International Journal of Home Science 2020; 6(2): 110-112

International Journal of Home Science

ISSN: 2395-7476
IJHS 2020; 6(2): 110-112

www.homesciencejournal.com
Received: 25-03-2020
Accepted: 29-04-2020

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Biomechanical factors contributing while effective shooting in basketball

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Abstract
This paper mainly used the two dimensional technique to analyze the Three Point Shoot performance of Basketball and to acquire relevant bio-mechanic parameters of the execution of the motion at three different positions i.e: right side guard position, left side guard position and centre position. Mainly including the loss rate of body horizontal and vertical velocity of the ball, Wrist angle, Elbow angle, Shoulder angle, Hip angle, Knee angle, Ankle angle, Release height, Release angle and Release velocity, in order to analyze the recording in a more convenient way, we divide Three Point Shooting exertion movement in three phases as Preparation and Ball Elevation phase, Stability and Ball Release phase and Inertia and Follow through phase. Thirty skilled active, right handed shooters male and female basketball players were participated in this study. A lot of combinations of shoulder, elbow and wrist angular velocities exist for each release condition. When the forearm and hand are vertical at release, the shoulder rotation contributes to the vertical component of ball release velocity, and the elbow and wrist rotations are vital considering the parabolic trajectory the ball may go into the basket ring when going for the trailing edge of the basketball ring, the scoring rate will be approx. 60.00% higher.

Keywords: Three Point Shoot, Two dimensional analyses, Bio-mechanics, Basketball shooting.

Introduction
Basketball is one of the most popular sports in the world. In Basketball a team can score a field goal by shooting the ball through the basket during regular play. For shooting the ball there are variety of shots, which includes the hook shot, the jump shot, the set shot and the lay-up shot. Lay-up shot for goal is most commonly used if a player is dribbling towards the basket and doesn't want to pass the ball and can get around the defenders. Therefore shooting technique is one of the core techniques in basketball movement. Excellent basketball shooters have a beautiful arch, input the proper backspin, and minimize the lateral deviation from the optimal shot path plane. They manipulate their shoulder, elbow and wrist to produce the optimal ball speed, angle and angular velocity at release. It is vital to analyze the kinematics of the shooting arm to understand good shooting. Knudson (1993) [3] proposed six key teaching points for jump shots based on many basketball shooting studies, and mentioned that biomechanical studies have not clearly identified the optimal coordination of human joint actions. The main objective of each basketball player during a game is to score points. In an attempt to do so, an athlete might perform a jump shot, set shot, layup or a free throw. As the discipline has evolved and more athletic players have practised this sport discipline, defence has become increasingly efficient. As a result, the two- legged jump shot has become more frequent, amounting to over 70% of all the shots during a game, which necessitates a greater performance level for athletes executing the jump shot to increase the height at which the ball is released (i.e., the release point) (Oudejans *et al*., 2012) [5].

Methodology
Thirty highly skilled active, right handed shooters male and female basketball players were participated in this study. All of the participants were practicing according to their team's regular training schedule. All the subjects were playing from all the post guards, forwards, and centers. The participants were free of any kind of musculoskeletal injuries at the time of data collection. In three point basketball shooting different parameters play a great role for making a shot 'successful' and 'unsuccessful' shooting in the performance such as psychology,

physiology and anthropometry of the player and etc. But here we selected only the biomechanical parameters and worked on it and try to find out the effect of selected biomechanical parameters on the successful and unsuccessful. Three Point Shoot of basketball. The selected biomechanical variables in the study were as:

Phase 1	Phase 2	Phase 3
Ball Elevation phase	**Ball Release phase**	**Inertia**
Wrist Angle	Wrist Angle	Wrist Angle
Elbow Angle	Elbow Angle	Elbow Angle
Shoulder Angle	Shoulder Angle	Shoulder Angle
Ankle Angle	Ankle Angle	Ankle Angle
Hip Angle	Hip Angle	Hip Angle
Knee Angle	Knee Angle	Knee Angle

The acquired data was given an appropriate statistical treatment to draw a conclusion in this investigation. In this study, successful and unsuccessful shot; mean and standard deviation of all variables were computed in the data analysis.

Results

Table 1: Democratic profile of respondents

S. No.	Democratic Profile	Mean
1.	Age (Years)	23.3
2.	Weight (Kg)	168.7
3.	Height (Cms)	65.8

The purpose of the present study was to determine the kinematic influence of the 'Three Point Shooting'. The Table 1 depicts the democratic profile of the respondents with age mean of 23.3, weight mean is 168.7 and height mean of 65.8. This skill is divided into three phases such as Phase I Preparation and Ball Angle, Phase II Stability and Ball Release, Phase III Inertia and Follow Through. In phase I, the parameters wrist angle, elbow angle, shoulder angle, hip angle, knee angle, ankle angle, were selected for the analysis. Table 2 the result that no significant differences are found in the body joints angles during the phase I, but there were calculation differences (random) between the successful and unsuccessful shooting (Diar, 2014). During the study it was observed that the wrist angle displayed for successful Three Point Shoot as Mean ± SD = 136.62 ± 7.75 and for unsuccessful Three Point Shoot Mean ± SD = 133.24 ± 6.81, The elbow angle for successful Three Point Shoot as Mean ± SD = 66.83 ± 6.30 and for unsuccessful shot Mean ± SD = 62.26 ± 6.23. Shoulder angle for successful & unsuccessful as 87.24 ± 19.83 & 82.58 ± 21.39 respectively. The subjects displayed hip angle for successful as 156.98 ± 5.78 and 155.13 ± 7.67 for unsuccessful. The knee angle and ankle angle for successful shot were 111.08 ± 6.18 & 161.00 ± 12.61, whereas for unsuccessful as 116.65 ± 7.55 & 158.34 ± 14.20 respectively. No significant changes were showed on Knee angle and ankle at the initial stage (extension) of the execution (Diar, 20214; Nassaif & Mazer, 1979) [4] least mean difference among the selected kinematics variables were observed between the successful and unsuccessful during Three Point Shoot.

Table 2: Preparation and ball elivation phase (I)

Variable	Performance	Mean	Standard deviation
Wrist angle	Successful	136.62	7.75
	Unsuccessful	133.24	6.81
Elbow angle	Successful	66.83	6.30
	Unsuccessful	62.26	6.23
Shoulder angle	Successful	87.24	19.83
	Unsuccessful	82.58	21.39
Ankle angle	Successful	161.00	12.61
	Unsuccessful	158.34	14.20
Knee angle	Successful	111.08	6.18
	Unsuccessful	116.65	7.55
Hip angle	Successful	156.98	5.78
	Unsuccessful	155.13	7.67

Table 3, shows significant difference in shoulder angle in making the score during Stability and Ball Release phase. The selected parameters for the phase II were wrist angle, elbow angle, shoulder angle, hip angle, knee angle, ankle angle, release height, release angle and release velocity. The wrist angle for successful & unsuccessful are 146.62 ± 17.35 & 143.24 ± 16.11 and elbow angle shows 166.03 ± 15.20 & 162.20 ± 17.23 (as Mean ± SD). But both wrist and elbow angle displays a no significant result.

Diar, 2014 and Rojas, 2000 also supports that a significant result in angle of shooting arm shoulder joint at the end of the preparatory phase was showed due to the player is used to lap the ball near his chest with full flexion of the elbow joint. Shoulder angle towards the end of the pushing in flight in favor of shot in making it successful. Hip angle, the boys display the hip angle for successful as 116.88 ± 8.38 and for unsuccessful as 115.53 ± 7.67. The variable knee angle, the boys display the knee angle for successful Three Point Shoot as Mean ± SD = 161.08 ± 6.31 and for unsuccessful Three Point Shoot Mean ± SD = 171.26 ± 8.31. No significant change was observed in the angular contrast for the knee joint at the ball release stage (Rojas, 2000). And the ankle angle successful Three Point Shoot was 116.10 ± 12.61 and for unsuccessful 118.36 ± 11.28.

Inertia and Follow Through is the third and last phase of the Three Point Shoot. Table 4 shows wrist angle as the only significant value among all the selected variables. Wrist flexion in the meantime and the forefinger compel set out toward the end is accord with human body development mechanics principle, index finger, and metacarpal is one of the longest, in this way, the longest and the working separation to dial out to the ball from this side, is useful to quicken the speed and exactness of basketball accuracy (Zhen, 2015) [6].

Table 3: Stability and ball release phase (II)

Variable	Performance	Mean	Standard Deviation
Wrist Angle	Successful	146.62	17.35
	Unsuccessful	143.24	16.11
Elbow Angle	Successful	166.03	15.20
	Unsuccessful	162.20	17.23
Shoulder Angle	Successful	187.32	9.93
	Unsuccessful	182.38	8.36
Ankle Angle	Successful	116.10	12.61
	Unsuccessful	118.36	11.28
Knee Angle	Successful	161.08	6.31
	Unsuccessful	166.85	5.55
Hip Angle	Successful	116.88	8.38
	Unsuccessful	115.53	7.67

From table 4 it was observed wrist angle for successful as 117.26 ± 3.53and for unsuccessful as 113.69 ± 4.76. The elbow angle as 160.91 ± 7.65 & 161.64 ± 6.98 shoulder angle as 171.05 ± 17.29 and as 114.36 ± 15.87 respectively. The mean and SD of lower extremities as hip, knee and ankle angles for successful Three Point Shoot are 165.19 ± 14.98, 124.89 ± 13.77 and 119.87 ± 8.13, whereas for unsuccessful 161.09 ± 12.56, 125.11 ± 11.87 and 134.23 ± 9.23 respectively. No significant changes were showed on Hip, Knee and Ankle angle at the end of absorption stage.

Table 4: Inertia and follow through phase (III)

Variable	Performance	Mean	Standard deviation
Wrist angle	Successful	117.26	3.53
	Unsuccessful	113.69	4.76
Elbow angle	Successful	160.91	7.65
	Unsuccessful	161.64	6.98
Shoulder angle	Successful	171.05	17.29
	Unsuccessful	114.36	15.87
Ankle angle	Successful	119.87	8.13
	Unsuccessful	134.23	9.23
Knee angle	Successful	124.89	13.77
	Unsuccessful	125.11	11.87
Hip angle	Successful	165.19	14.98
	Unsuccessful	161.09	12.56

Conclusion

Three Point Shooting abilities contain laws and principles of human movement, among them, the development mechanics content assumes a significant part. While shooting from any position out of three point line, elbow ought to aim at the ring. Shoulder, elbow, wrist, fingers and the ball ought to be on a similar plane of the movement, in this way when the ball is tossed towards the basket ring for the successful score. In the meantime, players likewise need to utilize fingers to control and shoot the ball. A lot of combinations of shoulder, elbow and wrist angular velocities exist for each release condition. When the forearm and hand are vertical at release, the shoulder rotation contributes to the vertical component of ball release velocity, and the elbow and wrist rotations are vital considering the parabolic trajectory the ball may go into the basket ring when going for the trailing edge of the basketball ring, the scoring rate will be approx. 60.00% higher.

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