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## Biomechanical factors contributing to effective layup shot in basketball: A review study

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### Abstract

**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. Literature is review to create the content from the past for the new study to be conducted with new subjects and newly obtained data.

**Objective:** The objective of this study is to critically evaluate the scientific study related to the biomechanics of lay-up shot for better shooting performance and also to get the accuracy in basketball game.

**Methods:** This article critically reviews the biomechanical factors which contribute to the layup shot in basketball from referred published research work and unpublished thesis. The scholar identified very few studies which directly focus on the biomechanical analysis of basketball shooting skills and also in lay-up shot.

**Conclusion:** Biomechanical factors like approach speed, take off velocity, take off angle, height of ball release, angle of ball release, speed of ball release, segmental joint angle at release, duration of total flight, landing angle are related with better performance layup shot in basketball.

**Keywords:** Biomechanical factors, lay-up shot, basketball, review

### Introduction

Biomechanics in sports can be stated as the muscular, joint and skeletal actions of the body during the execution of a given task, skill and/or technique. Proper understanding of biomechanics relating to sports skill has the greatest implications on: sport's performance, rehabilitation and injury prevention, along with sport mastery. As noted by Doctor Michael Yessis, one could say that best athlete is the one that executes his or her skill the best.

Basketball is one of the most popular and widely viewed sports in the world. Points are scored by throwing (shooting) the ball through the basket from above, the team with more points at the end of the game wins. Shooting is one of the primary skills of the game and requires a great deal of practice assisted by good models, scientifically based. Since players were accepted to shoot often in order to score. They developed a variety of shots, which includes the hook shot, the jump shot, the set shot and the lay-up shot.

Lay-up shot is one of the most fundamental actions in the game of Basketball, have two steps and hop (Alteckretee, 1988, p382) It is mainly by players who are not tall enough to dunk the ball when on a fast break as well as for players who are close to basket with no opponents in their path. Learning how to shoot a basketball lay-up is an efficient action for all basketball players and can help to make them all a better well rounded player. However there are many biomechanical principles involved in performing an efficient basketball lay-up. Its accuracy is also a cause for why it is so popular. For a player to improve their layup, improve accuracy, make the shot more efficient and speed up the run into the shot it is important to look at a few biomechanical principals. These principals tell us how to move our body efficiently and improve our skills.

In the layup shot the player runs towards the basket while dribbling the ball in their right hand, they then place their right foot followed by their left and take off, releasing the ball towards the basket by completely extending their shooting arm (Sandeep & Bhardwaj, 2011).

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The layup is considered one of the more basic shots in basketball. The main obstacle when performing a layup is getting near the baskets rim and avoiding the taller defenders blocks (Sandeep & Bhardwaj, 2011). The layup is made with one hand and from a position under or beside the basket (Sandeep & Bhardwaj, 2011).

### Main Part

Rojas FJ, Cepero M, Ona A, Gutierrez M. (2000) <sup>[2]</sup> carried a study on "Kinematic adjustment in the basketball jump shot against an opponent". The aim of this study was to analyze the adjustment in technique made by a basketball player shooting against an opponent. The subject was consisted of ten professional basketball players of the Spanish First division League. Three dimensional motion analysis based on video recordings (50 Hz) was used to obtain the kinematic characteristics of basketball jump shots with and without an opponent. It was found that when performing against an opponent the release angle of the ball increased, the height time was reduced and postural adjustments as determined by the angles at the knee and shoulder increased, all significantly. There was several other non-significant divergences that helped to interpret the changes in technique imposed by the presence of an opponent. It was suggested that when shooting with an opponent, players attempted to release the ball more quickly and form a greater height. This strategy will lessen the chance of the opponent intercepting the ball. It was concluded that the divergences noted in the technical execution of the skill had implications for practice. It was suggested that training would benefit from practice with an opponent for at least some of the time to condition players to the demands which they were more likely to meet the game situation.

Aftabi, R.G., *et al.* (2001) <sup>[10]</sup> conducted a study entitled, "Performance comparison of the right and left basketball lay-up in hand and foot ipsilateral and contralateral conditions." The result showed that performance of right contralateral lay-up group is more significant than other groups that mean this superiority of performance compared with right and left lateral group was significant and in other groups was low and meaningless.

Phillips P.R (2007) conducted a study on, "A Comparison of Two Methods of Shooting The Lay-up Shot in Basketball Among College Women". The purpose of this study was to compare the overhand and underhand lay-up shots, among college women classified as beginning basketball players. Thirty-six subjects were divided into two groups and assigned either the overhand or underhand methods of shooting the lay-up shot. All subjects were administered a revised version of the bounce and shoot test to evaluate initial ability to execute a lay-up shot. Following this test, the two groups of subjects received instruction and practice in the lay-up shot and were tested again at periods of two and four Weeks after the initial test, A two.factor analysis of variance for repeated measures was employed to analyze the data. The results showed no significant difference (p i.,25) in accuracy and time scores between students executing an overhand lay-up shot and those performing an underhand shot following a four week instruction period. Both the overhand and underhand groups improved significantly (p = .001) in shooting accuracy over this period. Based on the results of this study, it was concluded that beginning basketball students can be equally successful with either the overhand or underhand lay-up shot following a four week instruction period and can improve in shooting ability, using either technique, during this period.

Yadav S.K. (2011) conducted a study entitled as "Construction of an objective skill test for Lay-up Shot in basketball". The purpose of this study was to construct an objective skill test for lay-up shot test in basketball. The experiment was initially conducted as a pilot study on 15 inter collegiate male basketball players on three different variations of lay up shot namely: Dribble and lay up shot, Underhand lay up shot and lay up shot with passive defense. Reliability of all the three tests was computed and the first test was statistically significant, whereas the other two were insignificant. Hence, the Dribble and Lay up shot test were selected for further study. Fifty male basketball players who participated in Inter-collegiate/District level basketball tournament were selected to serve as a subject for this study. The age of subjects ranged between 18 to 25 years. The criterion measure was the scores obtained in Johnson's Basketball test. Before administering the test, the subjects were briefed about the purpose of the study (To measure the ability of a player's skill in dribbling and lay up shooting in basketball.) and details of the test were explained to them. The subjects were given a demonstration of the test by a trained helper. They were also given sufficient number of trials to enable them to become absolutely familiar with the test. To ensure uniform testing conditions, the subjects were tested in the morning and evening sessions after warming-up during practice sessions. The duration of test administration was set in a manner so that fatigue may not occur. The players being tested stood behind half court line, with a standard size basketball in his hands. One point was awarded for each successful basket. Three trials of the 10 lay-up shot attempts were given to each subject. Best of the 3 trials was the scores of the player. Lay up, Dribble and Lay up time and the composite scores of these two were calculated for further analysis. Analysis of data on Dribble and Lay up Shot test indicated that the constructed test in basketball was found to be reliable. The findings of the study further reveal that the Dribble and Lay up Shot test in basketball was found to be objective. The significant values showed that the directions for administration of the test were specific and clear for performance as well as evaluation. Finally the constructed test for the Dribble and Lay up shot was also found to be valid as the test items scores correlated significantly with the scores obtained in Johnson Basketball Test.

Hanna J.S, (2014) <sup>[1]</sup> conducted a study entitled, "Comparison of Some Kinematic Variables of Layup Basketball of Older and Young Players". The length and speed of first and second step for older players is higher for the older player than the youth. The older players were better in all tested variables (horizontal and vertical distance, hips displacement for jumping, height of palm, distance of take-off from basketball). The objective of this study was to investigation biomechanical parameters of layup which can effect on the score and to find out the difference between the layup techniques of players experienced and younger group player of the same university team. A descriptive research design used in the current study. The population of this study was undergraduate male basketball players of the University of Mosul -Iraq, for the academic year 2012-2013, each sample included (6) male basketball players; young players=(176.7 cm tall), (18,3 years age) older player =(179.6 cm tall), (23,3 years age). The procedure of this research started with warm up for 15 minutes followed by passing, shooting, and the players performed the layup technique by repeated 3 times and the best performance of layup was selected to analyze. Data were analyzed using SPSS version 19.0, Mean variables

compared by T-test at 0.05. Programs of Maxtra and Dartfish used for analysis. This study conclude that -The length and speed of first and second step for older players higher for the older player than the youth. The older players were better in all tested variables (horizontal and vertical distance, Hips Displacement for jumping, Height of palm, distance of take-off from basketball).

Nathial Mandeep Singh (2014) <sup>[8]</sup> conducted a study entitled, "Analysis of set shot in basketball in relation with time to perform the course and displacement of center of gravity". The purpose of the study was to analysis of the technique of set shot while attempting free throws with the performance, in relation with time to perform the course and displacement of center of gravity. Sixty National level male basketball players of three different height groups were selected as the subjects. The data was obtained from two given positions (i) Moment of stance in set shot and (ii) Moment of release of ball in set shot. Total ten attempts were given and the successful shots marked as score out of ten as criterion measure of performance. It was found that there is significant relationship between the time to perform the course and the performance in set shot of different height group players in basketball and there is no significant relationship found between the displacement of center of gravity and the performance of set shot of different height group players in basketball and therefore, the selected variable puts no impact on the performance of set shot. Further it was concluded that displacement of center of gravity was significantly different in first group from the other two groups.

Khan Nazia (2015) <sup>[7]</sup> conducted a study entitled, "Relationship of Selected Kinematical Variables with the Performance of Female Basketball Players in Lay- Up Shot". The purpose of this study was to measure the relationship of selected kinematical variable to the performance in lay-up shot. The study was delimited to female basketball players of C.S.J.M. University, Kanpur. The study was further delimited to the 10 subject belonging to the age group 17 to 28 years. The subjects were only right handed shooters. The scores of the subjects in Lay-up shot were used as the criterion variable in the study. The performances of the subjects were assessed by three judges however elements related to the accuracy of shooting were also added. Used in three point scale. Three point awarded in correct action and basket scored. Two points awarded in correct action but not scored. One point awarded in touches the ring or board. Siliconcoach pro 7 software was used for kinematical analysis of Lay-up shot in basketball. A Casio Exilim F-1 High Speed Camera, which was positioned at 7.90m from the subject at an height of 1.50m. from the subject on an extension of free throw line. Camera was also set for capturing 300 fps. The subjects were made to take three Shots only. The angular kinematical variables of the body were calculated at moment execution. The videos as obtained by the use of digital videography were analyzed (the best trial) by siliconcoach pro 7 software. Only one selected frame was analyzed. Selected variables were as under. Were represented by the angles at selected joints as Ankle joint, Knee joint, Hip joint, Shoulder joint, elbow joint, Wrist joint and Body inclination. Other variables were height of release, last stride, arm span and Standing Height of Player. In case of Ankle joint (right), shoulder joint (right), Elbow joint (right) Wrist joint (right) and Hip joint (right) showed insignificant, but Elbow joint are very closed to the significant and incase of knee joint (right), showed significant relationship with the performance of subjects in Lay- up shot. Since the researcher has calculated the relationship individually. This might be

done that the angle of right knee joint was more accurate or perfect rather than the other joints of the body. It becomes significant because the player use to jump to the maximum height at moment execution because lay-up shot depends upon the jump of the player and height of the player, plays a very important role in jump The performance of lay up also depends upon the muscular strength of an individual. The explosive strenght is the factor that can determine as the major cause which increases the performance capacity of the player. It is also very helpful for a player to reach his / her maximum height. It is also found that the other factors can also influence the performance in lay up shot like, motivation level, their previous learned skill, their used technique, the environmental condition, physiological and psycholgocal condition. This may be attributed to the fact that the angles at different joints mentioned in this study such as Knee joint, Ankle joint, Hip joint, Shoulder joint, Elbow joint, Wrist joint change from one individual to another according to his Anthropometric measurement. i.e. his height, leg length, arm length.

The accurate Lay- up shot depends upon the physical fitness of the player, velocity of the ball, take off and height of release. For the accuracy converting into the basket, releasing of ball is also determine.

Ranjith P. and Dr. Rajini Kumar P. (2014) <sup>[6]</sup> conducted a study entitled, "Biomechanical Analysis of Set Shot in Basketball". The aim of this study was to analyse the selected biomechanical factors of set shot in basketball. Twenty one men Basketball players represented university were purposively selected from Tamil Nadu state, India for this study, the age of the subjects ranged from 18 to 28 years. The subjects had past playing experience of at least four years in basketball. Written informed consent was obtained from players. To acquire biomechanical data the high definition camera (Sony 10) was used to record the performances. Video footage was digitized using Kinovea software for data analysis of speed of release, relative height, angle of release, apex of the ball and accuracy. Descriptive statistics and pearson's correlation coefficients were applied to establish the relationships among the variables measured. Data were analyzed using SPSS (Statistical Package for Social Science) version 15.0. The level of significance was fixed at 0.05. The finding reveals that the accuracy has significant relationship with speed of release, relative height and angle of release. Among the selected variables accuracy and speed of release having highest relationship.

Struzik Artur, Pietraszewski Bogdan, Zawadzki Jerzy (2014) <sup>[5]</sup> conducted a study entitled, "Biomechanical Analysis of the Jump Shot in Basketball". The aim of this study was to compare the biomechanical characteristics of the lower limbs during a jump shot without the ball and a countermovement jump without an arm swing. The differences between variables provide information about the potential that an athlete can utilize during a game when performing a jump shot. The study was conducted among 20 second-league basketball players. The variables measured included the take-off time, mean power, peak power, relative mean power, jump height, maximum landing force and calculated impact ratio. Surprisingly, more advantageous variables were found for the jump shot. This finding suggests a very high performance level in the jump shot in the studied group and a maximum utilization of their motor abilities. Both types of jumps were characterized by high mean and peak power values and average heights. The high forces at landing, which result in considerable impact ratios, may have prompted the

studied group to land softly. Use of the countermovement jump without an arm swing is recommended to assess and predict the progression of player's jumping ability.

### Conclusions

After analyzing the scientific research papers which were conducted on basketball shooting skills specially on the lay-up shoot, the following conclusions may be drawn- 1. The accurate Lay-up shot depends upon the physical fitness of the player, velocity of the ball, take off and height of release. 2. Performance of right contra lateral lay-up is more significant than others. 3. The Dribble and Lay up Shot test in basketball was found to be best method among the various methods of lay-up shoots. 4. The length and speed of first and second step for older players higher for the older player than the youth. 5. There is significant relationship between the time to perform the course and the performance in set shot of different height group players in basketball. 6. There is significant relationship between approach speed, take off velocity, take off angle, height of ball release, angle of ball release in lay-up shoot. 7. The factors that can influence the performance in lay-up shot are like, duration of total flight, landing angle, motivation level, their previous learned skill, their used technique, the environmental condition, physiological and psychological condition. 8. The segmental joint angle at release such as Knee joint, Ankle joint, Hip joint, Shoulder joint, Elbow joint, Wrist joint change from one individual to another. 9. For the accuracy converting into the basket, releasing of ball is also determine. 10. The accuracy has significant relationship with speed of release, relative height and angle of release. Among the selected variables accuracy and speed of release having highest relationship. 11. The high forces at landing, which result in considerable impact ratios, have prompted the players to land softly. 12. The high forces at landing, which result in considerable impact ratios, have prompted the players to land softly.

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