Biomechanics analysis of free throw shooting in basketball and possible impact of the resultof the Representation mental test

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Introduction:

The free throw is the single most important shot in the game of Basketball, as close to twenty per cent of all points in NCAA Division 1 Basketball are scored from free throws (Kozar, Vaughn, Lord, Whitfield, & Dve, 1994). The shot becomes more important later in the game, as free throws comprise a significantly greater percentage of total points scored during the last 5 minutes than the first 35 minutes of the game for both winning and losing teams (Kozar et al., 1994). The free throw should be one of the easiest shots in basketball (Okubo & Hubbard, 2006), since the player is all alone, 15 feet from the basket, with no defense and no close distractions. All the player has to do is get ready, aim, cock the ball and shoot. A skilled intercollegiate team should shoot at least 80 per cent from the free throw line, but very few teams are able to accomplish this task. Successful free throw shooting requires good concentration, but most importantly good mechanics in the shot. However, good mechanics alone cannot account for success in shooting free throws.

Successful FT shooting requires accuracy, precision and good concentration, but more importantly it requires good mechanics with the shot. As described by Elliott (Elliott B 1990), an understanding and application of movement mechanics are necessary to use the ‘‘good technique’’ and to help athletes’ potential to be fully developed. Several authors suggest that a player’s shooting success can be enhanced with proper training using a scientific approach (Burns FT 1990, Brancazio PJ 1981). Burns (Burns FT 1990) and Hudson (Hudson JL 1985) highlight the importance of developing good shooting technique.

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There are two basic styles of free throw used in basketball- the overhand push shot and the underhand loop shot. (Rist, 2000) favored the underhand loop shot due to the steeper angle of entry and smaller drift of the ball from better stability provided by holding the ball with both hands and applying greater spin at release.

This study's main subject is to compare kinematic characteristics and successful shooting variability, As well as to identify the impact on the level of mental activity. Some studies tried to identify the differences between individual free shootings. They were using more than one attempt per individual. None of them has found intra-individual variability of the technique. Motor control researches (Newell and Crocos, 1993) state that, considering the level of sensomotoric system's freedom, ″it seems impossible that specific individual makes identical model of movements in on performing the same target″. If intra- individual variability is an inseparable part of sport techniques, more complex measuring is necessary to reach the valid representation and performance. The previous studies on free shooting used 2D analysis techniques.

Fault tests for 1024 free throws done by NCAA Division I for men's basketball competitions obtained the following results: 32,8% of missed free throws were too far, to the left, over the line and 19,5% to the right. This is indicative Moreover (Walters, M., Hudson, J., Bird, M. 1990).(Owen E 1982)suggests that one of the reasons for the low percentages of success in FT is that most players never learned in early stage the proper technique. Consequently, the identification of key components related to success in FT shooting is necessary for the development of proper feedback training and technique learning in beginner basketball players. for the movements outside of sagittal plane.

Therefore, the present study was conducted to analyze selected biomechanical parameters of FT shooting repeated 15 times by One college sports student with the principal purpose of comparing shooting mechanics in successful versus failing attempts and to identify required shooting technique focusing on angular displacements, velocities of the hand, and the release time. The identification of characteristics which are consistently employed in a successful FT and conspicuously limited in a failing FT could lead to improved teaching and coaching proper FT technique.

Materials and methods:

College sports student (age: 27 years; body mass:66 kg; height: 171 cm; inexpert in basketball) participated in this study.. Fifteen FT in standing position were performed with the right hand , and their attempts were recorded in a biomechanical laboratory with two-dimensional (2D) video data collection (i.e., using 50 Hz camera resolution, Sony brand).

Table (1)

The primary data on subjects is given in the following table:

Name	Weight(kg)	High(cm)	Birth Year	FT
M. Ali	66	171	1989	15

Table (2)

The free throws technique as the subject of the research is defined by following variables:

Variables	From Simi Motion	From Mental Test
1	Made(1)/ Missed basket (0)	Performance of the mental test : error rate
2	FT performance	Performance of the mental test : motor time
3	Release angle	Performance of the mental test : cognitive time
4	Maximal hand velocity	
5	Maximal knee angle	
6	The velocity hand of throwing hand.	
7	The absolute angle in the shoulder joint	
8	The absolute angle in the elbow joint	
9	The absolute angle in the wrist joint	
10	The absolute angle in the hip joint	
11	The absolute angle in the knee joint	
12	The shooting angle (release angle)	
13	Duration(total movement–phase1-phase2)	

Table former most important biomechanical variables that were used in the present research shows, as well as mental variables.

Procedures:

To record the FT shots, a calibration space of 150 : 251 cm was measured (Fig. 1) to allow a complete view of the player during the FT recording. A 50 Hz camera was set parallel to the FT line to obtain a side view of the player. Nine markers (Fig. 1) were attached to: (1) the right side of the subject's body; (2) the top of the head marker; (3) the shoulder marker; (4) the elbow marker, the center of the right wrist joint for the wrist marker; (5) the metacarpophalangeal joint of the pinky finger for the finger marker; (6) the greater trochanter of the femur for the hip marker; (7) the lateral epicondyles for the knee marker; (8) the ankle marker; and (9) the toe marker

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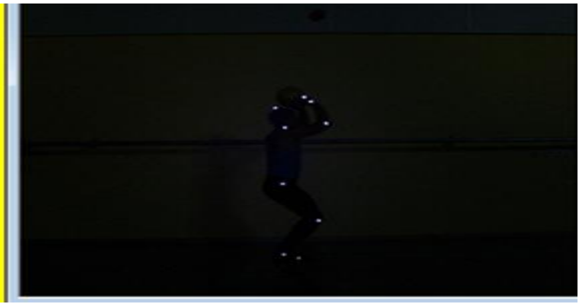

Fig. 1 Experimental set-up and anatomical marker placement

The made and missed baskets were registered manually in a protocol. To examine shooting mechanics, the researcher analyzed the identified FT using the system software SIMI Motion. In each video frame, the following points were manually digitized: head, shoulder, elbow, wrist, finger, hip, knee, ankle, and toe. Connections were made between specific points to create the following segments:

(1) Right arm between shoulder and elbow.

(2) Right forearm between elbow and wrist.

(3) Right hand between wrist and pinky finger.

(4) Right trunk between shoulder and hip.

(5) Right thigh between hip and knee.

(6) Right leg between knee and ankle.
(7) Right foot between ankle and pinky toe.

Identify the phase structure of the movement by using the module "phaser" (see software SIMI Motion).With this module you can define the structural compo- nent.figuer 1shows the desktop of SIMI Motion using an example from basketball free throw. Were identified three stages of the performance for the way the corners of the body (joints) and two preliminary stage, and the main and final, Start the preliminary phase of the standing position of the player and less flexion angle in the knee and ends at the beginning of the extension of the knee angle, START primary stage of the moment along the angle of the knee and going full stretch for the whole body and ends the moment of leaving the phalanges of the fingers of the ball and the final stage when the primitive flexion of the wrist and ends at the bottom of the body back to its normal status.

Data analysis:

Computation of raw data, respectively filtered data in 2D- data. Work on biomechanical parameters and characteristics (see SIMI motion) according to the task. Conduct an initial attempt to make sure the containment calibration for each cubic phases of skill. I using velocity hand. Using angles (5) angle: (shoulder angle, elbow, hand, hip, knee).

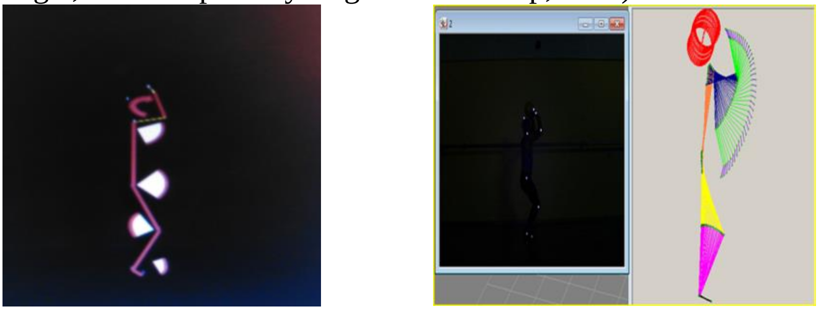

Fig. 2 Experimental setup and anatomical angle selection

For the purpose of assessing the precision of FT, the performance in each attempt was determined by the 5-point scale model used by (Zachry et al2005). The entry of the ball into the basket received 5 points, hitting the ball to the basket ring 3 points, touching the basket backboard and ring 2 points, hitting the basket backboard 1 point, and an air ball received no points.

Statistical procedures:

The data was exported as txt files and then imported into Spss 22. All values were expressed as average ± SD. Using SPSS for version 22; I tested the normality of distributions using Shapiro–Walk before running any statistical tests. The paired T test (parametric test for the normal distribution) and the Wilcoxon test (non-parametric test for the abnormal distribution) were used to determine if a significant difference existed between made and missed baskets (with respect to the body angles and hand velocity).

The Pearson correlation test (parametric test for the normal distribution) and Spearman test (non-parametric test for the abnormal distribution) were used to determine, (1) the sociations of phase's durations, body angles and hand velocity with the success in FT basketball and (2) the associations of the phase's durations and body angles with the speed of the throwing hand. Significance was set as p\0.05.

Mental testing procedures (pre and post mental test):

Been prepared pretest of the sample is a set of frames for skill free throw in basketball is arranged according to the performance of the right and the sample arrange the frames according to imagine mental performance and the number of images 15 Frame and takes into account the time of motor and time cognitive pull Al frame.

An execution of 15 FT on the basket, and then re-test again in order to know the impact of practice on the mind.

Result:

Correlation between hand. V and body angles/ phases duration:- (In total movement)

Table (3)

Correlation between hand . V and body angles/ phases duration (In total movement)

Variable		knee	hip	shoulder	elbow	wrest
hand.v	Pearson Correlation	-.471	.143	-.308	-.003	-.124
	Sig. (2-tailed)	.076	.611	.263	.992	.660
	N	15	15	15	15	15

Fig3: Correlation between hand. V and body angles/ phases duration (In total movement)

Evident from the above table (3) and fig (3) there is not correlation between hand velocity and all body angle values p > 0.05.

Table (4)

Correlation between hand. V1 and body angles/ phases duration (In Preparation phases)

Correlations		hip1	knee1	wrest1
hand.v1	Pearson Correlation	-.198	-.234	-.563*
	Significance(2-tailed)	.479	.401	.029
	N	15	15	15

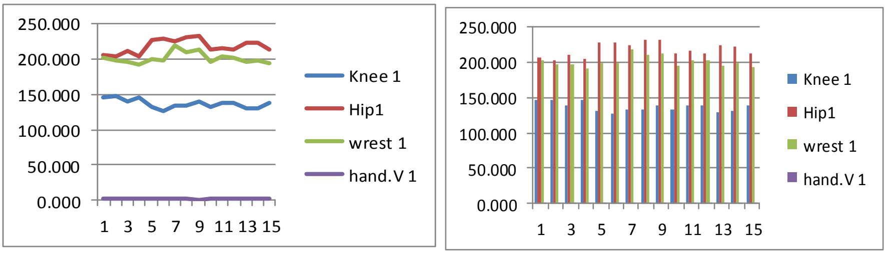

Fig4: Correlation between hand. V1 and body angles/ phases duration (In Preparation phases)

Evident from the above table **(4)** and fig **(4)** there is median correlationnegative between the wrest1 and hand velocity with p < 0.05 and R= 0.563. However, no correlation between hand velocity and Hip, Knee angle.

Table (5)

CorrelationSpearman's betweenhand. V1 and body angles/ phases duration (In Preparation phases)

Correlations Spearman's rho		shoulder1	elbow1
hand.v1	Correlation Coefficient	-.604*	.343
	Significance (2-tailed)	.017	.211
	N	15	15

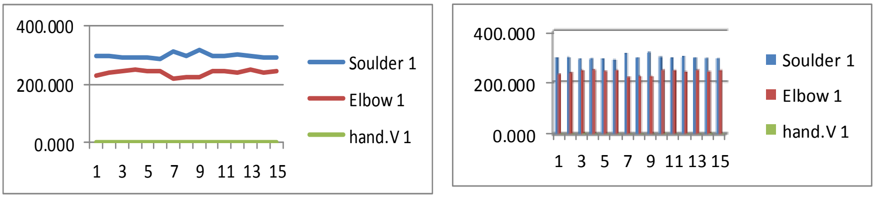

Fig (5) Correlation Spearman's between hand. V1 and body angles/ phases duration (In Preparation phases)

Evident from the above table (5)and fig (5) there is a negative correlation relationship between the shoulder and hand velocity with $p < 0.05$ and R= 0.604 .however , no correlation between hand velocity and elbow angle.

Table (6)

Pearson Correlation between hand. V2 and body angles/ phases duration (In mean phases)

Correlations		hip2	shoulder2	elbow2
hand.v2	Pearson Correlation	.189	-.176	-.335
	Significance(2-tailed)	.501	.530	.222
	N	15	15	15

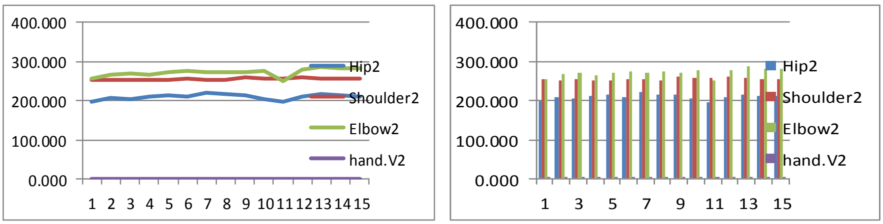

fig (6) Correlation between hand . V2 and body angles/ phases duration (In mean phases)

Evident from the above **table (6)** and **fig (6)** there is not correlation between hand velocity2 and hip2, shoulder2 and elbow2 angle values p > 0.05.

Table (7)

Correlation spearman between hand. V2 and body angles/ phases duration (In mean phases)

Spearman's rho		knee2	wrest2
hand.v2	Correlation Coefficient	-.068	.336
	Significance (2-tailed)	.810	.221
	N	15	15

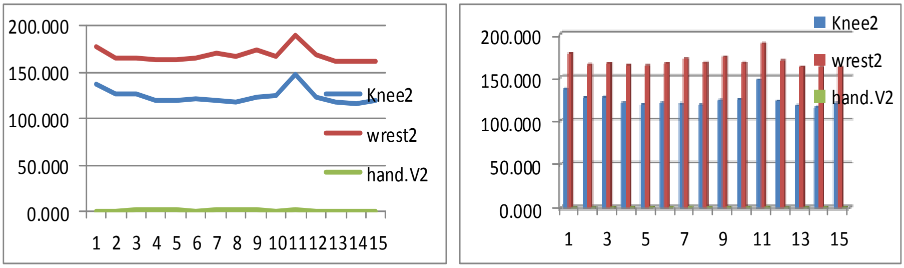

fig (7) Correlation spearman between hand. V2 and body angles/ phases duration (In mean phases)

Evident from the above table (7) and fig (7) there is not correlation between hand velocity2 and knee2, wrest2 angle values p > 0.05.

- Difference Between phase 1 and phase 2 in body angle and hand velocity:-

Table (8)

Difference Between phase 1 and phase 2 in body angle and hand velocity (variable normality)

T. Test Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	hip1 - hip2	8.20296	7.80632	2.01558	3.87996	12.52596	4.070	14	.001
Pair 2	hand.v1 - hand.v2	.58519	.35025	.09044	.39122	.77915	6.471	14	.000

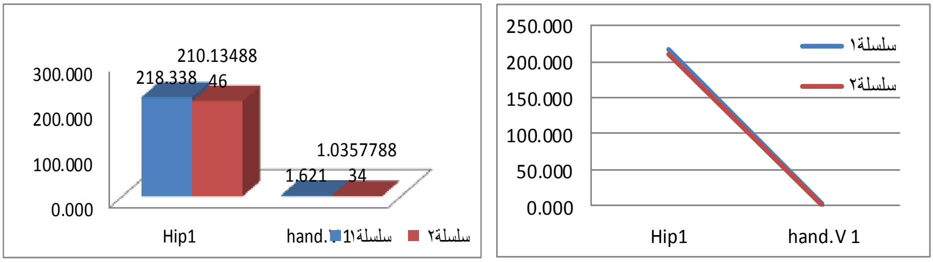

Fig (8) Explain Difference Between phase 1 and phase 2 in body angle and hand velocity (normality)

Evident from the above **table (8)** and **fig (8)** there is Difference Between phase 1 and phase 2 in body angle and hand velocity .there was significant different between hip1- hip2 and hand velocity 1 – hand velocity 2 .

Table (9)

Difference Between phase 1 and phase 2 in body angle and hand velocity (variable non - normality)

variable	knee2 - knee1	shoulder2 - shoulder1	elbow2 - elbow1	wrest2 - wrest1
Z	-3.237b	-3,408 c	-3,408 b	-3,408 c
Asymp. Sig. (2-tailed)	.001	.001	.001	.001

b. Based on positive ranks c. Based on negative ranks

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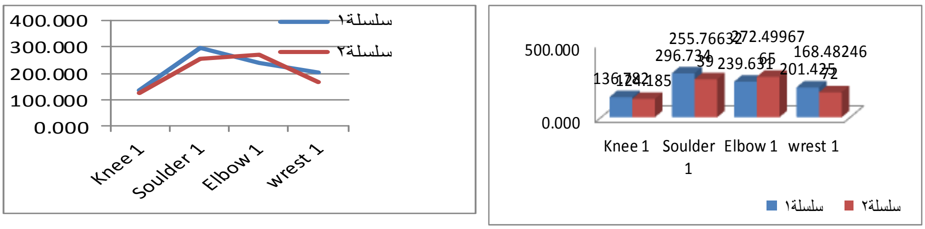

Fig (9) Explain Difference Between phase 1 and phase 2 in body angle and hand velocity (non-normality)

Evident from the above **table (8)** and **fig (8)** there is Difference Between phase 1 and phase 2 in body angle and hand velocity. There was significant different between knee1- knee2 and shoulder 1 – shoulder 2, elbow1 – elbow2, wrest1 – rwest2.

Difference Between made and missed basket:

Table (10)

Difference Between made and missed basket (normality)

Independent Samples Test		Levine's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
hip2	Equal variances assumed	.002	.970	2.588	13	.022	11.30933	4.36916	1.87033	20.74834
	Equal variances not assumed			2.518	1.305	.191	11.30933	4.49105	-22.14265	44.76131

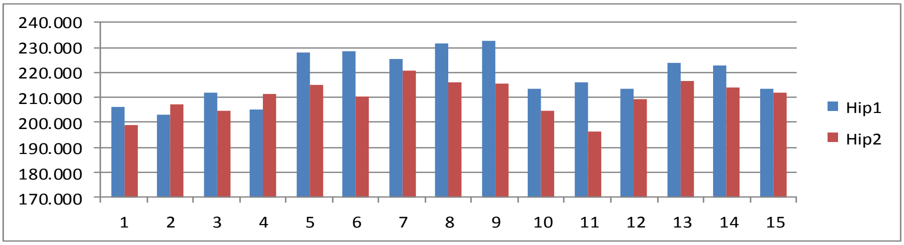

Fig (10) : Difference Between made and missed basket (normality)

Evident from the above table **(10)** there is Difference Between mead and missed basket. There was significant different between hip2 and performance.

Table (11)

Difference Between made and missed basket (non - normality)

Test Statisticsa	Performance	shoulder1	elbow1	knee2	wrest2	Duration1	Duration2	MaxHandV
Mann-Whitney U	0.000	7.000	9.000	1.000	7.000	10.500	2.500	0.000
Wilcoxon W	91.000	10.000	100.000	92.000	98.000	13.500	93.500	91.000
Z	-2.505	-1.019	-.679	-2.038	-1.019	-.427	-1.809	-2.212
Asymp. Sig. (2-tailed)	.012	.308	.497	.042	.308	.669	.070	.027
Exact Sig. [2*(1-tailed Sig.)]	,019[b]	,381[b]	,571[b]	,038[b]	,381[b]	,686[b]	,076[b]	,019[b]

a. Grouping Variable: Made Missed

b. Not corrected for ties.

Evident from the above table **(11)** there is Difference Between mead and missed basket. There was significant different between performance, knee2, maximal hand velocity.

Table (12)

Correlation between performance and variables which show significant difference (made - missed)

CorrelationsSpearman's rho		knee2	MaxHandV
Performance	Correlation Coefficient	,624*	.148
	Sig. (2-tailed)	.013	.598
	N	15	15

* Correlation is significant at the 0.05 level (2-tailed).

Evident from the above table (12) there is Correlation between performance and knee in mean phases values with p < 0.05 and R = 0.624.however, no significant correlation was maximal hand velocity and performance values (p > 0.05).

-Correlation between result of mental test and results of Simi (body angle hand velocity):-

Table (13)

Correlation between of mental test and results of Simi

Correlation	N	Sig. (2-tailed)	Correlation
MenErPre - wrest2	15	.045	0,523
PreTotal – wrest 2	15	.037	-0, 543*
MenCogPost - shoulder2	15	.009	-0,650**
MenCogPost – elbow2	15	.003	-0,707**
PostTotal - shoulder2	15	.016	-0,609
PostTotal - elbow2	15	.005	-0,688

Evident from the above table **(13)** there is a medium Correlation between mental test and results of Simi motion analysis in this variable MenErPre - wrest2, PreTotal – wrest 2, MenCogPost - shoulder2, PostTotal - shoulder2, PostTotal - elbow2, values with p < 0.05 and R = 0.523, R = - 0.543, R = -0.650, R = -0.609, R = -0.688 and a high correlation between PostTotal - elbow2 values with p < 0.01 and R =- 0.707,R = 0.523 R = 0.523R = 0.523R .However, no significant correlation was mental test and other results of Simi motion analysis values (p> 0.05).

Table (14)
Difference between per and post mental test (i.e, in performance, motor and cognitive times)

Test Statistics[a]	MenErPost - MenErPre	MenMotPost - MenMotPre	MenCogPost - MenCogPre	PostTotal - PreTotal
Z	-2,000[b]	-2,453[b]	-,909[b]	-1,306[b]
Asymp. Sig. (2-tailed)	.046	.014	.363	.191

A. Wilcoxon Signed Ranks Test **b. Based on positive ranks.**

Evident from the above table (14) there is Difference Between per and post mental test. There was significant different between MenErPost – MenErPreand MenMotPost - MenMotPre with $p < 0.05$.

discussion:

The results of this study revealed significant some differ- incest between basketball classes in the FT shooting mechanics required for a clean shot. Apparently, different techniques, as demonstrated by several aspects of the shooting motion and ball trajectory.

In Total movement there wasn't a correlation between the hand velocity and the angle values p>0.o5. In Preparatory phase there was a medium negative correlation between the hand velocity and the wrist angle with $p<0.05$ and $r=-0.56$ that's mean the increase in the values of wrist angles for FT attempts resulted in a decrease of hand velocity values.

To shoot successful free throws, players in the lower classes adopted a strategy, which used a steeper ball trajectory. This however required players to generate more force and velocity in the shooting arm. As the results indicated, the lower classes accomplished this by using greater maximum angular velocities at the shoulder and elbow. These results coincide with those of Miller and Bartlett [21], who found that elbow extension angular velocity increased as shooting distance increased. In addition, the lower classes tended to use a smaller start angle of the elbow (more flexed), which may have been an effort to increase elbow range of motion and generate the necessary impulse during arm elevation required for the ball to reach the basket**(Miller S, Bartlett RM.1993).**

The variations in the correlation results for the preparatory phase of the 15 FT attempts seem to be due to the correlation intra movement. In main phase there wasn't a correlation between the hand velocity and the angle values. This results seems to contradict with the previous study of (**achraf et al, 2015**) . The present study's results seem to have no relationship between the hand velocity and the body angles.

There was a significant difference between the hand velocity in phase 1 and 2 with $p<0.001$. There was a significant difference between the hip angle in phase 1 and 2 with $p<0.001$.

There was a significant difference in body angle(knee,shoulder,elbow and wrist) between phase 1 and 2 .Where knee and elbow based on positive rank and the shoulder and wrist based on negative rank.

We conclude that all this angle increased to transfer the kinetic energy to the hand to have more force and speed to deliver it to the ball during the release.

Statistical analysis showed (table) a significant difference between made and missed basket for performance, hip, knee, maximal hand velocity t.(13) = 2.588 p = 0.022, and sig p = -0.012, p = 0.042 and p = 0.027.

Statistical analysis showed (table 12) of a medium correlation between performance and knee, angle values with $p < 0.05$ and R = 0.624. However, no significant correlation was shown between the performance and the maximal hand velocity values $p >0.05$.

Statistical analysis result of Correlation between mental test and results of Simi motion analysis in this variable MenErPre - wrest2, PreTotal – wrest 2, MenCogPost - shoulder2, PostTotal - shoulder2, PostTotal - elbow2, values with $p < 0.05$ and R = 0.523, R = - 0.543, R = -0.650, R = -0.609, R = -0.688 and a high correlation between PostTotal - elbow2 values with $p < 0.01$ and R =- 0.707. However, no significant correlation was mental test and other results of Simi motion analysis values ($p> 0.05$).

There was a correlation mental Er post – mental Er pretestwhere $p < 0.05$ and mental mat post – mental motor pretest with $p < 0.05$. .

However, no significant correlation was mental test and other results of Simi motion analysis values (p> 0.05).

Recommendation:

The researcher recommends of the following:

- The dimensions of any external stimulation for the player during the test perception of mental.
- The dimensions of any external stimulation for the player during the test perception of mental(protest,posttest).
- Put some strength exercises for speed-of the hand throwe.

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