Pattern Analysis of Angular Kinematic Variables for Successful and Unsuccessful Free Shot In Basketball

Singh Uma Kant
Asst. Professor, LNIPE, Gwalior, India

Abstract

The study aimed at revealing the linear kinematical variables responsible for a successful free shot in basketball. Five subjects of homogenous nature in terms of anthropometric measurements and training age was selected. Casio Exilim EX-F1 high speed camera was used for recording of performance and Silicon Coach pro 7 software and Kinovea software were used for the analysis of data. The patterns values were superimposed which revels that there exists a difference in pattern of successful and unsuccessful free throws.

KEYWORDS: Basketball, Free shot, kinematics, Analysis

INTRODUCTION

Shooting is the principal method used to score points in Basketball and for this reason it is the most frequently used technical action (hay 1994). The free throw shot is distinguished as the most important of all the shooting actions (Hess 1980).efficacy in shooting is identified with the ability to perform well in this sport and consequently it is extensively practiced.

The free throw is the single most important shot in the game of Basketball, a close to 20% of all points in NCAA division. The shot becomes more important later in the game, as the free throws comprise a significant greater percentage of the total points scored during the last 5 minutes than the first 35 minutes of the game for both the winning and losing team (Kazan 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 defence and no close distractions, all the player has to do is to get ready, aim, cock the ball and shoot.

The majority of coaches identify shooting as the most important skill of Basketball. It doesn’t deny the importance of other skills- dribbling, passing or foot work- but only assumes that all offensive actions end in shooting. With this level of significance in the game, all fundamentals in the teaching methodology of shooting should be assured by the coaches. Usually it’s based on permanent adjustment of theoretical sentences of performance and individual characteristics of the players. Shooting is the first technical content of Basketball that youngsters want to learn. The youngster’s feeling of success in the game result from the efficacy of shooting performance (Krausse, 1984). The quality of the shooting learning process is very important in the development of young players. Such a process must be conducted by coaches with care and knowledge. It is reasonable to accept the theory that, “shooters are not born but made” (Newell & Benington, 1962).

Biomechanics is most useful in improving performance in sports or activities where technique is the dominant factor rather than physical structure or physiological capacity. One of the major problems in this field is the measurement of what one might call good body mechanics, objectively, without undue dependence upon inconsistent subjective judgments. A Kinematics assessment is provides information on the relationship of parts of the body to each other. This is useful in measuring joint angles during complex movement and has provided the basis of understanding functional activities that comes from kinematics assessments. Thus the current study intended to:

1. To find out the pattern of successful free throws
2. To find out the pattern of unsuccessful throws.
3. To find out the difference in pattern.

METHODS

Subjects

Five right handed male university level basketball players with an age range from 18 to 23 years having same playing experience were selected for this study. Purposive sampling was used to select the sample. All the subject were with equal arm length and almost equal height (180cm± 1 cm) without any anatomical deformity and also free from any orthopaedic or neurological disorders.

Variables

Based on literary evidence, correspondence with the expert and scholar's own understanding and keeping the feasibility criterion in mind, the research scholar selected the following kinematic variables for the study.

- Height of ball release at moment execution phase.
- Distance of ball travelled.
- Instant Velocity of ball release.

Instruments

Casio Exilim EX-F1 high speed camera was used for recording of performance and Silicon Coach pro 7 software and Kinovea software were used for the analysis of data.

Filming Protocol and Analysis

The two video cameras (Casio Exilim EX-F1) were adjusted on a tripod at a height of 1.20 mts from the ground. The camera was positioned perpendicular to the saggital plane and parallel to the medio-lateral axis (camera optical axes perpendicular on the saggital plane) so as that the shooter's arm gives approximately a 90^{o} between their respective optical axes.

The 300 frames per second as obtained by the use of high velocity videography were analysed (the best trail) by Silicon coach Pro-7 software. Only selected frames were obtained and the Research Scholar developed the stick figures from which various kinematic variables were obtained. The stick figures were developed by using joint point method in which the body projections at the joints facing the camera were considered for the study. The skill was sub divided into six phases namely Preparatory Phase, Wind up Phase I & II, Propulsion phase I, II & III.

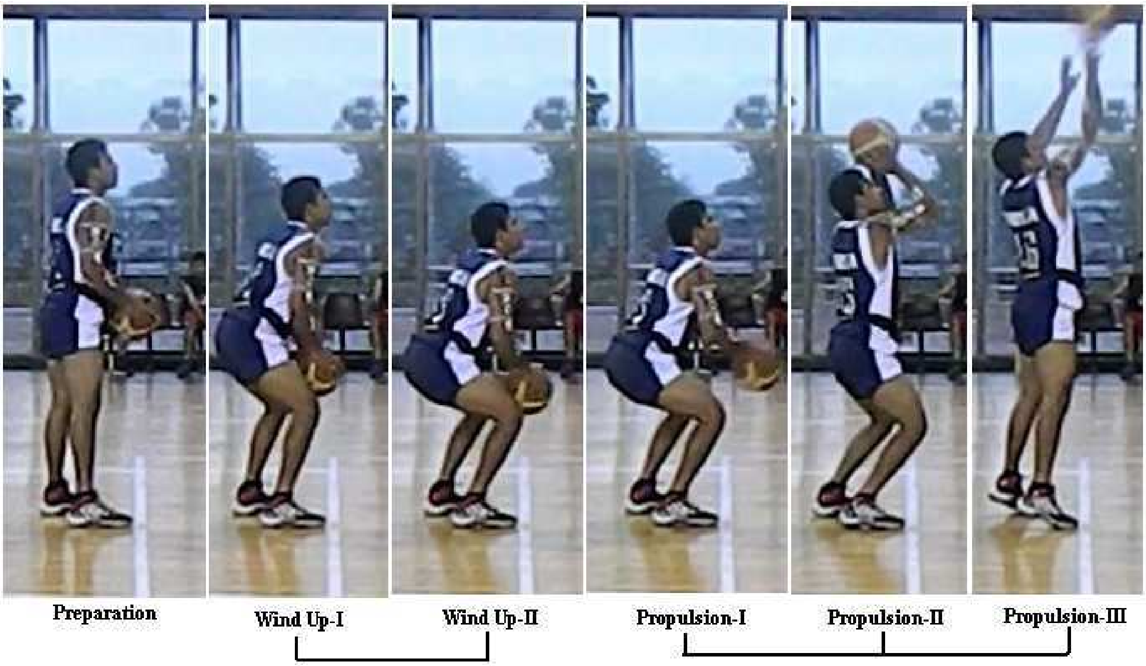

Figure 1: Phases of analysis

FINDINGS

Table 1: Descriptive statistics of angular kinematic values of different joints in different phases.

Phase	Successful					Unsuccessful			
Preparatory	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	88	100	94	3	88	97	93.13	3.54
	Knee	118	131	125.8	3.73	121	135	125	4.6
	Trunk	133	151	141.7	3.81	135	150	139	4.46
	Shoulder	12	16	13.87	1.06	12	16	14	1.25
	Elbow	71	82	76	3.53	59	69	63	3
	Wrist	140	152	144.13	3.25	128	145	134	5.84
Phase	Successful					Unsuccessful			
Wind Up I	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	70	82	76	3	70	79	74.73	3.28
	Knee	106	116	111	3.34	114	128	118	4.6
	Trunk	109	127	117.3	4.13	112	127	116	4.46
	Shoulder	8	12	9.87	1.25	8	18	12	2.42
	Elbow	74	84	78	2.36	80	90	84	3
	Wrist	139	151	142.9	3.53	138	155	144	5.84
Phase	Successful					Unsuccessful			
Wind Up II	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	58	70	64	3	62	73	67	3.74
	Knee	89	99	94	3.34	89	103	93	4.6
	Trunk	104	122	113	3.93	107	122	112.4	4.53

	Shoulder	5	9	6.73	0.88	7	39	9	7.87
	Elbow	92	102	96	2.3	85	95	89	3
	Wrist	132	144	136.1	3.25	119	136	125	5.84
Phase	Successful					Unsuccessful			
Propulsion I	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	54	66	60	3	56	65	60.33	3.48
	Knee	97	107	102.1	2.22	95	109	99	4.6
	Trunk	117	135	126	4.07	121	136	125	4.46
	Shoulder	51	55	53	1.07	51	153	53	25.9
	Elbow	72	83	76.07	2.91	83	93	87	3
	Wrist	140	152	144	2.56	152	169	158	5.84
Phase	Successful					Unsuccessful			
Propulsion II	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	77	89	83.4	2.97	69	86	80.67	4.7
	Knee	97	107	102.4	3.07	96	110	100	4.6
	Trunk	129	147	138	4.07	135	150	139	4.46
	Shoulder	107	111	109	1.07	109	113	111	1.41
	Elbow	65	75	69	2.3	49	59	53	3
	Wrist	157	169	161	3.27	135	152	141	5.84
Phase	Successful					Unsuccessful			
Propulsion III	Joint	Min	Max	Mean	SD	Min	Max	Mean	SD
	Ankle	113	125	119	3	115	124	118.8	3.14
	Knee	143	153	148	3.34	145	159	149	4.6
	Trunk	161	179	170	4.07	170	185	174	4.46
	Shoulder	122	140	130.9	3.54	127	131	129	1.41
	Elbow	127	137	131	2.54	142	152	146	3
	Wrist	167	179	171.1	3.25	176	185	179	2.17

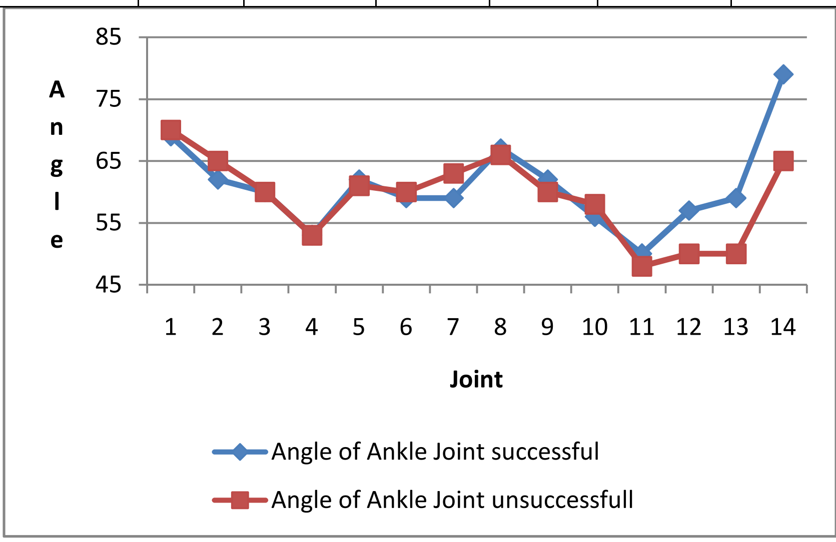

Fig. 2: Graphical Representation of Ankle Movement in Free Throw Shot

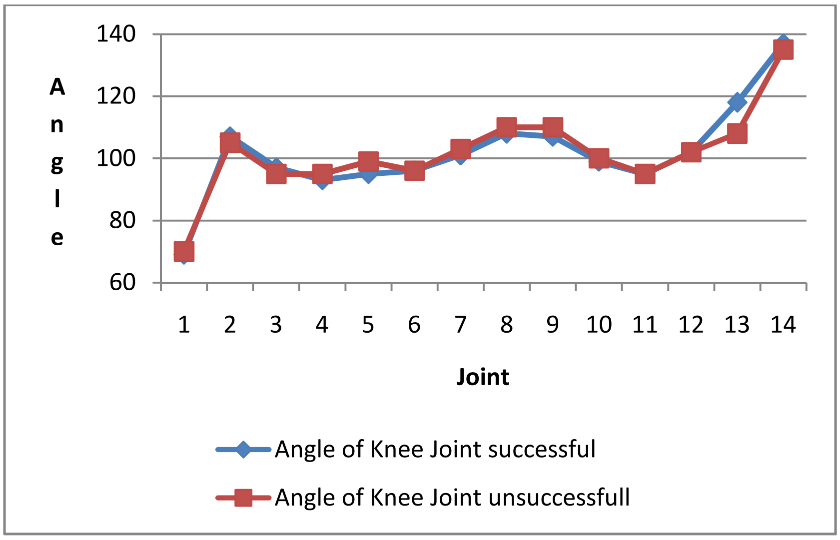

Fig. 3: Graphical Representation of Knee Movement in Free Throw Shot

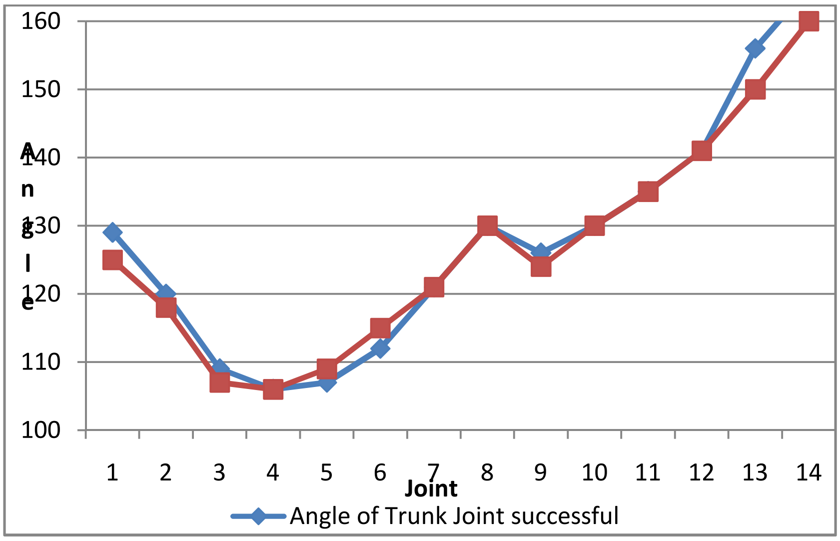

Fig. 4: Graphical Representation of Trunk Movement in Free Throw Shot

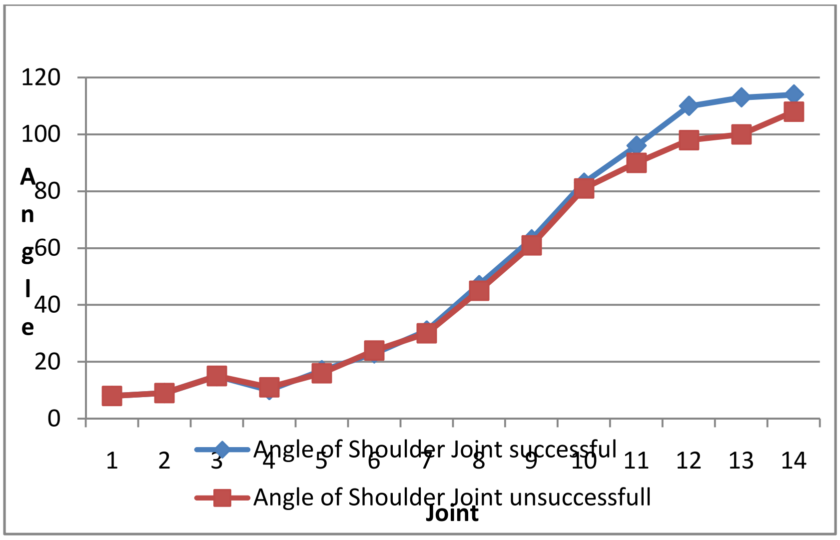

Fig. 5: Graphical Representation of Shoulder Movement in Free Throw Shot

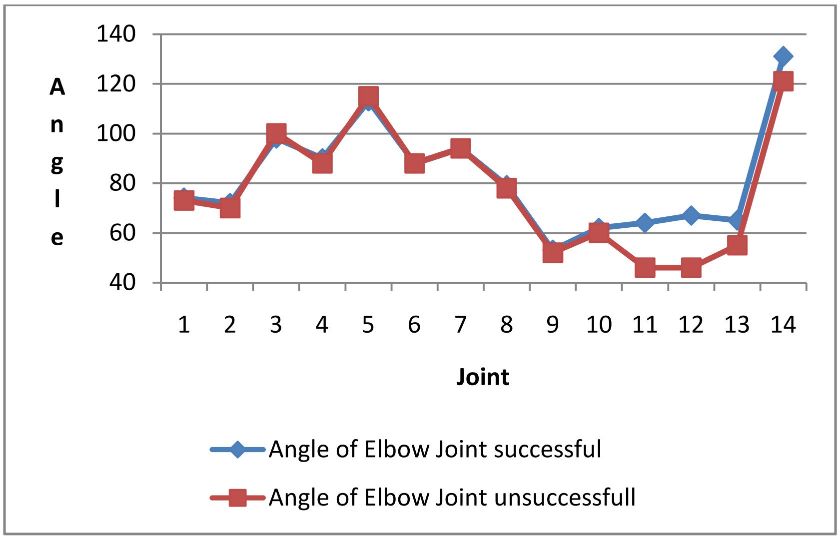

Fig. 6: Graphical Representation of Elbow Movement in Free Throw Shot

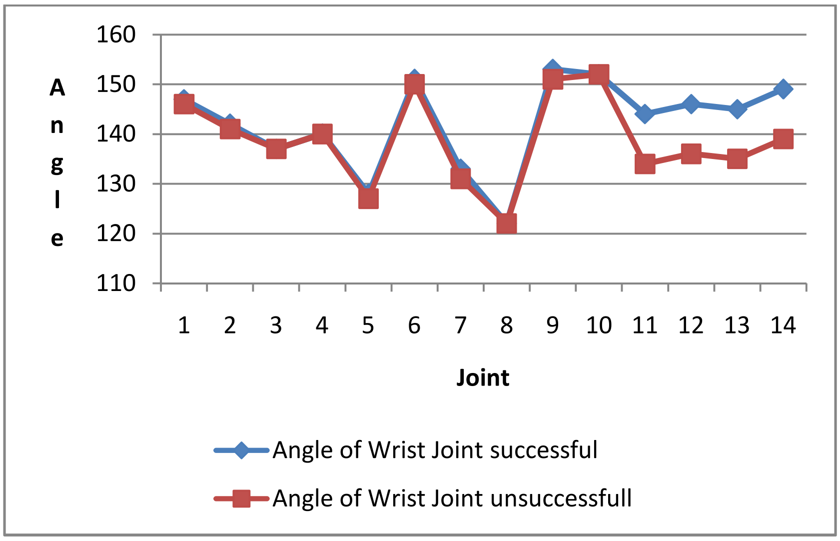

Fig. 7: Graphical Representation of Wrist Movement in Free Throw Shot

DISCUSSION

The preparatory phase is the beginning of the shot and is crucial to the execution. In order to begin the shot, the player needs to balance his body. The player must also complete this phase with their centre of mass over the base of support. The preparatory phase is just before the breaking the inertia of the body.Mean angle of different joints were: - Ankle (94 ± 3), Knee (125.8 ± 3.73), Trunk (141 ± 3.8), Shoulder (13.87 ± 1.06), Elbow (76 ± 3.5) and Wrist (144.13 ± 3.25).The wrist loose and the finger and hand relaxed. The wrist should be in extension in order to help support the ball and be in position to provide propelling force for the shot.Lower extremity joints pattern was in increasing order – Ankle, Knee and Trunk. Upper extremity joints pattern was also in increasing order- Shoulder, Elbow and Wrist.

This phase begins as the knee joint angle decreasing. Contraction of different joints start and this result in shortening of the muscles as it is the force producing phase.Ball is held stationary at waist level with the shooting hand behind the ball. Ankle joint, knee joint, trunk joint and wrist joint show different rate of flexion, flexion rate was higher in trunk, knee and ankle in lower body, and shoulder, elbow and wrist in upper body joints. Flexion of joints will produce more hyper extension at the neck so the shooter can retain focus on the rim. This neck hyper extension may produce unwanted tension in the The subject executes the knee and hip flexion and ankle dorsiflexion prior to the shot, the lower body gets flexed and centre of gravity gets lower. This crouched position will stretch the quadriceps and hamstring muscles to be used in the extension and produce a more forceful extension. The results also support the findings of Antnio (1985) in a study aimed at kinametic analysis of the Basketball shooting.

The pattern of flexion in lower body joints continue to decrease from preparatory to win-up phase 1. The ranges of angle of joints were - Ankle (72-82^0), Knee (106-116 ^{0}), Trunk (109-127 ^{0}), Shoulder (8-12 ^{0}), Elbow (74-84 ^{0}) and Wrist (139-151 ^{0}).Contraction of muscle and flexion of knee continue in this phase. This phase is the end of wind-up phase and start of propulsion phase. Flexion of joints of upper and lower part continues to decrease, except the elbow joint. This shows that elbow joint start propelling. The average ankle joint, knee joint, trunk joint, shoulder joint, elbow joint and wrist joint were 64, 94, 113, 6.73, 96 and 136.1 respectively.

In this study propulsion phase was divided in three sub phase i.e. propulsion I, propulsion II and propulsion III. In this phase extension of all joints occurs. Movements of the body part produce upward and forward force to project the ball to the basket which includes leg and trunk extension as well straightening of the shooting arm. Transfer of force takes place in this phase. Pattern of ankle joint extension in propulsion 1, propulsion 2 and propulsion 3 were 60, 83.4 and 119 degree respectively. The knee joint averages were 102, 102, and 148. Trunk averages were 126, 138 and 170. Rate of extension is more in trunk joint as compared to knee and ankle joints. The shoulder joint averages in different propulsion phase were 53, 109 and 130.9. Again, the rate of extension is high in shoulder joint as compared to lower body part, as shoulder joint contribute more force to the ball velocity. The pattern of elbow joint is not consistent in all the three phases of propulsion; the values were 76, 69 and 131. Wrist joint shows consistent extension as its value increased from 144 in phase 1 to 171 in phase 3.Propulsion phase begins when the trunk reaches the vertical position and the ball is held just above shoulder level. At this point knee are in maximal flexion. The knee and hip joint will extend first followed by shoulder flexion, then elbow extension and wrist flexion. Wrist flexion imparts more back spin to the ball in order to stabilize its flight. Van den Tillaar R, and Ettema G (2003) also concluded with similar results in their study which support this finding. R. E. Vaughn (1998) also attained similar results in the study conducted to examine intra-individual variability for Basket ball free throws.

REFERENCE

Alexander RM, “Optimum Timing of Muscle Activation for Simple Models of Throwing” Journal Of Theoretical biology, Volume 150, 1991.

Árpadillyes and Rita M. Kiss, “Shoulder muscle activity during pushing, pulling, elevation and overhead throw” Journal of electromyography and kinesiology, Volume 15, issue 3, 2005.

Árpadillyes and Rita M. Kiss. “Comparative EMG Analysis Of The Shoulder Between Recreational Athletes And Javelin Throwers During Elementary Arm

Motions And During Pitching" Physical Education And Sport Vol. 1, issue 10, 2003.

Bryan T. Kelly et.al, "Electromyographic Analysis and Phase Definition of the Overhead Football Throw" The American journal of sports medicine, 2001.

Bartlett. R, "Throwing: Fundamentals and Practical Applications" International Symposium on Biomechanics in Sports, 18, 2000.

Chris Buttona, Morven Macleodb, Ross Sandersb & Simon Colemanb, "Examining Movement Variability in the Basketball Free-Throw Action at Different Skill Levels" Research Quarterly for Exercise and Sport, Volume 74 (3), 2003.

Christensen H and Frederiksen, "Quantitative Surface EMG during Sustained and Intermittent Submaximal Contractions" Electroencephalograms Clinical Neurophysiology, Volume 70, 1988.

David R, Mullineaux & Timothy L, "Coordination-variability and kinematics of misses versus swishes of Basketball free throws" Journal of Sports Sciences, Volume28 (9), 2010.

Denise Derbyshire, "Physical factors influencing the throwing action in netball and cricket players" Stellenbosch University, 2007.

Escamilla RF, Speer KP, Fleisig GS, Barrentine SW and Andrews JR, "Effects Of Throwing Overweight And Underweight Baseballs On Throwing Velocity And Accuracy" Sports Medicine, Volume 29, 2000.

F. J. Rojas, M. Ceprero, A. Ona and M. Gutirrez, "Kinematic adjustment in the Basketball jump shot against an opponent" Ergonomics, Volume 43, Issue 10, 2000.

Gowan ID, Jobe FW, Tibone JE, Perry J, Moynes DR. "A Comparative Electromyographic analysis of the Shoulder during Pitching: Professional versus Amateur Pitchers" American Journal of Sports Medicine, Volume15 (6), 1987.

Gordon R. Hamilton & Christoph Reinschmidt, "Optimal trajectory for the basketball free throw" Journal of Sports Sciences, Volume 15, issue5, 1997.

Hof AL, Pronk CN & van Best JA "Comparison between EMG to force processing and kinetic analysis for the calf muscle moment in walking and stepping" Journal of Biomechanics, Volume 20, issue2, 1987.

Hoffman, Shirl J, Imwold, Charles H and Koller, John A, "Accuracy and prediction in throwing in between male and female children "Research quarterly for exercise and sports, Volume 54, issue 1, 1983.

Hore J, Watts S, Tweed D, Et Al. "Over arm Throws with the No dominant Arm: Kinematics Of Accuracy" J Neurophysiology, Volume 76, issue 6, 1996.

Hug F, Laplaud D, Lucia A, &Grelot L "EMG Threshold Determination In Eight Lower Limb Muscles During Cycling Exercise: A Pilot Study" International Journal Of Sports Medicine, Volume 27, issue 6, 2006.

H. Okuboa & M. Hubbardb, "Dynamics of the basketball shot with application to the free throw" Journal of Sports Sciences, Volume 24(12), 2006.

Ioannis, B, Giorgos, G, And Konstantinos, B, "Accuracy and Throwing Velocity In Handball", International Symposium On Biomechanics In Sports, 1998.

Istvan karacsony and Ivan Cuk, "Pommel Horse: Exercise Methods, Idea, Curiosities, History" (Ljublijana: faculty of Sports, University), 1998.

Ikram Hussain and Mohd. Arshad "Biomechanical analysis of cricket ball throwing techniques" Journal of Education and Practice, Vol. 2, issue 3, 2011.

Jobe FW, Tibone JE, Perry J and Moynes, "An EMG Analysis of the Shoulder in Throwing and Pitching: A Preliminary Report" American Journal of Sports Medicine, Vol. 11, 1983.

Jackie L. Hudsona, "Prediction of Basketball Skill Using Biomechanical Variables" Research Quarterly for Exercise and Sport, Volume 56(2), 1985.

Juan Antonio Garcíaa, Rafael Sabidob, David Barbadob &Francisco Javier Morenob, "Analysis of the relation between throwing speed and throwing accuracy in team-handball according to instruction" European Journal of Sport Science, Volume 13, Issue 2, 2013.

Jaspal S. Sandhu, S.M and Shweta S "An Electromyographic Analysis of Shoulder muscle activation during push-up variations on stable and labile surfaces" International Journal Of Shoulder Surgery, Vol. 2, 2008.

J. Hore, S. Watts, D. Tweed, and B. Miller, "Over arm throws with the no dominant arm: kinematics of accuracy" Journal of Neurophysiology, Volume 76, 1996.

Laurie A. Malone, Pierre L. Gervais, Robert D. Steadward, "Shooting mechanics related to player classification and free throw success in wheelchair basketball" Journal of Rehabilitation Research and Development, Vol. 39 (6), 2002.

Masaya Hirashima et.al. "Sequential muscle activity and its functional role in the upper extremity and trunk during overarm throwing" Journal of Sports Science, Volume 20, 2002.

Moynes D.et.al, "An EMG analysis of the shoulder in throwing and pitching: A preliminary report", American Journal of Sports Medicine, Volume 11, issue1, 1983.

Marie A. Dupuya, Denis Mottetb & Hubert Ripollc, "The regulation of release parameters in underarm precision throwing" Journal of sports sciences, Volume 18, issue 6, 2006, Nissan, K. et. Al, “EMG signal analysis for identifying walking patterns of normal healthy individuals” Indian Journal of Biomechanics, 2009.

Roland T and Gertjan E. “Force-Velocity relationship and Coordination in over arm throwing” Journal of Sports Science and Medicine, Volume 3, 2004.

Saleh A. Al-Abood, Simon J. Bennett, Francisco Moreno Hernandez, Derek Ashford & Keith Davids, “Effect of verbal instructions and image size on visual search strategies in basketball free throw shooting” Journal of Sports Sciences, Volume 20 (3), 2002.

Schmidt A, “Movement pattern recognition in basketball free-throw shooting” Human Movement Sciences, Volume31 (2), 2012.

Tran, CM & Silverberg, LM, “Optimal release conditions for the free throw in men's basketball” Journal of Sports Sciences., Volume 26(11), 2008.

Van Den Tillaar R, And Ettema G, “Instructions Emphasizing Velocity, Accuracy, Or Both In Performance And Kinematics Of Overarm Throwing By Experienced Team Handball Players” Perceptual & Motor Skills Percept Mot Skills, Vol. 97, 2003.

Z. Ning, A. Faro, D. Sue and N. Hamilton. “Kinesiological Analysis of Over arm Throwing for Accuracy with Dominant and Non-Dominant Arms” International Symposium on Biomechanics in Sports, 1999.