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BIOMECHANICAL EVALUATION OF THE TECHNICAL SKILL FOR BACKHAND FLAT HIT IN FIELD HOCKEY

(Original scientific paper)

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Abstract

The aim of this study is to derive quantitative criteria for assessment of the technical skill for performing one of the basic field hockey strokes – the handback hit. The kinematic structure of 2 groups of participants was studied – beginners and field hockey players from V.Levski National Sports Academy. A Casio Exilim Pro was used to capture the movements of the participants. The motion analysis was conducted with the help of a video computer system with modified cubic spline interpolation for recovery *of missed data. Discriminant analysis discloses parasitic motor phases, irregular points in the unfolding of the kinematic structure functions and qualitative links between their swing and the accuracy of the hit. The results from the study can be successfully used for improvement of the training activity.*

Keywords: *biomechanics, quantitative criteria, movement control*

INTRODUCTION

From a biomechanical perspective, similar to other sports disciplines (Gantcheva (Ганчева), 2013), the technical skill for field hockey should ensure two relatively independent directions of the target function – the strength and the accuracy of the hit, respectively. The strength parameters can easily be determined quantitatively by means of the basic biomechanical assessment principles. However, precision analysis is a very complex function (superposition) of the control over all degrees of freedom participating in the motor activity.

A predominant goal of the study is - by means of a comparative biomechanical analysis of kinematic characteristics - to derive criteria for a quantitative assessment of the technical skill with one of the basic strokes in field hockey – the backhand flat hit.

METHODS

Two groups of participants in the study were formed - 11 beginner players and 12 experienced players from the NSA's hockey club. Each hockey player performed 14 hits from a distance of 12 meters. The ball had to reach a square located in the lower left corner of a standard hockey goal. Two perpendicularly placed Casio Exilim Pro were used to capture the hits.

The obtained 120 Hz cadence video files were processed with a videocomputer analysis system (Arakchiyski (Аракчийски), 2002a). An incompletely damping digital low-pass filter with a cutoff frequency of 10 Hz was used to smooth out of digitized data. A modified cubic spline interpolation for recovery of missed data was also used (Arakchiyski (Аракчийски), 2002b). Were registered coordinates of body landmarks as follows: lower limb – ankle, knee and hip (coxofemoral) joints; upper limb – wrist, elbow, shoulder joints and the end of the stick. The data were processed with the help of a variation and correlation statistical analysis.

RESULTS AND DISCUSSION

Figure.1 illustrates the curved paths of all major joint centers and the stick head. The target function is most directly impacted by the stick head path, therefore we consider the other paths as ancillary ones that adjust the precision of the major hit – the severity of the impact depends on the distance of the respective joint centers to the path resulting from the hitting point. Figure 2 illustrates the comparative analysis between two typical paths of the hits performed by a beginner and by an experienced player.

Clearly, the beginner attempts adjustments until the last moment, probably because it is more difficult for him to judge the necessary distance to the ball. For the experienced player the path of the last phase from point A to point B is a smooth function gradually decreasing the curve radius. Certain significant differences between beginners and skilled players are noticed. Generally, this is related to the stability of all spatial parameters, which we could expect, in as much as the degree of automation increases with the player's becoming more skilled.

Table 1 contains the statistical data from the com-

parative analysis between the two groups of participants in the study. The average statistical values obtained for the group of experienced players are used as model parameters.

The comparative analysis between the two groups defines certain assessment criteria (discriminant characteristics), the first one being the length of the downswing in the pre-hit phase. An interim phase appears the case of the beginners which is completely absent in the case of the experienced players. Moreover, the beginners' final phase lasts significantly longer and its path has a clearly expressed curve. For the sake of clarifying the variations between the two groups we conducted an experiment for statistical assessment in the individual behavior of the discussed parameters of two participants in the study – one beginner and one experienced player. Their multiple hits and the statistical processing are shown in Table 2.

Clearly, the average values of the angle at release have no informative value about the player's skillfulness. The significant differences are in the stability of the movement system (standard deviation 2 against 6.1 for the beginners). The conclusion can be drawn that in the case of the two above mentioned players, the beginner's imperfect skills are not a systematic error. From a statistical perspective, the impression of a random distribution feature is created. However, from a biomechanical perspective the studied process is controllable and hence future targeted experiments should focus on the causality of the above "pseudo-random" process.

Figure. 3 illustrates the velocities in the studied degrees of freedom of movement. The target function is most directly expressed by the stick movement curve. This function is in a causal relation with all curves illustrating the velocity features of the studied degrees of freedom in the cinematic chain. Irregular points are the local extremes in points 1, 3 and 4, the global maximum in point 5 and the inflexion point 2. The statistical features of the variation analysis for the values in the above irregular points are presented in Table 3.

Clearly, the average values, due to the assessment's statistical nature, lack the desired sensitivity of an indicator assessing the player's technical skill. Table 4 illustrates the values of the correlation ratio of the two groups compared to the performed hit precision.

Statistically important is only point 4 r = - 0.96 for the beginners. This information is a reliable parameter for improvement of the beginners' training process. We attempted to conduct a mini-experiment with super-fast

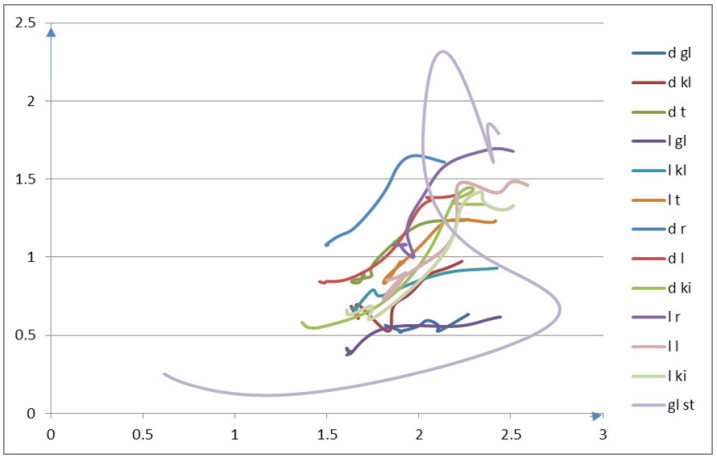

Figure 1. Curved paths of all major joint centers

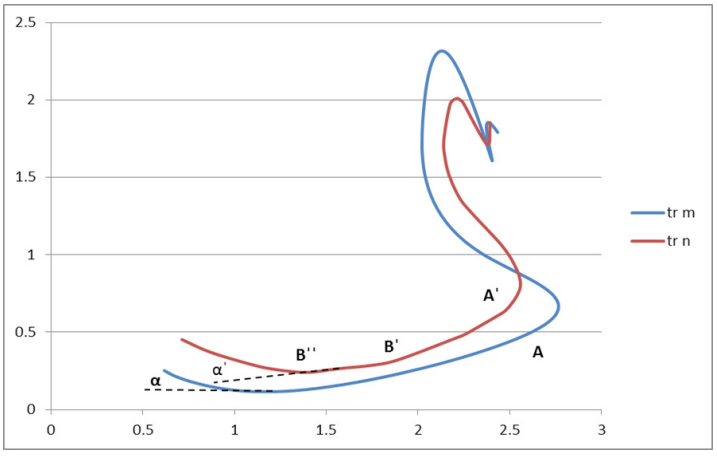

Figure 2. comparative analysis between two and the stick head two typical paths

Table 1. Statistical data from the comparative analysis between the two groups of participants

Parameters	X	S	V%	R
AB	86	3.8	4.41	12.1
	49	4.2	8.57	16.1
α	33	2.1	6.36	5.8
α'	36	4.6	12.78	12.2

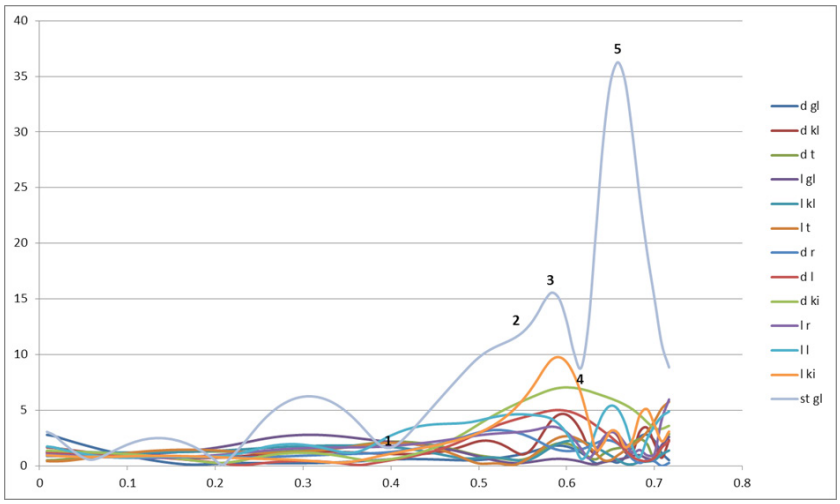

Figure. 3. The velocities in the studied degrees of freedom of movement

Table 2. Multiple hits

Parameters	X	S	V%	R
AB	91	3.4	3.74	8.1
α	32	2.0	6.25	4.4
α'	32	6.1	19.06	12.1

Table 3. The statistical features of the variation analysis for the values in the aboveirregular points

	Players				Beginners		
X	S	V%	R		S	V%	R
2.1	0.1	4.1	0.5	1.9	0.3	10.5	0.8
12.2	1.2	10.0	2.1	7.8	1.1	14.1	2.6
15.3	2.0	13.1	5.2	12.4	2.4	19.3	8.8
8.6	0.4	4.7	2.0	10.1	1.1	10.9	3.7
36.2	2.8	7.7	8.2	31.4	3.6	11.5	10.1

Table 4. Values of the correlation ratio of the two groups compared to the performed hit precision.

t / gr	3	4	5	3 - 4	4 - 5
Players	0.78	- 0.64	0.81	0.94	0.96
Beginners	0.36	- 0.96	- 0.28	0.67	0.84

information about the motor action control by requesting additionally a conscious change in the velocity at that point of the curve. This led to no positive result. The explanation could be that the additional request obstructs the biomechanical structure mastered up to that point in the overall movement system.

The results obtained from (Willmott & Dapena, 2012). about the impact of the planarity of the hitting surface of the stick and the variation of the grip as well as the studies of the link between (Viswanad & Kalidasan, 2014), the angular features of the basic cinematic pairs, point to performance of planned experiments for biomechanical analysis of the time rows of the functions describing the control in the entire cinematic chain. This approach could also reveal the development of individual methods for improvement of the training process. Similar initial attempt for analysis of the drag-flock hit has been conducted by Arakchiyski (Аракчийски), (2002b). However, the target function is not related to the performance precision. A similar goal regarding the strength and velocity is pursued in the studies of Subijana, Juarez, Mallo, & Navarro (2010). In all cases the precision control analysis calls for using more powerful mathematical instruments for assessing the causal links in the whole cinematic chain.

CONCLUSIONS

Specific irregular points have been discovered in the unfolding of the functions from the cinematic structure whereby the precision of the hits is mostly dependent on the swing. The obtained results have direct relation to the general principles of the bones and muscles movement and could also be used in precision analyses for other sports disciplines.

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