball at aiming.

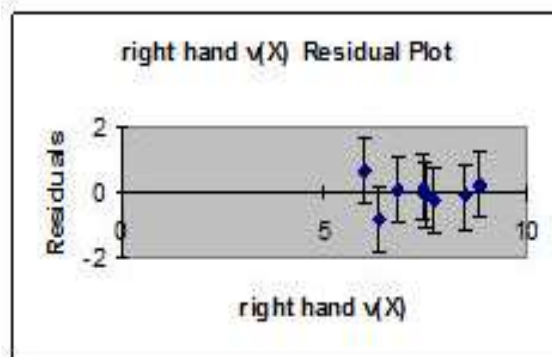


Fig. 5:

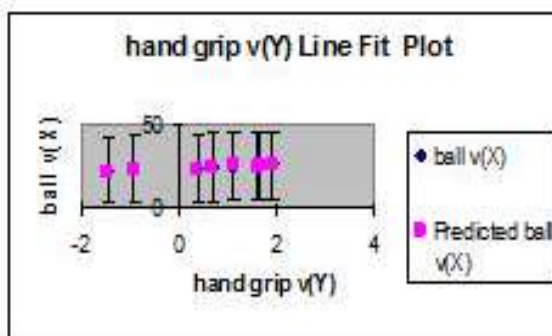


Fig. 6:

Second Indicator: It also appears from Table 2 and Figure 7 that the indicator of the vertical displacement of the ball is the second contributor in raising the level of the velocity of the ball in aiming by the skill of hitting with the flat face as it raised the contribution ratio from 27.43% to 99.89%, i.e. with a percentage of 72.46%. The researcher attributes the contribution of the vertical displacement of the ball at the moment of collision for it is despite the huge spin-off velocity of the stick handle,

Table 5: The correlation between angles and the ball VX at the moment the stick is parallel to the ground

Angles	Left elbow X	Left ankle-bone X	Ball v(X)
Left elbow X			
Left ankle-bone X	0.722		
ball v(X)	-0.946*	-0.711*	

R= 0.707

Table 6: Multiple regression analysis of angles at the moment the stick is parallel to the ground

Angles	Average	Standard Error	Residuals	F	p1	p2	%
Left elbow	157.058	2.823878	0.12612	587.4164	0.153886		98.8224
Left ankle	115.701	1.885497	0.0441	663.6547	-0.23191	0.524412	99.55

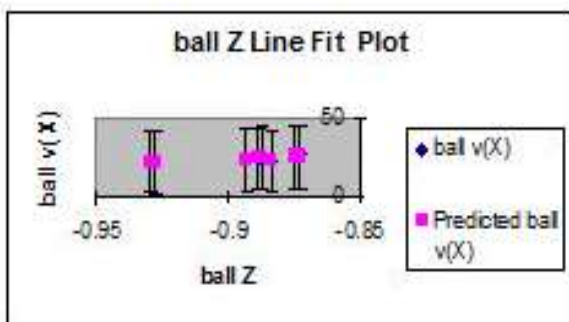


Fig. 7:

however the player, at the moment of collision, makes a breaking to this velocity in order to modify the position of the ball and at the appropriate location the ball takes off accurately towards the target.

Third Indicator: It appears from Tables 3, 4 and Figure 8 that the indicator of the vertical velocity of the left elbow is the third contributor in raising the level of velocity of the ball in aiming by the skill of hitting with the flat face, as it raised the contribution ratio from 99.89% to 99.91%, i.e. a percentage of 0.02%.

Fourth Indicator: It appears from Tables 3, 4 and Figure 9 that the indicator of the spin-off velocity of the face of the stick is the third contributor in raising the level of the ball velocity in aiming, as it raised the contribution ratio from 99.91% o 99.92%, i.e. a percentage of 0.01%.

First Indicator: It appears from Tables 5, 6 and Figure 10 that the indicator of the angle of the left elbow is the first indicator in the horizontal velocity of the ball, as the value of the angle was 157.058 degrees and the contribution ratio was 98.82%. The researcher attributes this such that as the value of the angle of the elbow decreases, the stick height gets up, which is regarded as a legal error. Also as the value of this angle increases, the stick gets more downward which affects the velocity of the ball.

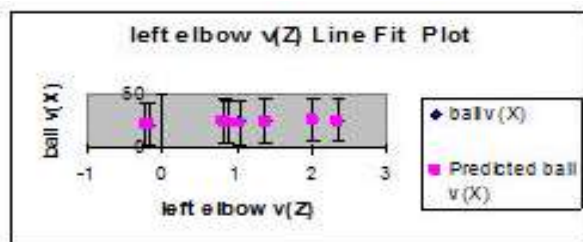


Fig. 8:

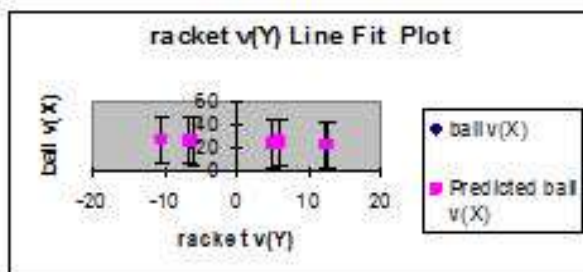


Fig. 9:

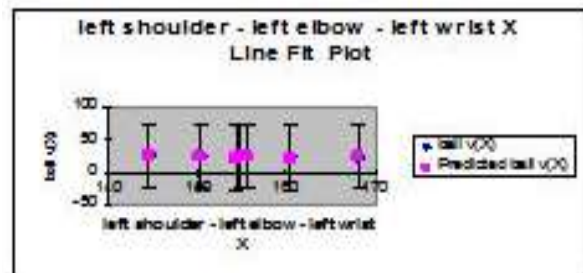


Fig. 10:

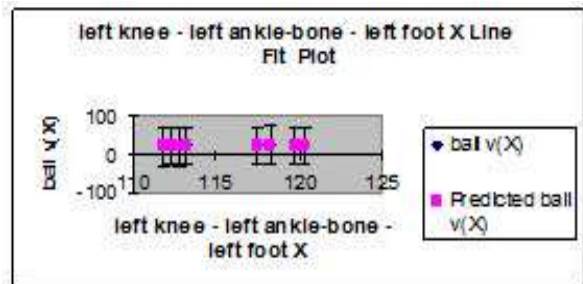


Fig. 11:

From the above, the Regression Line Equation is:
 $y = a + b_1 \cdot x_1$.

Second Indicator: It also appears from same Table 6 and Figure 11 that the indicator of the angle of the ankle of the left foot is the second contributing indicator to the horizontal velocity of the ball, as it raised the contribution ratio from 98.82% to 99.54%, i.e. an improvement percentage of 0.72%, as the angle of the left foot ankle was 115.70 degrees. The researcher attributes this such that the players will mount on the toe of the left foot, which means the transfer of the motor push from the back mounting foot to the front foot, the thing that helps players produce the best horizontal velocity of the ball.

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