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Three Dimensional Biomechanical Analysis of the Drag in Penalty Corner Drag Flick Performance

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Abstract
Penalty corner in field hockey is a complex motor skill. It required high level of coordination. The aim of this study was to provide important biomechanical variables related information for the Sports biomechanist, Young sports scientist, Coaches and also for drag flick specialist for their performance enhancement programs. Four specialist male drag-flickers of two different universities namely LNIPE, Gawalior , and Aligarh Muslim University , Aligarh, age range 19-25 years, height ranged 174-182cm and weight range 59.4- 66.8 Kg. and all having six to eight years of experiences were participated in this study. Three dimensional (3D) experimental setup was conducted for the study. All of the measurements were carried out on the Asto truf ground in their respective universities fields. Two video cameras Canon Legria SF-10 were used to capture all drag flick trials. The shuttering speed of cameras were set on 1/1000 and 50hz frame rate. Both cameras were set with the help of tripod placed at right side of the subjects mounted at a height of 1.2m. During captured drag flick, the distances of cameras were set at 13m and 17m from the stationary ball position and optical axes of the recording cameras were intersect each other on the subject at 90° and 60° respectively to right side in a field setting. The drag flickers and ball movement during the drag flick phase were recorded. Videos footages were edited and synchronized for 3D biomechanical analysis. DLT method was used to calibrate of both the cameras. The drag distance, stride length, ball velocity and acceleration, angles, linear and angular velocity and linear and angular acceleration of shoulder, knee, elbow, wrist of left and right side were digitized and three dimensional data was obtained with the help of Max TRAQ 3D motion analysis software.SPSSv.16. was used to calculate the selected parameters and statistical analysis mean and standard deviations. T-test was used to find out the comparison between LNIPE, Gawalior and A.M.U.Aligarh. And the result was found that drag distance and hockey stick blade, linear velocity of shoulder (L&R), pelvic (L&R), Knee (L) and wrist (R),angular velocity of shoulder (L&R), elbow (L&R), pelvic(L&R), Knee(L), ankle(R) and wrist(R), linear acceleration of hockey stick blade and ball, shoulder (L), Knee(R), ankle(R) and toe(R), angular acceleration of wrist (R) and joint angles of shoulder (L&R), elbow (L), wrist (R) and ankle(R) during drag differs significantly and hence does influences on drag flick technique under accuracy condition.
Keywords: Drag of Dragflick, Biomechanical, Three Dimensional, Motion analysis, performance

Introduction

The penalty corner is almost a sure opportunity for scoring in field hockey. Drag flick technique is mainly used by the player during penalty corner only. It is apparent that the drag flick is both the most frequently used, and most successful method for scoring goals (Laird and Sutherland, 2003; Mosquera et al., 2007). There are gender differences though, with the drag flick used less frequently by females than males (López de Subijana et al., 2012).

Drag flick is the main offensive action during the penalty corner and the team with more drag flicks on target has better chances to score and win a game. Drag flick technique has provide new dimension for the execution of penalty corner. Successful drag flicks need better execution of technique and accuracy, especially when drag flicking on goal to increase the scoring ability. For clear understanding of drag flick technique, drag flicker must understand their movement pattern which is to be used during performance of drag flick.

In any sports, biomechanical analysis has become increasingly important to understand the complex movement.

In hockey too the 3D analysis is required for better understanding of flicker's movement pattern used in drag flick. 3D video analysis is a biomechanical motion analysis which displays for athletes and coaches definitive data on different joint angles, body positions, and segmental velocity during a sport-specific movement.

Little researches have been done on it to define aspects of the drag flick technique. McLaughlin (1997) aimed to describe the kinematic variables of the drag flick and found stance width and drag distance to be the variables most highly correlated with the principal criterion ball velocity. Gómez et al. (2012) focused upon identifying the differences in kinematic variables of drag flicking depending upon the shot location. They found a significantly greater negative angular velocity of the stick when flicking to the right than the left. (Subijana et al, 2010) have studies on biomechanical analysis of the penalty-corner drag-flick of elite male and female hockey players and they found that both player groups showed significantly smaller ball velocity at release, peak angular velocity of the pelvis, and negative and positive peak angular velocities of the stick than the skilled subject. (Hussain et al,2012) have studied on biomechanical study on drag flick in field hockey between All India Intervarsity and Senior State level male hockey players and found that no significant differences among the groups.

Following from the above and prior researchers, this study has designed to describe the three diamensional biomechanics comparisons of specialized drag flickers technique between Lakshmibai National University of Physical Education (LNUPE), Gwalior (M.P) and Aligarh Muslim University (A.M.U.) Aligarh (U.P), accuracy on the basis of kinematical variables of the drag flickers technique.

Methodology

Four specialist male drag-flickers of two different universities namely LNIPE, Gawalior , and Aligarh Muslim University , Aligarh, age range 19-25 years, height ranged 174-182cm and weight range 59.4- 66.8 Kg. and all having six to eight years of experiences participated in this study. Each participant of this study was requested to provide informed consent prior to his participation. Three dimensional (3D) experimental setup was conducted for the study. All of the measurements were carried out on the Asto truf ground in their respective universities fields.

The subjects have used their own standard sticks as were approved by All India Association Committee, India. Ball position for every drag was placed 14.63mts from goal post, on shooting circle ahead of goal post. The subject performed the drag flick from stationary ball position. Each subject performed 10 consecutive drag flick trials. All ten drag flicks were performed to a target. For this study, Best six accurate trials out of ten have been selected for each subject. A trial was defined accurate every time the ball hit the target. Dimension of hanging target was in the form of circle with 1 feet diameter which was hanging on the right side of drag flicker and top corner of goal post. The video recording was stated after receive the signals from drag flicks. Execution of the drag flick was possible after sufficient practice.

Two video cameras Canon Legria SF-10 were used to capture all drag flick trials. The shuttering speed of cameras were set on 1/1000 and 50hz frame rate. Both cameras were set with the help of tripod placed at right side of the subjects mounted at a height of 1.2m. During captured drag flick, the distances of cameras were set at 13m and 17m from the stationary ball position and optical axes of the recording cameras were intersect each other on the subject at 90° and 60° respectively to right side in a field setting.

The video recording was done in sunny and clear weather condition at during morning training session. For best performance of subjects during drag flick under the accuracy condition, subjects were instructed to wear complete proper kit.

The drag flickers and ball movement during the drag flick phase were recorded (fig.1). Fig. 2,3 & 4 are representing stick figures of drag during the drag flick on different planes.

Fig.1

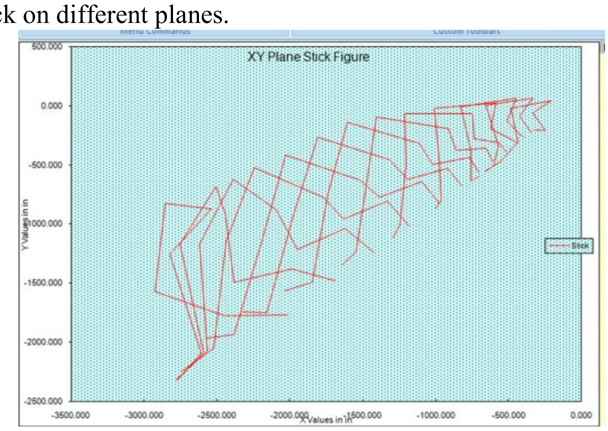

Fig.2

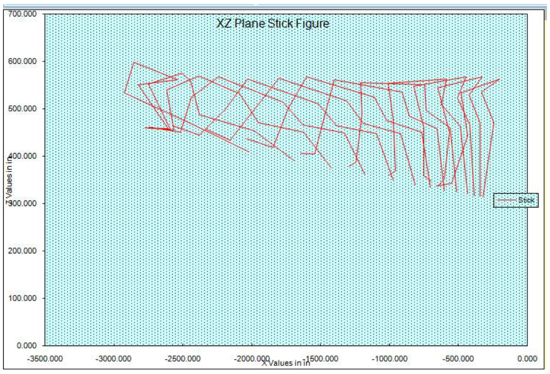

Fig.3

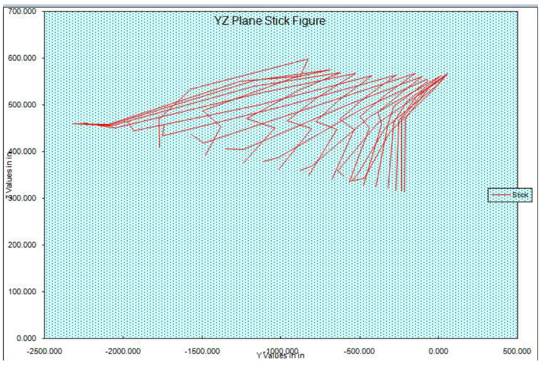

Fig.4

Videos footages were edited and synchronized for 3D biomechanical analysis. DLT method was used to calibrate of both the cameras. The drag distance, stride length, ball velocity and acceleration, angles, linear and angular velocity and linear and angular acceleration of shoulder, knee, elbow, wrist of left and right side were digitized and three dimensional data was obtained with the help of Max TRAQ 3D motion analysis software.
The ball velocity at drag phase was measured from ball-stick contact to the point of release the ball. Stride length of the subjects were obtained from right foot toe to left foot toe.
SPSSv.16. was used to calculate the selected parameters and statistical analysis mean and standard deviations. T-test was used to find out the comparison between LNIPE, Gawalior and A.M.U.Aligarh.

Result

For comparing the drag mechanism of specialist drag flickers of both universities were under the accuracy condition. The normal t-test was applied at 0.05 level of significant. The results are as below:

Table-1 Descriptive statistics of selected variables at drag flick performance.

Variable	University	Mean	SD	Cal. t
Stride Length	A.M.U.	1.428	0.209	1.222
	LNIPE	1.348	0.088	
Drag Distance	A.M.U.	1.433	0.333	2.281*
	LNIPE	1.196	0.135	
Hockey Stick Blade linear velocity	A.M.U.	6.391	1.320	4.226*
	LNIPE	3.954	1.499	
Ball linear Velocity	A.M.U.	6.384	1.350	1.171
	LNIPE	4.825	4.411	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22}$ = 2.074

The table-1 revealed that the drag distance and hockey stick blade during dragging of ball in field hockey game have shown $|t|_{cal}$. value are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the drag distance and hockey stick blade during dragging differ significantly and hence does influences on drag flick technique under accuracy condition.

Table-2 Descriptive statistics of selected variables left & right segment linear velocity at drag phase.

Variable	University	Left(L)			Right(R)		
		Mean	SD	Cal. t	Mean	SD	Cal. t
Shoulder	A.M.U.	5.579	0.884	2.718*	4.925	0.710	4.654*
	LNIPE	7.094	1.717		6.699	1.113	
Elbow	A.M.U.	6.809	1.080	0.760	6.255	1.458	1.019
	LNIPE	7.572	3.304		5.614	1.617	
Wrist	A.M.U.	7.687	2.301	0.522	7.147	1.983	3.007*
	LNIPE	9.335	10.698		5.110	1.255	
Pelvic	A.M.U.	4.214	0.532	3.928*	3.980	0.373	3.383*
	LNIPE	7.664	2.995		7.396	3.477	
Knee	A.M.U.	5.105	0.434	2.253*	3.841	0.558	1.742
	LNIPE	9.135	6.182		11.092	13.362	
Ankle	A.M.U.	6.610	1.418	1.812	4.856	2.720	1.437
	LNIPE	11.313	8.877		10.375	11.286	
Toe	A.M.U.	9.433	3.689	0.341	4.145	2.115	0.564
	LNIPE	10.213	7.006		4.993	4.761	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22}$ = 2.074

The table-2 revealed that the comparison of shoulder (L&R), pelvic(L&R), Knee(L) and wrist(R) during drag flick skill in field hockey game have shown $|t|_{cal}$. values are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the shoulder (L&R), pelvic (L&R), Knee (L) and wrist (R) during drag differs significantly and hence does influences on drag flick technique under accuracy condition.

Table-3 Descriptive statistics of left & right segmental angular velocity at drag phase.

Variable	University	Left(L)			Right (R)		
		Mean	SD	Cal. t	Mean	SD	Cal. t
Shoulder	A.M.U.	166.635	93.686	4.614*	100.804	50.455	3.747*
	LNIPE	-118.070	192.107		6.652	70.923	
Elbow	A.M.U.	158.186	107.176	5.976*	-31.657	86.582	4.403*
	LNIPE	-76.055	83.268		-245.054	59.984	
Wrist	A.M.U.	47.588	245.966	3.743*	33.405	51.950	5.318*
	LNIPE	171.746	210.462		-172.156	123.400	
Pelvic	A.M.U.	-93.573	45.571	3.489*	-24.256	77.138	2.078*
	LNIPE	22.616	105.994		78.627	153.140	
Knee	A.M.U.	66.581	82.237	3.411*	70.600	178.085	0.636
	LNIPE	-68.192	109.393		114.568	159.837	
Ankle	A.M.U.	98.745	143.897	0.787	101.954	108.006	2.967*
	LNIPE	61.856	75.039		-0.527	51.505	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22}$ = 2.074

The table-3 revealed that the comparison of shoulder (L&R), elbow(L&R), pelvic(L&R), Knee(L), ankle(R) and wrist(R) during drag flick skill in field hockey game have shown $|t|_{cal}$. values are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the shoulder (L&R), elbow (L&R), pelvic(L&R), Knee(L), ankle(R) and wrist(R) during drag differs significantly and hence does influences on drag flick technique under accuracy condition.

Table-4 Descriptive statistics of linear acceleration of hockey stick blade and ball at drag phase.

Variable	University	Mean	SD	Cal. t
Hockey Stick Blade	A.M.U.	37.695	36.587	0.725
	LNIPE	46.877	24.220	
Ball	A.M.U.	39.579	33.167	1.293
	LNIPE	67.943	68.397	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22}$ = 2.074

The table-4 revealed that the hockey stick blade and ball during dragging of ball in field hockey game have shown $|t|_{cal}$. value are less then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the hockey stick blade and ball acceleration during dragging does not significantly and hence does't influences on drag flick technique under accuracy condition.

Table-5 Descriptive statistics of left & right segmental linear acceleration at drag phase.

Variable	University	Left(L)			Right (R)		
		Mean	SD	Cal. t	Mean	SD	Cal. t
Shoulder	A.M.U.	4.664	8.178	1.337	7.270	6.111	4.935*
	LNIPE	-0.515	10.639		-4.699	5.765	
Elbow	A.M.U.	9.665	14.000	0.212	23.426	15.580	0.312
	LNIPE	8.663	8.502		26.409	29.281	
Wrist	A.M.U.	18.448	27.393	1.921	21.956	27.074	1.371
	LNIPE	61.781	73.167		33.891	13.290	
Pelvic	A.M.U.	-2.678	4.194	1.892	-1.891	3.972	1.537
	LNIPE	-9.456	11.683		-8.868	15.216	
Knee	A.M.U.	-3.916	4.273	0.442	-3.443	5.835	2.878*
	LNIPE	-1.987	14.487		60.986	77.316	
Ankle	A.M.U.	-8.189	9.731	1.672	-7.544	10.147	5.101*
	LNIPE	-15.298	11.052		85.327	62.242	
Toe	A.M.U.	-6.030	9.258	1.957	-4.033	15.709	4.964*
	LNIPE	-16.723	16.506		49.805	34.128	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22}$ = 2.074

The table-5 revealed that the comparison of shoulder (L), Knee(R), ankle(R) and toe(R) during drag flick skill in field hockey game have shown $|t|_{cal}$. values are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the shoulder (L), Knee(R), ankle(R) and toe(R) during drag differs significantly and hence does influences on drag flick technique under accuracy condition.

Table-6 Descriptive statistics of left & right segmental angular acceleration at drag phase.

Variable	University	Left			Right		
		Mean	**SD**	**t-value**	**Mean**	**SD**	**t-value**
Shoulder	A.M.U.	-667.942	1729.162	0.297	-545.833	1062.078	2.024
	LNIPE	-860.067	1420.010		225.360	784.216	
Elbow	A.M.U.	-604.894	999.826	0.172	-529.311	797.282	1.115
	LNIPE	-680.865	153.805		-125.101	970.173	
Wrist	A.M.U.	-891.582	999.850	0.186	779.729	848.894	4.816*
	LNIPE	-475.616	1632.737		-1337.778	1264.620	
Pelvic	A.M.U.	429.961	1009.109	0.878	-648.681	699.822	1.469
	LNIPE	961.879	1840.433		496.900	2608.319	
Knee	A.M.U.	133.540	664.934	1.845	-483.087	972.024	0.070
	LNIPE	560.518	447.515		-443.910	1667.196	
Ankle	A.M.U.	77.521	946.527	1.169	-1636.196	2308.742	0.978
	LNIPE	498.357	811.730		-781.642	1956.566	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22} = 2.074$

The table-6 revealed that the comparison of wrist (R) during drag flick skill in field hockey game has shown $|t|_{cal}$. value are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the wrist (R) during drag differ significantly and hence does influence on drag flick technique under accuracy condition.

Table-7 Descriptive statistics of left & right segmental joint angle at drag phase.

Variable	University	Left(L)			Right(R)		
		Mean	**SD**	**Cal. t**	**Mean**	**SD**	**Cal. t**
Shoulder	A.M.U.	97.952	31.948	3.776*	106.567	39.706	2.435*
	LNIPE	58.295	17.402		77.997	8.666	
Elbow	A.M.U.	99.103	32.124	3.658*	128.537	41.019	1.369
	LNIPE	134.777	10.459		145.226	10.062	
Wrist	A.M.U.	117.914	8.593	0.033	105.846	40.692	3.631*
	LNIPE	117.775	11.530		148.756	4.508	
Pelvic	A.M.U.	89.261	31.380	1.699	82.728	34.266	0.754
	LNIPE	68.497	28.434		90.361	7.362	
Knee	A.M.U.	96.722	59.870	0.294	88.960	52.195	1.639
	LNIPE	101.847	7.826		116.607	26.256	
Ankle	A.M.U.	92.551	36.925	2.269	77.876	36.608	2.435*
	LNIPE	60.462	32.198		50.422	13.597	

*Significant at 0.05 level of significance with 22 df , Tab. $t_{.05,22} = 2.074$

The table-6 revealed that the comparison of shoulder (L&R), elbow (L), wrist (R) and ankle(R) during drag flick skill in field hockey game have shown $|t|_{cal}$. values are greater then the $t_{.05,22}$ value at 0.05 level of significance. This statistical finding exhibits that the shoulder (L&R), elbow (L), wrist (R) and ankle(R) during drag differs significantly and hence does influences on drag flick technique under accuracy condition.

Discussion:

The aim of this study was to analyse the influence of two different universities field hockey drag flickers specialist technique on selected biomechanical parameters under accuracy condition in order to provide relevant information for drag flickers in field hockey. Maximum drag distance is obtained through hockey stick blade which is not possible without ball contact to hockey stick blade. As it was shown in the results the drag distance and hockey stick blade does influence on drag flick performance. The greater the drag distance, the greater the release velocity of the ball reported by Mclaughlin(1997). Linear and angular velocities of right and left shoulder and pelvis help to produce carrying the ball forward due to the conservation momentum through hockey stick blade. The utilization of rotation at the hip and shoulders also affects the ball velocity developed after the left foot has contacted the ground reported by Mclaughlin(1997).

Linear velocity of right wrist contribute in drag flick performance because right hand fully supportable to the stick grip which has possible movement through right wrist momentum. Left knee of the flicker is responsible for given comfortable position because during the dragging, flicker’s body should be well-balanced, with his left knees bent and back arched as low as possible to the ground.

Drag phase in hockey is the key phase to generate momentum and also significantly contribute in performance of drag flick techniques. The angular velocity of left shoulder, elbow, pelvis and knee and angular velocity of right shoulder, elbow, wrist, pelvis and ankle shows significance differences between the both universities flickers.

Linear acceleration of right shoulder, knee, ankle and toe shows significance differences between both university players.

Angular acceleration of right wrist shows significance differences exist in between both universities flickers due to stick stores the energy and the wrist movement releases it. Differences in magnitude of angle right and left shoulder and left elbow and also in right wrist and right ankle have been found. Flickers stick shaft angle slightly back to give the ball added lift. Segmental length of players plays vital role in angular and linear kinematics during drag flick techniques. Results of this study show that both university players have kinematical differences. These kinematical differences proportionally affect the performance and produce differences in different kinematics of the flicker.

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