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## IMPROVEMENT THE FREE THROWS IN BASKETBALL GAME

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**Abstract:** In the present study, which is part of a larger study, we try to develop some very limited data on movement patterns used by players to achieve free throws in basketball. Thus, the objectives consist in a comparison of two throws of the same athlete (throwing valid and invalid) and throws a comparison between the girls and boys, watching various aspects of throwing technique.

**Keywords:** dynamic model, free throw, basketball game

### 1. INTRODUCTION

In order to obtain as precise information on growth performance at the free-throw we make an analysis of the throws with an high speed camera made in the Department of Product Design, Mechatronics and Environment, Institute CDI PRODD, Lab of Research Systems in Advanced Mechatronic from University "Transilvania" of Brasov.

From the multitude of throws made were not digitilzate than 16 throws. At these throws, all markers positioned in the joints (ankle, knee, hip, shoulder, elbow, hand) were tracked and recorded. in Adobe After Effects . The data obtained from the analysis for each marker were exported to Excel.

Thus, for achivement the objectives, the steps are:

- Breakdown phases filming on the basic mechanism of free throws;
- Establishing the duration of each phase of the basic mechanism of throws
- Extracting data from Excel tables corresponding keyframes;
- Establishing the difference between valid and invalid throw
- Comparation and determination of differences between boys and girls throwing;;
- Încadrarea în modelul matematic și dinamic din teză.

### 2. METHODS

In modern basketball, the process by which it is at the free throw with one hand. The basic mechanism of free throws can be divided into 4 stages or moments:

- preparatory phase
- body flexion
- throwing itself
- final position

The table below shows the throw extracted for analysis and action to be performed:

Table nr. 1

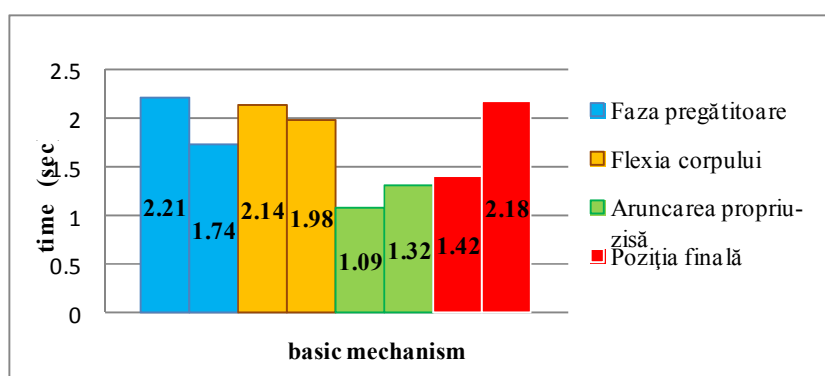
Name of athletes	Free throw		Action performed
	Valide	Invalide	
C.A	-	alex_al_1	Comparation between valid and invalid throw
S.O	ovi_al_1	ovi_al_3	
A.E	-	kati_al_1	Comparation with boys throw
F.M	maria_al_3	maria_al_1	

			and invalid throw	
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After we extracting the keyframes from each throw and from Excel tables we find the corresponding dates for those. This dates are shown in the table nr. 2

**Table nr. 2**

Basic mechanism	Invalide throw		Valide throw	
	Total keyframes 209 of which	Total time of the shooting is 6,86 sec, time allocated for each stage:	Total keyframes 220 of which	Total time of the shooting is 7,22 sec, time allocated for each stage:
<b>Preparatory phase</b>	0 – 68 (68 frames)	2,21 sec	0 – 54 (54 frames)	1,74 sec
<b>Body flexion</b>	69 – 133 (65 frames)	2,14 sec	55 – 114 (60 frames)	1,98 sec
<b>Throwing itself</b>	134 – 166 (33 frames)	1,09 sec	115 – 154 ( 40 frames)	1,32 sec
<b>Final position</b>	167 – 209 (43 frames)	1,42 sec	155 – 220 ( 66 frames)	2,18 sec



**Figure 1** – Graphic representation of basic mechanism stages for throw “ovi\_al\_3 (invalid) and ovi\_al\_1 (valide)”

To do the kinograms for this dates we need the joints coordinates: (ankle – pct. A, knee – pct.B, hip – pct.C, shoulder – pct.D, elbow – pct.E, hand wrist – pct F) shown in the tables nr. 3 and 4

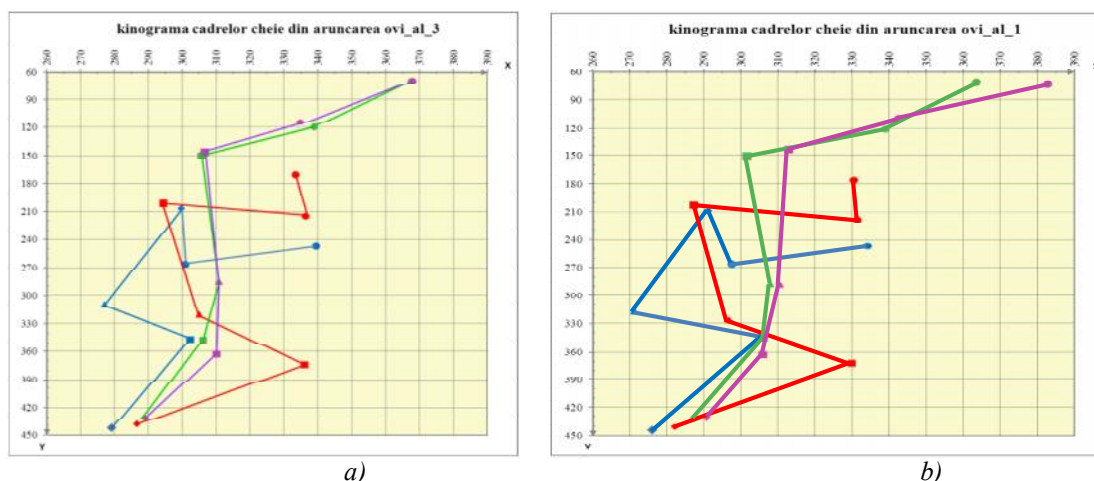
**Table nr. 3**

ovi_al_3 – invalide throw											
Ankle		Knee		Hip		Shoulder		Elbow		Wrist hand	
X <sub>A</sub>	Y <sub>A</sub>	X <sub>B</sub>	Y <sub>B</sub>	X <sub>C</sub>	Y <sub>C</sub>	X <sub>D</sub>	Y <sub>D</sub>	X <sub>E</sub>	Y <sub>E</sub>	X <sub>F</sub>	Y <sub>F</sub>
279,25	442,47	310,12	363,21	277,09	309,32	299,71	206,81	300,90	266,45	339,47	247,07
286,62	438,21	336,05	374,25	305,01	320,25	294,48	201,33	336,36	214,90	333,39	170,93
288,63	431,17	306,20	347,28	310,77	284,79	305,66	150,29	338,93	119,93	367,59	69,80
289,13	430,96	302,36	346,61	310,88	285,18	306,67	146,14	334,83	114,26	367,95	69,93
ovi_al_1 – valide throw											
276,10	443,87	305,94	362,80	271,22	316,51	291,18	208,37	297,58	266,39	334,24	246,85
282,18	440,18	329,94	372,41	296,75	325,67	287,33	202,56	331,50	218,57	330,47	176,34
287,32	431,52	306,16	345,96	307,97	287,23	301,64	150,91	338,98	121,01	363,56	71,48
290,75	430,21	305,43	345,21	310,57	287,57	312,95	144,26	342,50	109,97	382,78	73,47

**Table nr.4**

Comparing the angles segments according with dynamic model									
teta 1		teta 2		teta 3		teta 4		teta 5	
valide	invalide	valide	invalide	valide	invalide	valide	invalide	valide	invalide
69,80	68,71	126,87	121,51	79,50	77,55	-83,83	-88,86	27,64	26,67
54,93	52,30	125,54	119,89	94,15	95,06	-21,24	-17,95	90,53	93,86
76,79	76,09	89,06	87,20	92,99	93,00	33,51	31,75	66,44	66,56

80,20	81,08	84,90	82,10	89,04	91,73	49,24	48,54	42,18	53,23
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**Figura 2** – Graphic representation of keyframes for:  
a) ovi\_al\_3 where: - frame 68 , - frame 133 , - frame 166 , - frame 209  
b) ovi\_al\_1 where: - frame 54 , - frame 114 , - frame 154 , - frame 220

For boys throws, from a first analysis of the time allocated to each phase we can see that in the case of invalide throw they are higher for the first two phases. (0,47 sec for preparatory phase , respective 0,16 sec. for body flexion). Maintaining strong flexion of the body, increases muscle tension, which is reflected in the movement to be executed (they are no longer smooth and continuous, with small discrepancies in execution). This can be seen in the video analysis as well as the kinograms and angles between segments. In a similar study, S. Bradley and J. Martin „Analysis of Basketball free throw shooting” concluded that a stable position and a smooth movement is the successful for many throws filmed [2].

In analysis the girls throw we extracted the dates necessary for comparisons (keyframe of the throws, joints coordinates for kinograms, angles segments according with dynamic modell). All this dates are shown in the next tables (nr. 5, 6, 7).

In this case, after analysis the videos and all the dates we conclude that in the case of invalide throw the athlete made a wrong movement. She didn't raised the shooting arm enough, so the angle in the sholder joint was too small ( $106^{\circ}$  = angle between arm and trunk) and after throwing she pulled backward the arm. All this action cause a tension in the shoulder and neck muscle. Another important point in the throw is the height of release. Because the arm wasn't high enough, the height of release was too small and that cause the angle of release to be too small.

Barnes (1980) supports the idea of alignment of the head, back and pelvis, considering that it provides better stability in preparation for throwing player. [1]

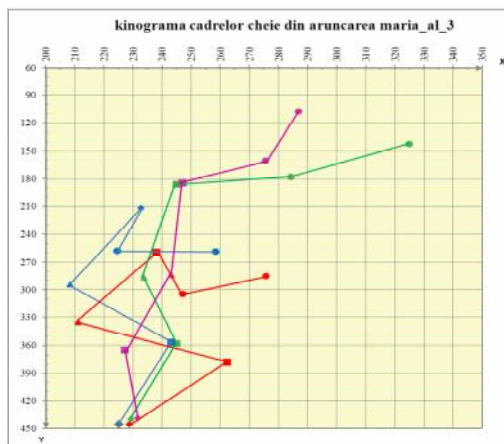
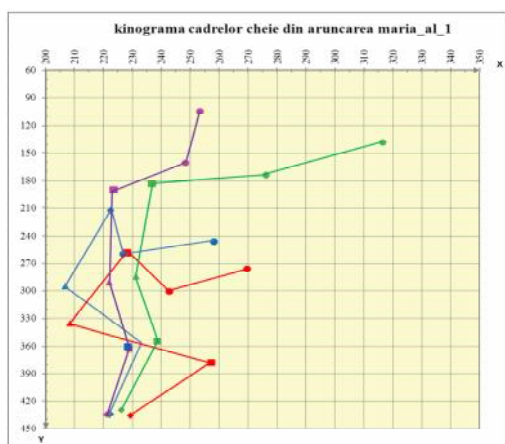
**Tabel nr. 5**

Basic mechanism	maria_al_1 – Invalide throw		maria_al_3 – Valide throw	
	Total keyframes 220 of which	Total time of the shooting is 8,75 sec, time allocated for each stage:	Total keyframes 233 of which	Total time of the shooting is 7,65 sec, time allocated for each stage:
<b>Preparatory phase</b>	0 – 47 (47 frames)	1,51 sec	0 – 18 (18 frames)	0,56 sec
<b>Body flexion</b>	48 – 90 (43 frames)	1,42 sec	19 – 67 (49 frames)	1,61 sec
<b>Throwing itself</b>	91 – 126 ( 36 frames)	1,19 sec	68 – 99 ( 31 frames)	1,06 sec
<b>Final position</b>	127 – 266 ( 140 cadre)	4,63 sec	100– 233 ( 133 cadre)	4,42 sec

**Tabel nr. 6**

maria_al_1 invalide throw											
Ankle		Knee		Hip		Shoulder		Elbow		Wirst hand	
X <sub>A</sub>	Y <sub>A</sub>	X <sub>B</sub>	Y <sub>B</sub>	X <sub>C</sub>	Y <sub>C</sub>	X <sub>D</sub>	Y <sub>D</sub>	X <sub>E</sub>	Y <sub>E</sub>	X <sub>F</sub>	Y <sub>F</sub>
222,22	434,69	228,89	362,70	206,87	294,76	222,5	212,82	226,83	259,63	258,18	246,25
229,35	436,04	257,29	377,93	208,45	335,34	228,23	258,38	242,85	300,67	269,67	276,02

226,19	429,85	238,60	354,75	231,28	284,00	236,80	183,63	276,24	173,98	316,53	138,13
221,10	434,85	228,44	360,48	222,01	290,76	223,5	190,44	248,30	160,76	253,39	104,77
<b>maria al 3 valide throw</b>											
225,28	445,80	227,23	364,86	208,39	293,68	232,73	212,23	224,59	257,61	258,43	258,42
228,71	445,60	262,34	378,02	211,10	334,83	238,10	259,54	247,08	304,66	275,66	285,05
229,27	440,11	245,06	358,07	233,79	286,28	244,98	186,12	284,30	178,01	324,89	142,19
231,63	438,79	243,20	356,98	243,22	283,58	246,96	184,63	275,48	160,54	286,83	107,67

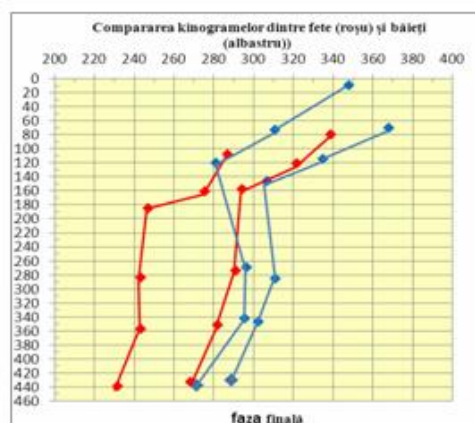
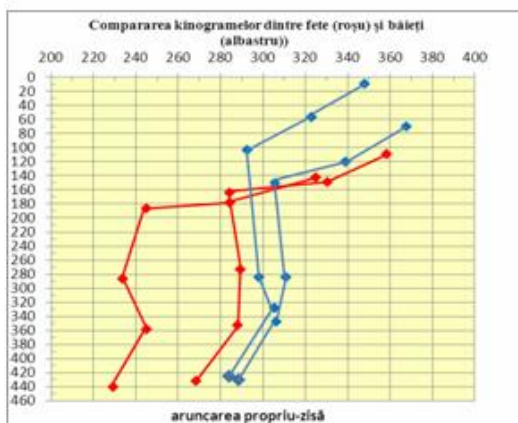
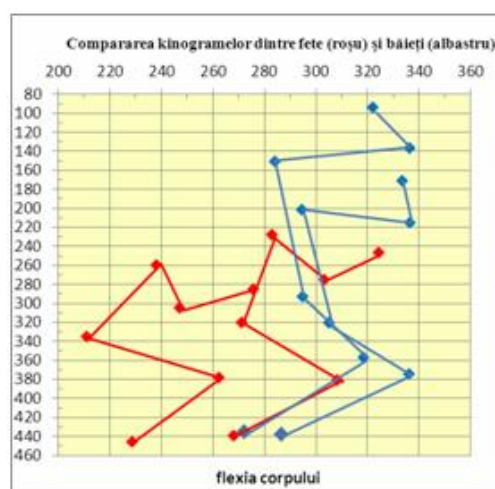
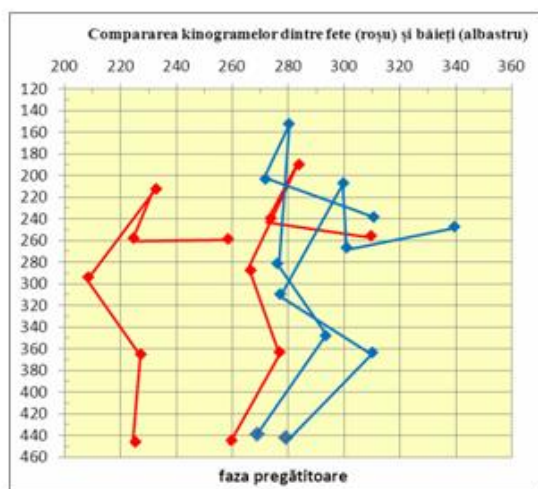


a)

b)

**Figura 3** - Graphic representation of keyframes for:

- a) maria\_al\_1 unde: - **cadrul 47**, - **cadrul 90**, - **cadrul 126**, - **cadrul 266**  
b) maria\_al\_3 unde: - **cadrul 18**, - **cadrul 67**, - **cadrul 99**, - **cadrul 233**



**Figura 4** – comparing throws between girls (red) and boys (blue)

After analysis we conclude that there are differences between boys and girls throwing. Release height of the ball is higher to the boys than girls. The preliminary movements for the free throw (R handed shooter) are very individual, and are slightly different for every player. Most players use these movements to repeat mentally the shot and to attempt to relax and free the muscles of tension and tightness.

In the first two phases there are not significant differences. In the final of the body flexion phase we can see that the ball is in higher position in the boys case than the girls..

The critical moment of throwing is that of ball release. In this moment the trunk and the legs should be extended, indicating that these joints have made a full contribution to the flight of the ball. Here we can see some common errors made by players. One of the boys, hasn't full extended the join of legs, and the trunk is to float slightly backwards. When the ball is release, the soothing shoulder is almost pointing vertically to the ceiling. In the girls case, we can see that the shooting arm is not in that positions, and the angle in the shoulder joint is lower.

### 3. RESULTS:

Qualitative analysis of joint angles compared with time was made to observe statistically significant differences between valid and invalid throws.

The free throw model has a stereotypical shooting pattern for all players evaluated and is caracterized by a proximal and distal in joint motion for upper and lower body.. The free throw is caracterized by a pattern of angular velocity which varies depending by the joint motion during the release phase. The coordonations of those represent the critical factor in determining the validity of a throw. Stable postures of the body and a smooth movement through release appear to be characteristics of more successful shooting motions.

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